

# Objects Specialty Group Postprints

Volume Eight

2001



American Institute for Conservation of  
Historic and Artistic Works

# Objects Specialty Group Postprints

## Volume Eight

2001

Compiled by Virginia Greene and Lisa Bruno

Proceedings of the Objects Specialty Group Session  
June 2, 2001  
29th Annual Meeting  
Dallas, Texas



## Table of Contents

Foreword .....	2
Renée Stein, Katherine Singley, Mimi Leveque, Alexandra Klingelhofer, and Ronald Harvey, “Restoration Revisited: Ancient and Modern Repairs Encountered in the Conservation of An Ancient Egyptian Collection” .....	3
Lori Trusheim, “Under Construction: The Installation of Large Scale Egyptian Reliefs at the Walters Art Gallery” .....	15
Patricia S. Griffin, “Helping the Mute Stones Sing: Achieving an Aesthetic Resolution” .....	29
Julie Wolfe and Eleonora Nagy, “Considerations for the Structural Stabilization of Deteriorated Industrial Rubber” .....	77
Mary Fahey and Clara Deck, “Responsibilities, Realities and Ranking: How a Collections Tiering Policy Aids Conservators in Ethical Decision Making and Judicious Resource Allocation at the Henry Ford Museum and Deerfield Village” .....	97
Leslie Williamson and Emily Kaplan, “The Role of Conservation in the Move of Collections of the Smithsonian National Museum of the American Indian” .....	106
Sara Caspi and Emily Kaplan, “Dilemmas in Transporting Unstable Ceramics: A Look at Cyclododecane” .....	116
Paula Artal-Isbrand, “Mosaic Conservation at the Worcester Art Museum” .....	136
Deborah Long, “ The Treatment of a 19 <sup>th</sup> Century Buckskin Jacket” .....	150
Beth Richwine, “Jerome Exposed: Treatment of a 19 <sup>th</sup> Century Anatomical Model” .....	155
From the Poster Session:	
Elizabeth Brown, “An Evaluation of Quillwork and Hair Stabilization Methods Used at the National Museum of the American Indian” .....	166
Lisa Anderson, Dominique Cocuzza, Susan Heald and Melinda McPeck, “Storage System for Archaeological Textile Fragments” .....	181

## Foreword

This is the eighth volume of *Postprints* published by the Objects Specialty Group (OSG). This includes most of the papers presented at the OSG Session, June 2, 2001 at the AIC meeting in Dallas, Texas. This volume will hopefully serve as a useful compendium of the papers presented for both those who attended that meeting and those who were unable to attend. The papers were minimally edited for format, punctuation, and English usage. This is not a peer reviewed publication, and readers will notice stylistic differences in the individual papers. Authors are encouraged to submit these papers to a peer-reviewed publication such as the *Journal of the American Institute for Conservation*. The authors retain all reproduction rights to their text and images.

The theme of this session is *Problem Solving: How Conservators Make Decisions When There Are No Easy Answers*. The papers covered a broad range of topics, but all managed to relate to each other. Four papers by Therese O’Gorman, Renee Stein, Lori Trusheim, and Pat Griffin all address how the deadlines associated with collections reinstallations can often present problems for conservators. Julie Wolfe and Nora Nagy address the problems associated with installing unstable modern materials, while Deborah Long speaks to the problems associated with exhibiting fragile organic materials. Three papers discuss planning for the travel of collections, whether it be traveling large fragile mosaics, as Paula Artal-Isbrand does in her paper, or moving whole collections to a new storage facility in another location as Leslie Williams, Emily Kaplan, and Sara Caspi do in their presentations. Finally, two papers discuss how conservators can accomplish projects when there is simply not enough time and resources. Mary Fahey, and Clara Deck discuss a collections care policy that guides conservation resources, while Beth Richwine describes decision making processes to successfully complete a treatment with a specific time and budget. Two presentations from the Poster Session have been expanded into papers and have been included in the volume of the *Postprints*.

On behalf of all of OSG, I want to give my sincere thanks to Virginia Greene for her commitment and dedication to producing these *Postprints* for all these years. I also want to offer a heartfelt thanks to all the speakers for their agreeing to share their thought processes in such an open and public forum. We all benefit from this kind of communication, and it will assist us all when we are faced with tough choices ourselves.

Lisa Bruno  
OSG Chair

## **RESTORATION REVISITED: ANCIENT AND MODERN REPAIRS ENCOUNTERED IN THE CONSERVATION OF AN ANCIENT EGYPTIAN COLLECTION**

Renée Stein, Katherine Singley, Mimi Leveque, Alexandra Klingelhofer, and Ronald Harvey

The acquisition of the Niagara Falls Museum collection of Ancient Egyptian objects launched a two-year conservation project which has involved the cooperative efforts of numerous museum staff, scholars, scientists, curators, and conservators. This paper is a reflection of that on-going collaboration.

Conservation of the mummies and coffins in preparation for their installation in the renovated galleries has provided an opportunity to consider the variety of repairs and restorations seen among the collection. Some of these restorations are clearly modern, probably dating to the nineteenth or early 20<sup>th</sup> centuries. Other modifications, however, appear to be ancient, indicating damage that was repaired, materials that were re-used, or constructions that were recycled for continued use in antiquity. Technology of construction, ancient alterations, modern repairs, and subsequent damage all had to be interpreted and reconciled with current treatment and aesthetic goals. The primary objective has been the stabilization and long-term preservation of the coffins and mummies. Visual compensation and integration are intended to aid the interpretation of these objects as part of a major permanent gallery installation.

A brief survey of these complex objects reveals a wide range of conditions and preservation issues. Many of the coffins were separated along joints in the pieced wood constructions, and one coffin was broken into numerous pieces. All of the wood and paint surfaces had layers of dust and grime. Several of the coffins appeared to have been near a fire, as evidenced by surface coatings that were embrittled from extreme heat and heavy soot that concealed the painted images. Direct contact with water, perhaps again in association with a fire, caused paint discoloration and staining from the migration of dirt and residues from the bodies. Water damage also caused lifting and distortion of painted linen and plaster layers, compromised the structural integrity of the wood, and promoted the efflorescence of salts. Extensive paint loss revealed the underlying wood and preparation layers, detracting from the legibility of both images and hieroglyphs. Abrasions, damages, flaking paint, and deteriorated surface coatings disfigured the carefully carved and painted faces (Fig. 1).

Many of the coffins were previously repaired, during their almost 150 years as part of the Niagara Falls Museum collection. Rusting iron nails and screws were added to repair or reinforce failing joints. New boards, held in place with nails, plaster and a densely woven cloth, were attached to the undersides of severely weakened coffins. Structural and surface losses were often filled with a hard grey or white compound that tested positive for lead. A similar lead-containing putty, resembling window caulking, was applied to the rims of several coffin bases to secure contoured glass, making the coffins into vitrines for the mummies inside. Modern dowels were added, mimicking the ancient joining technique and often attempting to disguise the new additions with a layer of simulated “mud”. New pieces of wood were often inserted to plug losses or reinforce the ancient constructions. These small, oddly shaped additions are usually

roughly contoured to the loss and only sometimes toned to match surrounding surfaces, thus leaving them readily visible.

These modern repairs sometimes accompanied extensive restorations. A set of inner and outer coffins were a nested pair built and decorated around 700 BCE for the female mummy of Iawttayesheret, who had been a servant to the Divine Adoratrice or Highest Priestess of Amun at Thebes during Nubian domination. The nesting coffins were constructed from numerous planks of an unidentified hardwood joined with wood pegs. The tenons that join the lid to the base are still in good condition and have been drilled to receive a dowel securing the two halves together. The wood of the outer coffin is left partly exposed, while the inner coffin is completely painted on both interior and exterior. In damaged areas along structural joints of the inner coffin, it is possible to see a dark-resinous pitch-like material directly on the wood substrate. Coarse fibers are often interspersed in the dark resin. This resin appears to have been used as an adhesive along joints and as a preliminary coating. The decorative paint lies on a white preparation that is layered with linen, visible through shallow losses and in cross-section samples viewed under magnification.

When the inner and outer coffins arrived at the Carlos Museum, both faces had disturbing, oversized yellow eyes made from plaster. These eyes were certainly not ancient and were probably added to the coffins in the 19<sup>th</sup> or early 20<sup>th</sup> century. In antiquity, the faces would have been inset with eyes formed from bronze, stone, shell, or glass. Inlaid eyes were easily removed from the coffins for reuse of materials or for separate sale. The large plaster eyes, surrounding fabric, and overpaint on the nested coffins were removed during recent conservation to reveal carefully carved cavities which would have received the inlaid eyes. A black line that served to outline the shapes for carving is preserved on the wood of the eye cavities (Fig. 2). During treatment, exposed wood was covered with layers of Japanese tissue, and the final layers were toned to match the surrounding painted surfaces. New eyes and eyebrows modeled after ancient examples of bronze and stone inlays were then fabricated from Milliput epoxy putty. The epoxy was molded into the carved cavity over a barrier layer. Once cured, the epoxy putty was painted to simulate bronze. Toned paper was used to re-create the stone eyeballs and pupils. The replacement eyes were then adhered in place with Acryloid B-72.

Not all repairs and restorations seen on the coffins are, however, modern additions. The small wedges and rectangles of wood seen among the long planks of the 25<sup>th</sup> dynasty outer coffin were installed in antiquity (see Figure 3). The notches and plugs serve no structural or joinery purpose in the construction of the coffin. These boards were probably originally cut for some other ancient object, perhaps an article of furniture or a boat. Good timber was valuable, relatively scarce and often imported into Ancient Egypt. Previously cut boards were recycled to build this coffin, and the voids were filled with small pieces of wood held in place with wooden pegs and mud. The damage seen on the foot board of a 21<sup>st</sup> dynasty coffin may provide evidence of another example of ancient re-use. The square board at the end of the coffin is pierced near its center with numerous holes, approximately 0.5cm in diameter. Damage from wood-boring insects or worms is evident in only one other board in the coffin construction, and the body

within the coffin showed little sign of insect activity. It, therefore, seems that this localized damage may have occurred to the board prior to the coffin's construction.

Sometimes entire coffins seem to have been re-used in antiquity, presumably discarding the original occupant and perhaps modifying the coffin for burial of another deceased. Evidence from two coffins in the Carlos Museum collection suggests their probable re-use in antiquity. Careful examination of a 21<sup>st</sup> dynasty coffin lid reveals that the painted areas around the hands have been modified. The open hands indicative of a female, or closed hands representing a male, on 21<sup>st</sup> dynasty coffin lids are carved separately and peg-joined to the coffin before decoration. If a coffin were to be reused for a deceased of a different gender, the hands could be removed and replaced with relative ease. The painted areas surrounding the hands on one coffin lid are unvarnished and lack the glossy finish of the surrounding surfaces. The painted pattern of the broad collar has been replicated, but the shapes are clumsy and the strokes are much less refined. Filling and repainting of isolated damage using materials apparently similar to the original is not typical of the modern repairs seen throughout the collection. After discussing this repair with curators at the Carlos Museum and with visiting researcher John Taylor, it was concluded that this repair to the hands is likely to be ancient. Of course, raised additions to the coffins are also likely sites for damage, but there would be little opportunity to notice and repair such damage in antiquity unless the coffin were removed from its tomb, probably to be re-used for another burial.

The ancient re-use of a second coffin became apparent during the conservation treatment of another 21<sup>st</sup> dynasty example. The coffin is typical of the construction and decorative style common around Thebes (modern Luxor) during the period dating approximately 1075 to 945 B.C.E. The boards are cut from local hardwood, probably sycamore fig, which was cultivated in Ancient Egypt for its fruit and timber. Long contoured side-boards are secured with wooden dowels to the base board. A curved board is attached at the head and a single square board at the foot. A recessed channel is carved in the rim to receive the lid. Deep sockets held tenons that secured the lid to the base. The wood surfaces are covered with a mud layer of varying thickness, sometimes followed by a white preparation layer. The mud layer covered joints in the wood construction and provided a uniform surface in preparation for painting. A thin layer of yellow paint served as the background for the decorative painting. Scenes and text panels were outlined in red or black paint, and the details were painted in progression - red, blue, green, and then black (Fig. 4). Whether this ordered application was to allow paint to dry or if each color represents the work of an individual artisan is unclear. Many coffins were then coated or "varnished".

Examination of the exterior of the coffin revealed curious areas where the hieroglyphs were over-painted in yellow, and in one area additional hieroglyphs were painted over the yellow (Fig. 5). Assisted by visiting Egyptologist Joyce Haynes, curators at the Carlos were able to decipher the hieroglyphs. They discovered that the original occupant of the coffin was a woman named "Tanakhtanettahat", and that she had served as a chantress in the Temple of Amun at Thebes. When the coffin was re-used in antiquity, the name of Tanakhtanettahat was obscured



with yellow over-paint and the name “Ta’aset”, was added to identify the second occupant of this coffin. Similar overpaint conceals the name of the original occupant where it appeared on the lid of the coffin. The interior of this 21<sup>st</sup> dynasty coffin is also painted, and many of the images on the interior side-walls are overpainted with a matte red paint. In some instances the re-paint carefully outlines existing images, leaving them visible in the field of red. Other figures were completely over-painted and can be seen only as shadows under the red paint. On the bottom of the coffin, linen from the first mummy was overpainted in the second campaign and linen from a second mummified occupant is adhered to the topmost paint layers. A large crack and surrounding paint loss extended across the ankle region of the re-used coffin lid. Inspection of the painted surface at the ankles and lower legs revealed a confusion of layers (Fig. 6). Portions of the decorative surface appear to have been repainted. Similar to the repaired hands on a coffin lid discussed earlier, isolated areas are unvarnished, the designs are more crudely rendered, and the colors are limited to red and blue on yellow. In contrast, the surrounding surfaces are delicately painted with green and black as well as red and blue, followed by a thick coat of varnish. Looking at the underside of the lid helped to clarify the confusion of the painted surface. Ancient damage had left the central board of the lid pierced with multiple complex fractures. The cause of this damage is unclear, but it appears that a heavy object probably struck the lid from above. This disfiguring damage would have necessitated localized repair and repainting of the exterior prior to re-use of the coffin for its second occupant. The damaged area was patched with mud to create a more uniform surface for re-painting. The mud was layered with a white preparation and painted yellow. The registers of designs and images seen in the first decorative campaign were continued and repeated in the new painting, although with less refinement and a more limited palette. The layering, the pigments and the decorative motifs of the ancient repair are, therefore, similar to the original painting technique. During the recent conservation, the flaking layers of mud and repaint were stabilized. In some areas, the mud and repaint were reduced to reveal the more delicately painted images below and to minimize the visual confusion of the surface. Through conservation treatment, this ancient repair has been documented and preserved. The richly painted decorative surface with its ordered registers of designs and images has also been made more legible. The upper and lower halves of the coffin lid are now better integrated, allowing the high quality of the painting to be appreciated.

Ancient re-use of this coffin helps to explain the presence of a poorly mummified body in such a finely painted coffin. X-radiography, CT-imaging, and endoscopy have provided evidence of the body’s incomplete mummification, revealing that most of the internal organs were left within the body, counter to normal mummification in which only the heart would remain. The shrunken brain is clearly visible in a CT image of the skull (Fig. 7). The flesh is poorly preserved and brittle. Incomplete mummification could promote deterioration due to insect infestation. Examination of another mummy in the collection revealed pupal cases of the blow fly that probably infested the body soon after death. The blow flies, along with dermestid beetles, managed to survive and multiply for some time within the wrappings. Apart from these unusual cases, the poor state of preservation of most of the mummies was generally due to their having been partially or completely unwrapped either in antiquity or in the 19<sup>th</sup> century. The

unwrapping of mummies by tomb robbers looking for jewelry or amulets began in antiquity and continued into modern times. Once brought to the West, mummies were not immune from indignities: the Victorians were known to unwrap mummies as a morbid parlor game. It is evident that some of the Niagara mummies had been opened in antiquity, since both wrappings and bodies had been equally exposed to incursions of mud and soil. In some cases, however, it is clear that the unwrapping was more recent and done purely for voyeuristic purposes. Subsequent damage to the unwrapped mummies has been largely due to their long-term exposure to dust, light, heat - including a fire in some cases - and excessive moisture, probably in the attempt to put out the fire. The result to both bodies and textiles has been extreme soiling, discoloration, embrittlement, and the development of mold.

The examination and treatment of these mummies has been governed by respect for them as individuals and for the culture that produced them. While treatment of human remains is not acceptable in some cultures, for the ancient Egyptians, assurance of an afterlife was conditional upon remembering the person, repeating their name, and preserving the body. The separation of mummies and coffins is known to have occurred prior to sale in 19<sup>th</sup>-century Egypt, and bodies were shuffled among coffins at the Niagara Falls Museum. Recent work with the mummies has re-associated some bodies with their appropriate coffins, enabling their names to be read and then used in all written and verbal references to the body.

Using minimally invasive techniques of examination and stabilization we have had the opportunity to learn about these individuals and about mummification practices. The linens were gently dusted, layer by layer, into a HEPA filter vacuum and re-configured. After cleaning, the linens were rearranged, occasionally with added stitches. Some of the most damaged mummies required encapsulation in Stabiltex, a sheer polyester fabric that secures the delicate textiles while permitting details of the wrappings to remain visible. Figure 8 shows the mummy of a male priest prior to conservation, and Figure 9 illustrates the same mummy on the right after stabilization and encapsulation. After conservation, the mummies were placed on contoured boards to provide support and facilitate handling. These boards were cut from birch or MDO plywood, wrapped with Marvelseal, padded with polyethylene batting, and covered with pre-washed linen. Small feet cut from Ethafoam and hot glued to the bottom allow the mummy to be safely lifted without tilting. Once conserved, the mummies will be returned to their coffins.

Conservation of the mummies offered an opportunity to examine and document the variety of textiles used as wrappings, recording weave patterns and the use of colored threads. The wrapping technique of each layer was noted, including any interesting features such as delicate fringe or an unusual braid used to add height in compensation for damage to the feet. Ancient stitching and seams, as well as evidence of ancient wear and repair attest to the fact that these textiles had served other uses prior to becoming part of the mummy wrappings. One wadded textile found among the wrappings of a male mummy proved to be part of a shirt. Another tangled length may have once been a shawl or belt. A textile removed from near the head of another mummy bears an inscription that may offer further clues to the identity of the body.

Conservation of the coffins has provided the opportunity to document construction as well as the materials used in decoration. Samples of wood, preparation layers, pigments, and coatings were routinely removed for analysis. When pertinent to the treatment, samples were sent out for immediate identification. Further analysis and interpretation will continue in the future. One research area of particular interest is the variety of surface coatings seen among the collection. These coatings are often unevenly applied, varying in color, thickness, and coverage. These surface coatings generally fluoresce under ultraviolet light. Samples of coatings have been analyzed via FTIR and GC-MS. The coatings often contain a conifer resin, such as pine. The conifer resin may also be mixed with a *Pistacea* resin, the species from which mastic is produced. Conifer and *Pistacea* resins are known to have been used in ancient Egypt. Non-drying fat, head-bodied drying oil, and beeswax were also identified in samples of coating layers. In some examples it remains unclear whether the additional fat, oil, or wax components are mixed into the natural resin layer or if they comprise a separate, discrete layer. Some cross-sections reveal multiple coatings, while other samples appear to contain only a single layer. It is certain that many of the coffins have been restored and repaired in the past. The fat, oil, or wax could have been applied in a previous effort to re-saturate or consolidate the painted surfaces. These components could, however, be ancient. The surface of one 22nd-dynasty coffin is covered with an undecorated black layer of unquestioned antiquity. This layer was identified as animal fat. The surface of another coffin is varnished with natural-resin, but also shows isolated drips and patches of a darkened coating that was found to contain a head-bodied drying oil, possibly linseed oil. It has been suggested that this oil might have been applied in antiquity as a libation. The ancient Egyptians associated magical properties with wax and used it as an adhesive as well as to form ritual objects. The composition and antiquity of the various surface coatings certainly warrant continued investigation. Future research projects involving the Carlos Collection will hope to further investigate the coatings, construction methods, and intended appearances of the coffins.

## Acknowledgements

Numerous individuals contributed their interest and expertise to the on-going project of examining, documenting, and conserving the mummies and coffins in the Carlos Museum collection. This work was undertaken at the Parsons Conservation Laboratory of the Michael C. Carlos Museum, under the stewardship of Head Conservator Therese O’Gorman. Egyptologists Peter Lacovara, Curator of Ancient Egyptian & Ancient Near Eastern Art, and Betsy Teasley Trope, Assistant Curator for Permanent Collections, shared their knowledge and expertise. This project was further complemented by the collegueship of Bob Brier of Long Island University, John Taylor of the British Museum, and Joyce Haynes of the Museum of Fine Arts in Boston. X-rays and CT-images were interpreted with Heidi Hoffman of the Emory University Hospital. Cross section samples were prepared and examined by Philip Klausmeyer of Klausmeyer Conservation Studios and Susan Buck of Historic Paint and Architectural Services. Richard Newman and Michele Derrick performed FTIR and GC-MS analyses at the Museum of Fine Arts in Boston. Wood samples were identified by Regis Miller of the Center for Wood Anatomy

*Stein, et. al.*

Research and Kent Schneider of the U.S. Department of Agriculture. Visiting conservators, volunteers, and students assisted in the conservation treatments.

## **Materials**

### **Acryloid B-72**

Conservation Resources International, L.L.C., 8000-H Forbes Place, Springfield, VA, 22151, (800) 634-6932

### **Klucel G**

Talas, 568 Broadway, New York, NY 10012, (212) 219-0770

### **Marvelseal**

Bell Fibre Products, Bell Packaging Corp., P.O. Box 1158, Columbus, GA 31993, (706) 323-7316

### **Milliput**

Conservation Support Systems, P.O. Box 91746, Santa Barbara, CA 93190-1746, (800) 482-6299

### **Stabiltex**

Talas, 568 Broadway, New York, NY 10012, (212) 219-0770

## **Authors' Addresses**

Renée Stein, Michael C. Carlos Museum, Emory University, 571 South Kilgo St., Atlanta, GA 30322

Katherine Singley, Conservation Anthropologica, 1083 Oakdale Rd, NE, Atlanta, GA 30307

Mimi Leveque, ArchaeaTechnica Conservation, 83 Galen St., Waltham, MA 02451

Alexandra Klingelhofer, P.O. Box 2673, Macon, GA 31203

Ronald Harvey, Tuckerbrook Conservation, RD 2, Box 589D, Lincolnville, ME 04849



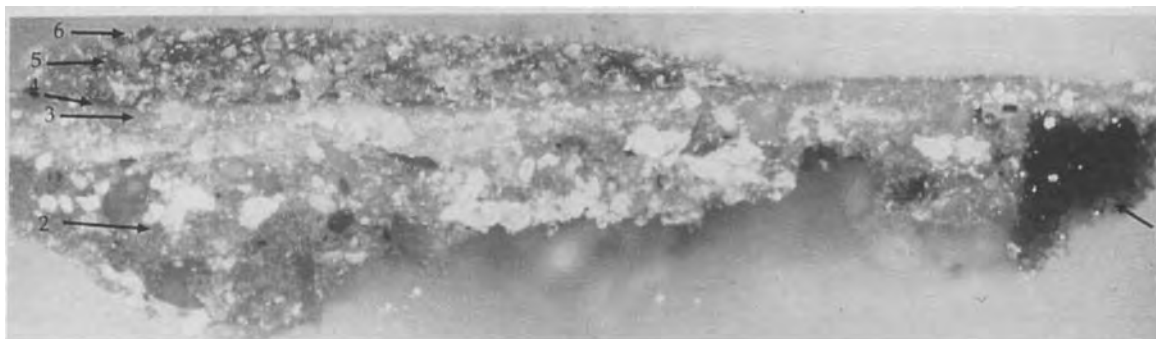
Figure 1. Detail of 21<sup>st</sup> Dynasty coffin showing typical conditions found among the recently acquired collection. Note separation along structural joints, old fills, flaking paint, and losses. Coffin of Tanakhtanettahat, 1075-945 B.C.E., 181cm, Charlotte Lichirie Collection of Egyptian Art, Michael C. Carlos Museum, 1999.1.17A.



Figure 2. Detail of the cavity carved into the wood of a 25<sup>th</sup> Dynasty coffin to receive the inlaid eye and eyebrow. Note the linen layer beneath the paint, especially visible above the eyebrow. Inner coffin lid of Iawttayeshet, 760-656 B.C.E., 171cm, Charlotte Lichirie Collection of Egyptian Art, Michael C. Carlos Museum, 1999.1.8D.



Figure 3. Detail of a 25<sup>th</sup> Dynasty outer coffin lid, showing small wedges and plugs of wood inserted to fill voids in recycled boards. Outer coffin lid of Iawttayesheret, 760-656 B.C.E., 191cm, Charlotte Lichirie Collection of Egyptian Art, Michael C. Carlos Museum, 1999.1.8B.



Photomicrograph of cross-section sample from painted surface of Egyptian Coffin Base, c. 950 BC, 10X objective used, Michael C. Carlos Museum, acc. no. 1999.1.134

- 1) fragment of wood substrate
- 2) mud surface preparation layer consisting of coarse particles and occasional plant fiber
- 3) yellow pigmented paint layer
- 4) very thinly applied wash of red pigmented paint
- 5) paint layer consisting of coarsely ground Egyptian blue pigment particles
- 6) thinly applied upper paint layer consisting of greenish brown pigment particles

Figure 4. Cross section of preparation and paint layers on a 21<sup>st</sup> Dynasty coffin. Prepared and examined by Philip Klausmeyer. Coffin of a Priestly Official, 1075-945 B.C.E., 187cm, Charlotte Lichirie Collection of Egyptian Art, Michael C. Carlos Museum, 1999.1.13A.

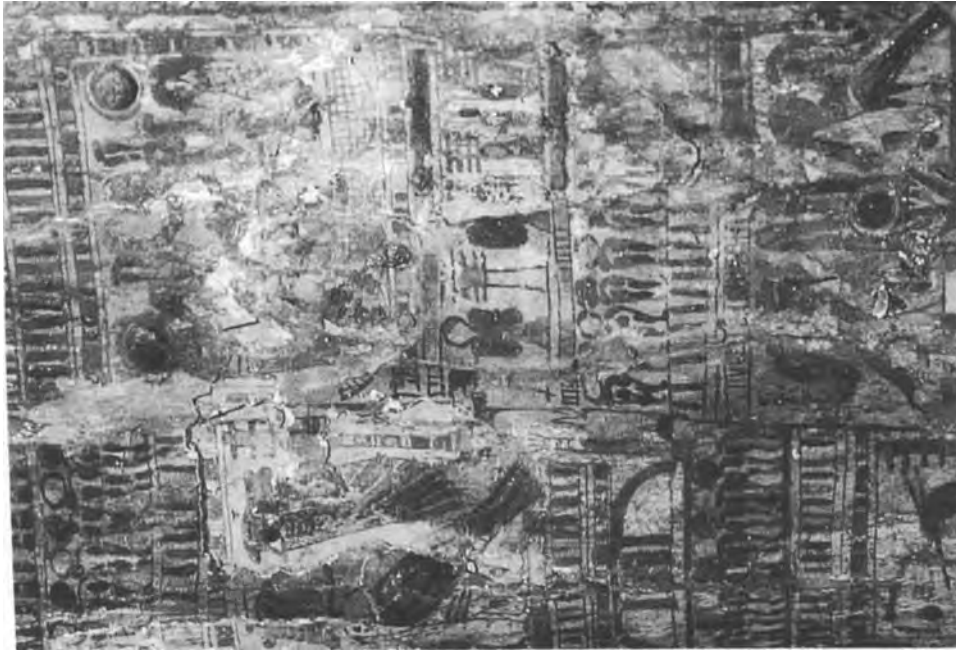


Figure 5. Detail of 21<sup>st</sup> Dynasty coffin showing ancient overpaint applied to repair and resurface the coffin prior to its reuse in antiquity. The winged eye toward the upper left of center is an element of the original painted decoration, visible within losses in the ancient overpaint. Coffin Lid of Tanakhtanettahat, 1075-945 B.C.E., 181cm, Charlotte Licherie Collection of Egyptian Art, Michael C. Carlos Museum, 1999.1.17C.



Figure 6. Detail of the hieroglyphs on the re-used 21<sup>st</sup> Dynasty coffin. The written name of the original occupant is overpainted with yellow paint in the right column. Coffin of Tanakhtanettahat, 1075-945 B.C.E., 181cm, Charlotte Licherie Collection of Egyptian Art, Michael C. Carlos Museum, 1999.1.17A.

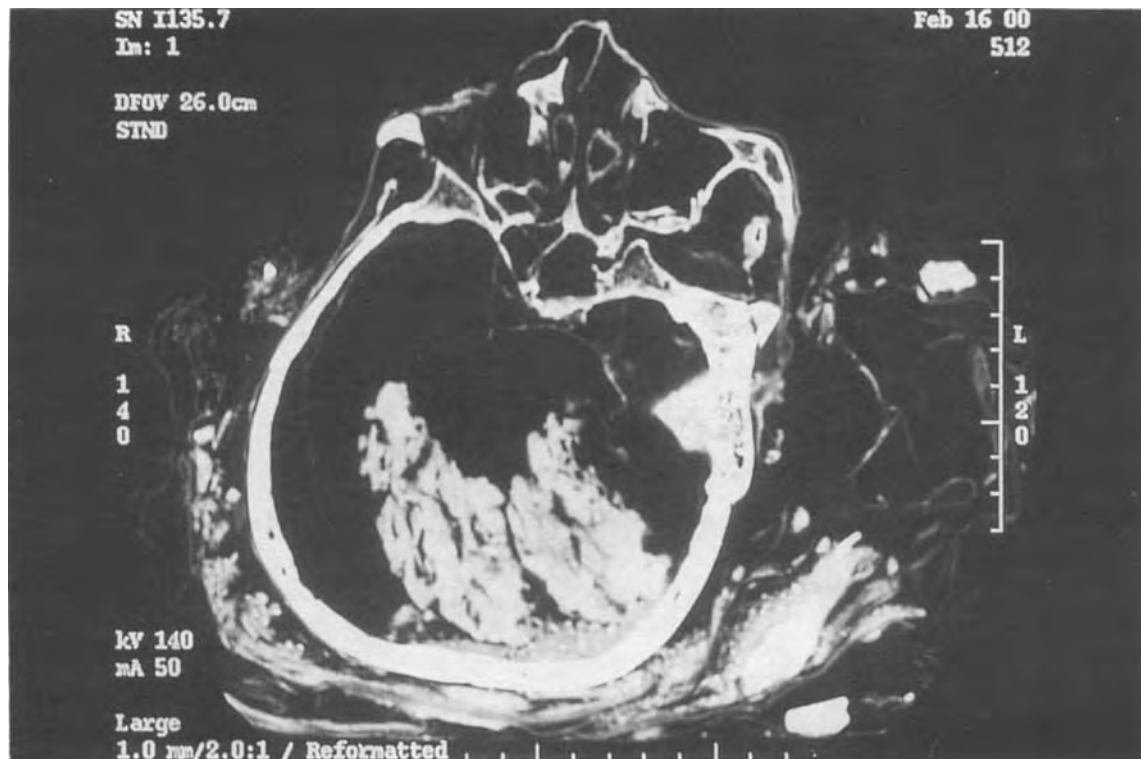


Figure 7. CT image of the skull in cross-section of a poorly mummified mummy, showing the shrunken brain in situ. Mummy of Ta'aset, date unsure, 145cm, Charlotte Lichirie Collection of Egyptian Art, Michael C. Carlos Museum, 1999.1.18.





Figure 8. Mummy before treatment showing partially unwrapped layers of linen. Mummy of a Priestly Official, 1075-945 B.C.E., 146cm, Charlotte Lichirie Collection of Egyptian Art, Michael C. Carlos Museum, 1999.1.14.

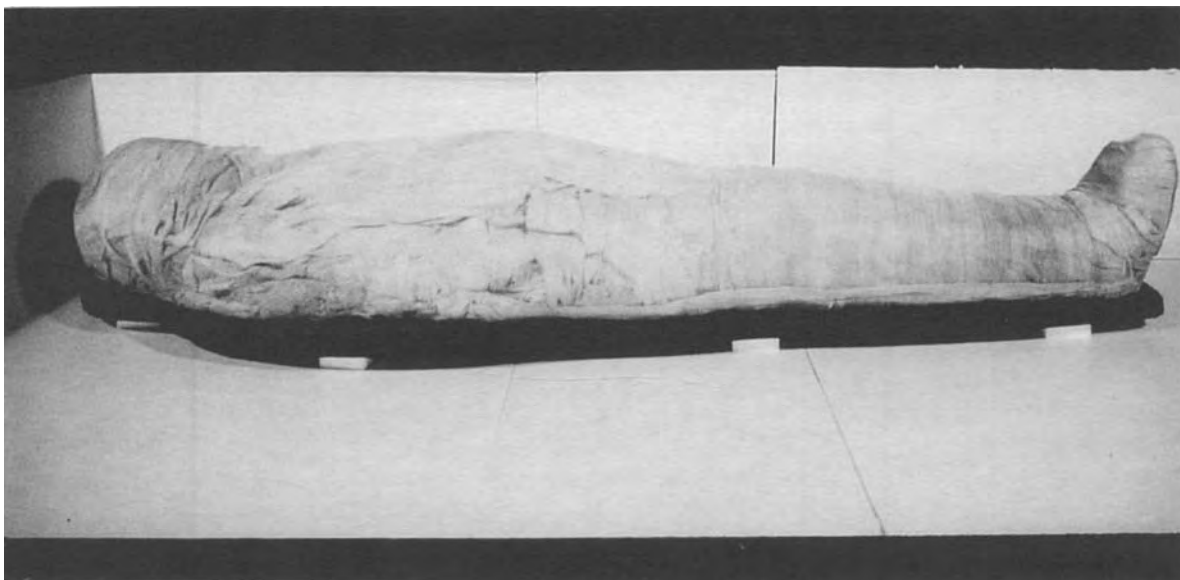


Figure 9. Mummy after treatment, enclosed in Stabiltex, and on padded support board. Mummy of a Priestly Official, 1075-945 B.C.E., 146cm, Charlotte Lichirie Collection of Egyptian Art, Michael C. Carlos Museum, 1999.1.14.

# **UNDER CONSTRUCTION: THE INSTALLATION OF LARGE SCALE EGYPTIAN RELIEFS AT THE WALTERS ART GALLERY**

Lori Trusheim

## **Introduction**

In 1998, the Walters Art Museum began a major renovation to one of its primary exhibition spaces, the Centre Street building. Constructed in 1974, this building consisted of three floors of gallery space that exhibited ancient through 19<sup>th</sup> century art, the conservation laboratories, curatorial offices, library, and an auditorium. The primary goal of the renovation was to upgrade the aging environmental systems in this section of the museum. As this work required major demolition, the museum took the opportunity to re-design the galleries, aiming to create more dynamic and informative exhibition spaces. The impact on staff was tremendous, not only due to the movement and storage of over 7,000 objects, but also because staff offices remained open on the upper floors while demolition proceeded on the floors directly below.

Part of the gallery de-installations included the removal of seven Egyptian granite architectural reliefs that were set into a gallery wall (Fig.1). These reliefs originated from two temple sites in northern Egypt, Behbeit and Sammanud, dating from the 4<sup>th</sup> century BC. The curators and designers planned to display four of the reliefs in a temple gateway reconstruction. Although the reliefs originated from two different temple sites, it was decided to display the reliefs together for educational purposes, since both temples originated under the rule of Nectanebo II (30<sup>th</sup> dynasty pharaoh) and had stylistically similar carving.

This paper will describe the challenges faced by conservators beginning with the relief de-installation from the gallery wall, followed by their conservation treatment, and concluding with their mounting and reinstallation in the renovated galleries.

## **De-installation**

The initial problem was twofold: to determine how these reliefs were mounted in the wall and to determine how they could be safely removed. During the installation in 1974, staff members were told that the blocks were supported only by a steel frame and that the reliefs could be pulled out of the wall, once a perimeter of decorative stucco was removed. From the initial 1998 examination, all that could be seen was that the stones protruded from the wall surface by ½ - 1", however, there was little information regarding the thickness of each relief. In looking for actual records of the installation, a single blueprint was found in the museum records documenting that the non-load bearing wall in which the reliefs were mounted was built of cinder blocks filled with concrete. It also noted that stainless steel straps were used to anchor the thin reliefs, but there was no mention of a steel frame used to mount the reliefs.

Because of the discrepancy between what staff were told in 1974 vs. what the blueprint showed,

it was even more critical to investigate how the reliefs were installed in the wall. Therefore, investigations were carried out by mechanically removing cement along the relief perimeter. Preliminary tests did not reveal any straps, and cement was consistently found in direct contact with the stone. It became apparent that no matter what method of extraction was used, cement would need to be mechanically removed from the perimeter of each stone edge to create a safety zone around each relief. Before cement removal was carried out, the relief edges were isolated using a barrier coat of 10% Paraloid B-72 in acetone (w/v) and then protected with 1/8" closed-cell polyethylene foam that was taped to the sealed stone edges. With invaluable help from volunteers and interns, cement was removed by hand, using stone-working chisels for better control. [1] Eventually, a few metal clips were found on the edges of some of the thinner stones, but these clips were just floating in the cement and were not anchored to any type of sub-structure. Excavating around the edges revealed that four reliefs were 1-3" thick, but the remaining three reliefs were greater than 3" thick. It became clear that the stones were physically locked into the walls by cement. This answered how the reliefs were installed – they were incorporated into the wall, like another cinder block, as the wall was being constructed. Unfortunately, the previous installation was built for permanence, not reversibility.

The next problem was how to safely remove the reliefs from the wall. Two methods were discussed: either the reliefs could be extracted or the entire wall could be taken down around the reliefs. During this early stage of the project it was essential to find colleagues with relevant experience. [2] The head mason at the National Cathedral in Washington, D.C. was consulted and helped identify a local stone working company that was willing to alter its standard operating methods to suit the needs of the project. [3] This company would also provide rigging of the reliefs, so that a third party contractor would not be necessary. This was a great advantage that streamlined the communication between conservators and masons. The weight of the cinder block wall above the reliefs combined with the configuration of the reliefs in the wall led to the decision to dismantle the wall around the objects, deinstalling the reliefs from the top down.

Before demolition, the stone surfaces were covered with protective packages of a 1/8" polyethylene foam directly next to the stone, followed by Esterfoam (ester-type polyurethane, 2 lb./cu.ft.), Ethafoam (polyethylene, 2.2 lb./cu.ft.) and finally Masonite (Fig.2). These protective packages were taped to the sealed stone edges and strapped to the surrounding cinder block wall. A padded Masonite shelf was secured on the top edges to protect them from any falling debris. After four months of preparation, the wall was ready to be demolished.

Stonemasons used a combination of a diamond-blade saw and an electric-operated chisel, called a Hummingbird chipper, to fracture the mortar joints in between the cinder-blocks. Once the cement joins were disturbed, the cinder blocks were wiggled free and so the wall was dismantled, block by block (Fig. 3). The amount of vibration from electric tools was kept to the minimum possible to dislodge the cinder blocks. Despite sealing entrances and air ducts to and from the gallery, and keeping dry cutting with saws to a minimum, the amount of dust created was excessive and a factor that should be calculated into any similar projects.

The following procedure was used to remove all reliefs. Holes were drilled below the object to allow cotton slings to be strapped vertically around the stone. As the slings were connected to a chain hoist, the weight of the stone was transferred to a steel beam that was fastened to the top rails of the scaffolding. As the cinder blocks were removed around the objects, the reliefs were supported from the scaffolding and could eventually be hoisted down onto a wooden pallet (Fig. 3).

After months of preparations, the seven reliefs were lifted out of the walls in only five days. Following dust producing, labor intensive cement removal from back and sides using hand tools, the stones were moved into a closed gallery space, ready for conservation treatment.

### **Conservation Treatment**

The primary aspects of conservation treatment involved: surface cleaning, fill removal, loss compensation and structural joining. Significant amounts of dirt and grime obscured the stone surfaces as well as a variety of old coatings. Close inspection identified coatings on both finished and damaged surfaces, indicating that the coatings were not original. Further evidence regarding the coating on one relief was found in an archival photo where a dealer's wooden frame surrounded the stone perimeter. With the dealer's frame now removed, a distinct border between the uncoated surface, protected by the frame and an inner dark coated surface could be seen along the top edge. Test cleanings confirmed that this distinct, non-original coating could be removed, in addition to surface dirt and grime. This particular relief was cleaned with an ammoniated water solution (pH 9), followed by a 1:1 mixture of ethanol: acetone (Fig. 4). Most of the remaining reliefs were cleaned with either distilled water or the ammoniated water solution. Dry cleaning tests were done using vinyl erasers in a mechanical pencil, but these proved ineffective at cleaning the textured surfaces of the stone.

Three reliefs contained old, discolored fills that visually obscured the surface. These painted plaster fills extended beyond the area of loss and over original surface. All of the old fill material was mechanically removed. The largest corner block had a pink and brown toned plaster fill in a horizontal band across the mid-section (Fig. 5). When this fill was removed, it was surprising to find a line of regular rectangular losses (2 ½" deep). These deep gouges were quarrying marks, most likely evidence for the re-use during Roman times of the valuable red granite from the collapsed temple site (Fig. 6). Leaving the quarrying marks unfilled would have provided a good example of historical evidence for the re-use of materials, yet due to the visual distraction to the carving and the installation setting, the decision was made to photograph the quarry marks and fill the losses with a reversible material. This decision was made jointly with the curator. An isolating layer of Paraloid B-72 was applied between the stone and fill material. The deep losses were filled with plaster of Paris and a top coat of Polyfilla, a commercial spackle compound. Shallow losses were filled with Polyfilla tinted with dry pigments. Fills were left slightly recessed and inpainted with Golden Fluid Acrylic Colors (Figs. 7, 8).

The last conservation treatment issue involved structural joins on the largest corner block. The main structural problem was the failure of an old vertical join. This damage was observed prior to its deinstallation and each subsequent move caused the gap to widen. Two rods and a cement-like material on both sides of the break edge could be seen in the join. An additional fragment from the upper left corner of the same block was removed in 1951 for unknown reasons and needed to be reattached.

Prior to treatment, the corner block was lifted by gantry and placed onto a steel, L-shaped plate (Fig. 9). As part of the final mounting system, the steel plate was designed to accommodate movement by forklift. While the weight and shape of the corner block made it stable sitting on this plate, braces were attached from behind to further stabilize the block during treatment and movement (Fig. 10). The primary vertical join was treated first. Working with the museum's art handlers, the join was pulled apart by slightly lifting the smaller portion with a j-bar and sliding Teflon strips below the stone. Once friction was reduced by the Teflon strips, the stone fragments were pulled apart. The rods across the join were examined and found to be in stable condition and slated for re-use. Both broken edges were cleaned by mechanically removing the cement-like adhesive. While the alignment was significantly improved, there was still a 1/4" gap across the join that could not be closed. After much consideration, it was decided to use a two-part epoxy to securely reattach the fragments into a single unit. The join was made as reversible as possible by coating the entire break edge and dowels with 30% Paraloid B-72 in acetone (w/v). The fragment was slipped into the closest possible alignment. Then, Araldite 2013 epoxy was injected into the join at a few, easily accessible spot locations. This epoxy system was chosen after discussion with the company's technical representative. It met the following criteria:

- it had the appropriate gap-filling properties
- the viscosity was spreadable without flowing on a vertical surface
- it gave off little heat when setting
- the working time was 1-2 hours
- it had an easy and controlled application (two-part epoxy sold in dual cartridge which can be placed into a dispensing gun, epoxy injected into mixing tube that ends in a fine tip applicator).

The second structural join, the attachment of the small corner fragment was done using the same method. The fragment and corresponding break edge had one dowel hole, which was re-used. The Araldite epoxy was used in spot locations to tack the fragment in place, instead of drilling for a second dowel. Final conservation included filling and inpainting the losses along the join.

## **Reinstallation**

The final phase of this project was the reinstallation of the conserved granite reliefs. A gateway structure to support the reliefs was designed by a structural engineer, under consultation with

conservator, designer and installer. The mounting provided a challenge as the design required an “invisible” mounting system, yet the conservators did not want to drill any new holes in the stone to mount the reliefs. A solution was developed working with Sanders Museum Services [4]. The mounting approaches had to be flexible in order to adapt to the wide range of sizes from the thin, flat relief above the doorway to the massive corner blocks on either side of the entrance. The mounts were designed to meet the individual needs of each relief and to safely and efficiently fit into the steel framework of the reconstructed temple gateway.

Sanders Museum Services provided consultation, design, manufacture of the mounts and the rigging to install the objects into the gateway structure. A basic procedure for installation was to secure the object into the mount and to raise the object by forklift into the gateway (Fig. 11). Once positioned, the mount was bolted to the steel framework. Basically, the gateway structure held the mount and the mount held the object; gravity is the primary action holding the thick corner blocks in place. Braces then were added to mechanically lock the objects in place for added security (Fig. 12).

The relief fragment above the gateway posed different challenges because of its long yet thin size. It measures 2 ¾” thick, but is 60” wide with the reverse surface sawed flat. Unlike the massive corner blocks, this relief was essentially too long and thin to support its own weight, even though it is granite. This relief has a repaired break, which runs horizontally across the upper section. It therefore required an auxiliary support. A steel frame was made with a shelf on the bottom to support the relief and an aluminum grid on the back to spread out the weight and give the object support during installation. Padded, steel clips were used to secure the object in the mount. As before, after positioning the relief, the mount was bolted to the framework in the gateway.

The exhibitions department coordinated the final cosmetic work to conceal the steel structure and mounting hardware. Carpenters began finishing work around the objects, and at all times the relief surfaces were protected with polyethylene foam. Conservators supervised the final finishing whenever the contractors were in close proximity to the artwork. The designer chose a textured, neutral background color so that the red or gray granite reliefs remained distinct from the gateway (Fig. 13).

## **Conclusions**

As the Walters’ renovation spanned over three years, the important common threads to this project were planning, flexibility and co-ordination. In the Egyptian relief deinstallation phase, investigations produced information, which in turn formed a decision on how to proceed. The actual conservation treatment was a very time consuming part of this project, but every detail could not be included in the scope of this paper. An overview of the general approaches was given and it should be noted that the treatment decisions, especially related to loss compensation, were made in regards to the reliefs context within a fine arts museum. The main principle

guiding the relief reinstallation was a non-invasive, reversible, mounting system. While other paths could have been followed throughout the course of this project, the choices made here resulted in the safe reinstallation of the Egyptian temple reliefs.

## **Acknowledgments**

A portion of this project was funded by the National Endowment for the Arts and the National Endowment for the Humanities and the author is grateful to these agencies for their generous contributions. The author would also like to thank Terry Drayman Weisser, Julie Lauffenburger, Meg Craft and Donna Strahan for their support and advice throughout the project.

## **Endnotes**

1. Lara Kaplan, Melanie Pereira, and Doug Woodworth were a great asset to this project and the author wishes to thank them for their endurance and patience.
2. The author is grateful to Ellen Pearlstein, Laura D'Allessandro, Arthur Beale and George Hagerty who generously shared their knowledge.
3. Joseph Alonso, Mason Foreman of the Washington National Cathedral referred us to Corinthian Stoneworks (Patrick Sanders, President), 4205 Knox Road, Suite B2, College Park, MD 20740-3131.
4. Sanders Museum Services (Bradley Sanders, Owner), Rt. 2, Box 794, Shepherdstown, W. Va., 25443.

## **Materials**

### **Araldite 2013**

Polymer Tooling Systems, 303 Commerce Drive, Exton, PA 19341, (610) 363-5440

### **Ethafoam and Esterfoam**

Advanced Packaging, 4818 Seton Drive, Baltimore, MD 21215, (410) 358-9444

### **Golden Fluid Acrylic Colors**

Golden Artist Colors, Inc., New Berlin, NY 13411, available at most art supply stores

### **Masonite**

available at most lumber yards

*Trusheim*

**Paraloid B-72**

Conservation Resources International, LLC., 8000-H Forbes Place, Springfield, Virginia 22151, (800) 634-6932

**French's Diamond Lab Plaster**

Samuel H. French & Co., 4446-50 Cresson St., Philadelphia, PA 19127, (215) 482-6770

**Polyethylene Foam (Nalgene)**

Fisher Scientific, (800)766-7000

**Polyfilla**

Polycell Products Ltd., ICI Decorative Products, Wexham Road, Slough. SL2 5DS UK 01753 550555, available at hardware stores in UK

**Author's Address**

Lori Trusheim, Walters Art Museum, 600 N. Charles St., Baltimore, MD 21201



Figure 1. View of Egyptian Gallery in Centre St. Building, prior to renovation. Seven granite architectural reliefs are set into the wall in the background.



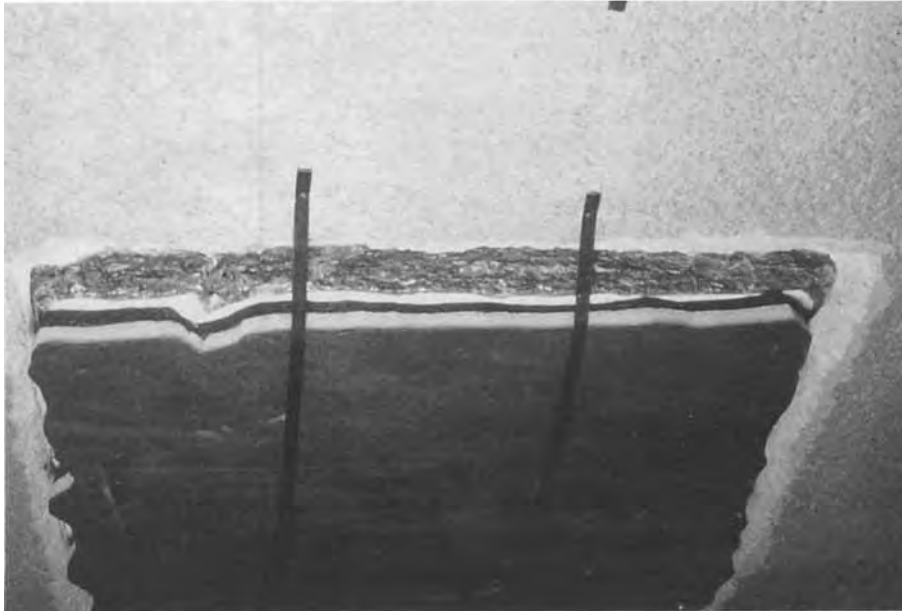


Figure 2. Side view of protective package covering the surface of the corner block (WAM 22.5). Cement mechanically removed from perimeter. Stone edge is isolated with Paraloid B-72. Relief protected with polyethylene foam next to the stone surface, followed by grey Esterfoam, white Ethafoam and a final outer layer of Masonite. The entire package is taped and strapped to the surrounding wall (straps not in contact with edge of stone).

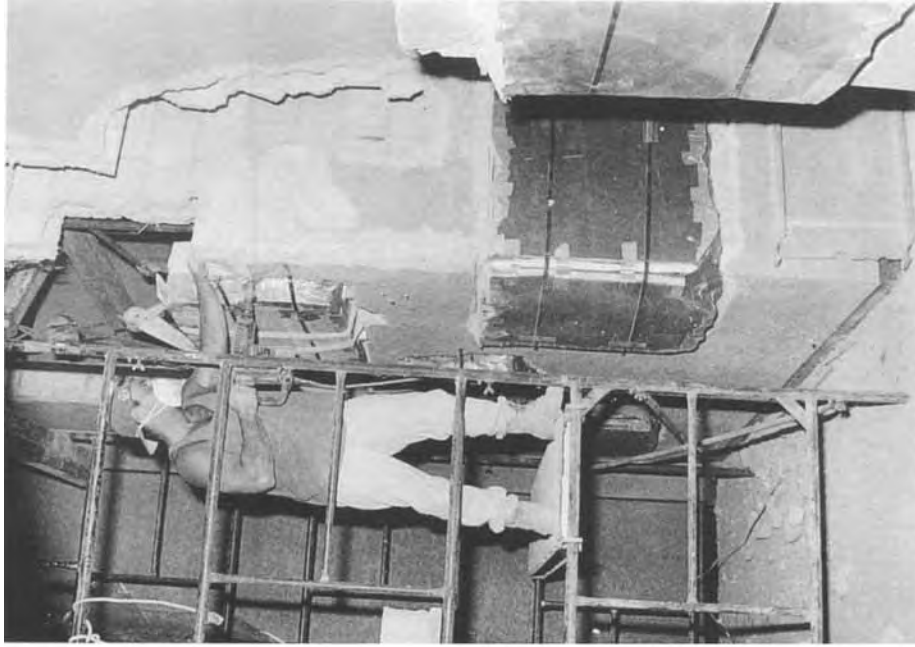


Figure 3. Stone mason fracturing the mortar joint to dislodge the cinder block. the weight of the upper relief (to the left of the mason) is transferred to the steel beam above. The relief is strapped with cotton slings attached to a chain hoist, which is connected to the steel beam.



Figure 4. Egyptian relief (WAM 22.200) during treatment: surface cleaning and removal of dark coating.

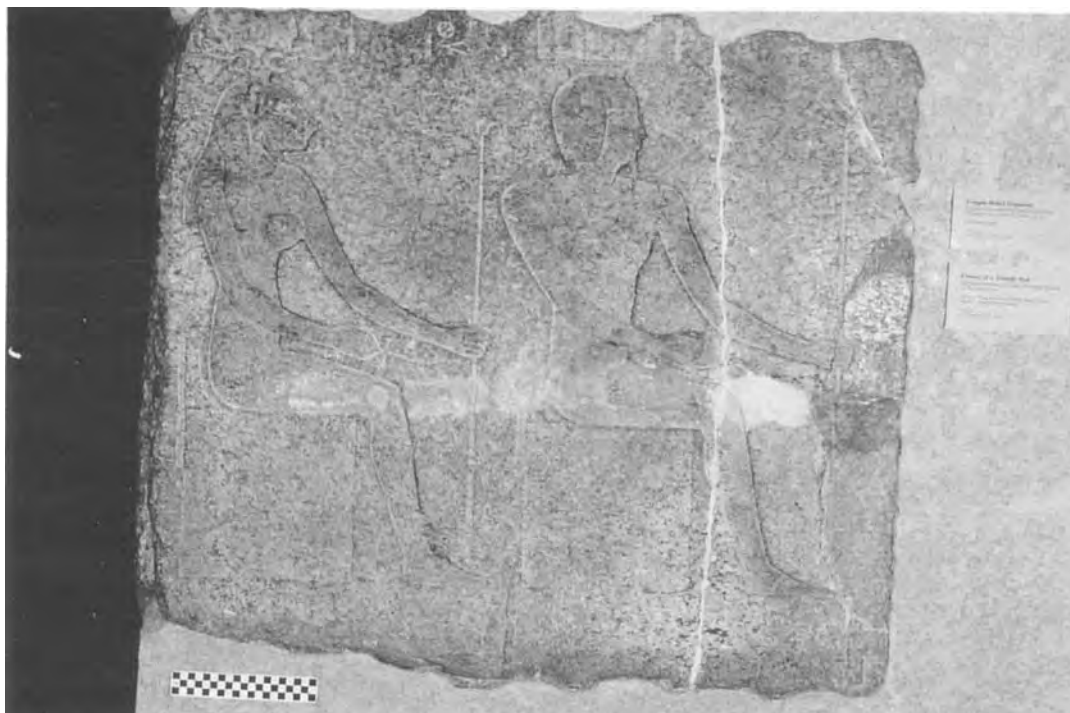


Figure 5. Egyptian corner block (WAM 22.5) before treatment, with old discolored fills.



Figure 6. Egyptian corner block (WAM 22.5) during treatment. The previous fill has been removed, revealing quarrying marks.



Figure 7. Egyptian corner block (WAM 22.5) during treatment, with losses refilled.



Figure 8. Egyptian corner block (WAM 22.5) after treatment, with fills inpainted.



Figure 9. Egyptian corner block (WAM 22.5) sitting on L-shaped steel plate as part of the final mount. Bradley Sanders is taking measurements for mounting and reinstallation. There are two structural problems on this block: the failure of the old vertical join, and a small fragment (not shown) which needs to be attached to the upper left corner.



Figure 10. Back view of Egyptian corner block (WAM 22.5), showing braces attached from behind to stabilize block during treatment and movement.



Figure 11. Egyptian relief (WAM 22.200) being raised by forklift into the steel gateway structure. The relief is secured in its mount and sandwiched between padded blankets and Masonite.

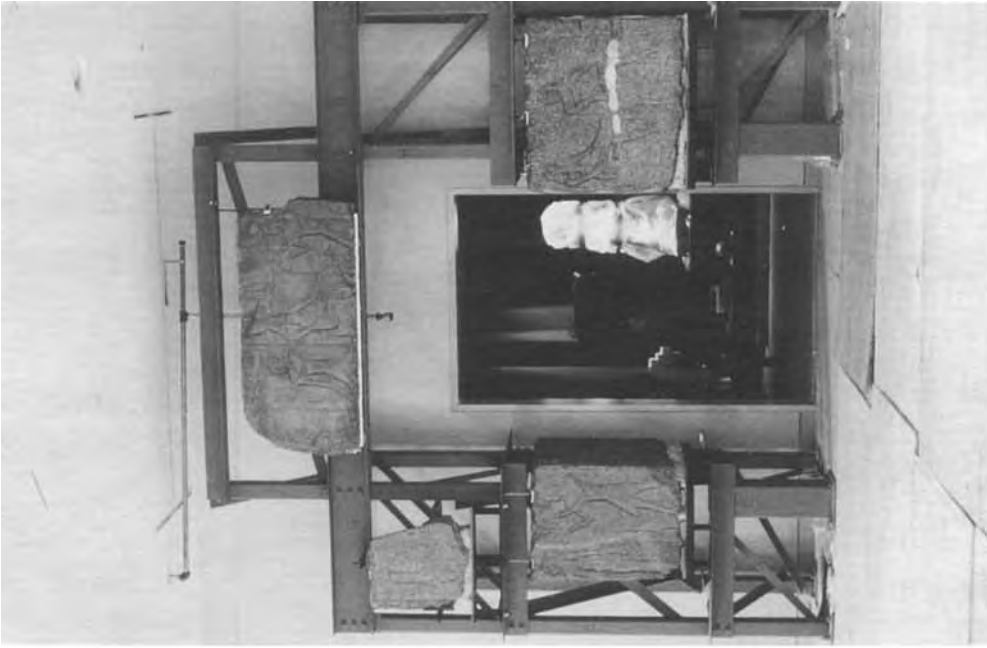


Figure 12. Four Egyptian reliefs (WAM 22.5, 22.8, 22.176, 22.200) secured into their mounts, which are bolted to the steel gateway structure.



Figure 13. View of completed installation of four Egyptian reliefs (WAM 22.5, 22.8, 22.176, 22.200) with the mounts and steel structure concealed.

## HELPING THE MUTE STONES SING: ACHIEVING AN AESTHETIC RESOLUTION

Patricia S. Griffin

### Introduction

The Egyptian collection of the Cleveland Museum of Art was historically the first to be acquired in the museum's history, with an important group of artifacts purchased in 1913, three years before the museum opened (Kozloff 1999). Therefore, Egyptian art has always been associated with the institution and has been a much-loved part of the Cleveland Museum experience. For this reason, the collection was one of two chosen for reinstallation as part of a "Convening the Community" project, supported by the Lila Wallace-Reader's Digest Fund. The newly installed Egyptian galleries were opened to the public on September 24, 1999 (Figs. 12-14). It was a collection reborn (Berman and Griffin 1999).

This rebirth came out of the extraordinary collaboration between curators, conservators and designers, which developed a shared sense of aesthetics that informed decisions regarding conservation and display. For the reinstallation, the reliefs were treated with a respectful eye toward both their current fragmentary condition and their continued preservation. New mounts were designed to be unobtrusive, yet provide complete support as reliefs on the gallery walls; and also, allowed the reliefs to be lit to their best advantage. A subdued color scheme in muted beige, moss and blue was used for walls and case furnishings; these colors not only provided a contextual background for display, but also maximized the visual impact of the artifacts (Berman and Griffin 1999). These design details were crucial for successful reinterpretation and presentation (Figs. 11-14). However, it proved to be the conservation treatments of the stone reliefs that were the most important factor towards achieving our aesthetic goals.

An important step in the recent conservation of the reliefs was to remove the old plaster repairs to expose the jagged outlines consistent with their fragmentary state. Conservators devoted many months to the painstaking tasks of freeing the images from the layers of plaster, as well as treatment of the reliefs to make them safe for display and more coherent to the viewer (Figs. 1-2). This integrated approach not only enhances their monumental, sculptural quality, but also reveals the subtle modeling of the surfaces and enlivens the remaining colors (Figs. 3-4).

Considerable thought went towards developing an approach to filling and toning of losses. The goals were to create visual coherence, and to unify the fragments in each relief without distracting from their distinct style and beauty. Fill compensation ranged from no intervention to full integration of missing elements. Decisions were on a case by case basis with curatorial consultation. In all cases, upon close inspection, restorations are readily visible. Typical of conservation treatments performed today, the materials used for filling and inpainting were carefully chosen for stability, good aging properties and reversibility. The results of this approach have restored both meaning and vitality to the reliefs, resurrecting them as masterpieces within a museum context.



This paper will present an overview of the conservation of the thirty-three stone reliefs in the collection. The reliefs date from the Old Kingdom (Dynasty 6) to the Late Period (Dynasty 25-30). However, despite the disparity in dates, all share similar aesthetic considerations based on their manufacture and history. All the reliefs are fragments of large-scale architectural depictions from tombs or other monuments. All the reliefs are sculptural and meant to be viewed as three-dimensional depictions. The legibility of the images relies on a subtle play of texture, shadow, and form crafted using flat planes, sunk relief, raised relief, delicate modeling and finely incised details. Most were intended to be polychromed; pigment survives on a few, usually in trace amounts.

The focus of discussion will be the aims of the conservation treatment of the reliefs, with an emphasis on the decision-making processes as influenced and guided by a heightened awareness of aesthetic considerations. This heightened awareness grew out of a close working relationship with curatorial staff that developed during multi-year examination and research project undertaken in preparation to producing a comprehensive catalogue of the collection. All of the objects were examined carefully by curators and conservators, with detailed technical studies resulting for most objects from the latter (Berman et al. 1999). These studies grew into an interest in reconstructing the original appearances of objects (Griffin 1999 and Griffin 2000). This in turn, led towards a critical evaluation of the current appearance of objects with the aim of restoring as much of their original impact and beauty as was possible. Therefore, aesthetic concerns were a primary focus for the development of conservation treatments.

Aesthetic and structural problems caused by the earlier treatment of reliefs will be summarized, followed by an overview of the current approach to treatment. The conservation problems encountered will be introduced; however, the primary topic for discussion will be the steps taken to address aesthetic problems in presentation. Finally, discussion will focus on a series of case studies to illustrate the profound effects that careful consideration of the surface and condition of each individual relief had towards developing an individualized treatment approach towards filling and inpainting. This approach enabled the visual appearance of the reliefs to be improved dramatically (Figs. 1-4), restoring both meaning and vitality to them, and increasing the public's appreciation.

### **Previous Treatment Approach**

The overall aesthetic of the previous reinstallation and treatment campaign can be described as tight and boxy, with the apparent goal of presenting the reliefs much as pictures on the wall (Figs. 5-6). Towards this goal the reliefs were encased in plaster and wood to produce uniform, rectangular, "free-standing" images; and they were sunk into the walls. The broken, ragged edges of the fragmentary reliefs were squared by three methods: (1) plaster fills or stone inserts were directly attached to the stone using pins, adhesive or by casting in place, (2) wooden inserts were fitted into losses and attached to the wooden frames surrounding the stone, (3) wooden frames surrounding the stone might be roughly contoured to match the profile of the stone. The

negative effects of this methodology were twofold: first, the reliefs were presented and viewed as complete, freestanding depictions rather than as fragments; and second, the finely carved surfaces were considerably flattened, visually diminishing their impact (Figs. 3-4).

This poor presentation was compounded by poor standards for the execution and quality of the treatments. Typically, the plaster fills were not level or smooth in texture, and the resulting unevenness and coarseness was visually invasive. In some cases when plaster was used to bridge the gap between two adjacent pieces of stone, it was not filled to be level with the two; rather it was lower and exhibited a visible meniscus, calling unnecessary visual attention to the restoration (Fig. 27, see especially upper left corner). In addition, the choice as to how fills were developed - whether they were flush with the surrounding stone surfaces, or recessed - appears to have been haphazard and not governed by careful consideration. Therefore, the patterns of shadow created by the fills often interfere with the carved relief surfaces, obscuring the impact of the image and the compositions (Figs. 1, 22).

In other cases, restorations were inaccurate or damaging, thereby changing meaning and appearance of the images in fundamental ways. The visual appearance of a series of six reliefs from the tomb of Nyankhnesut was compromised severely by the previous restorations. Problems introduced by treatment included misalignment of fragments, and excess plaster used to fill in missing areas, often traversing original surfaces (Berman et al. 1999, 135ff). In addition, restoration of missing sculptural details (hieroglyphs or figures) was often inaccurate and confusing. Plaster of Paris was spackled in between and over the adjoining edges of the fragment blocks. The texture of the plaster was left rough or as spackled. The attempted reconstruction of the decoration is crude, often obscuring the adjacent extant areas of stone, and contributed to the illegibility of the reliefs. For these reasons, the filling of losses made interpretation of the scenes and hieroglyphs difficult in many areas. One area on the lower proper right was recut to compensate for misalignments introduced during assembly (Fig. 8).

Finally, mounting of the reliefs was not well thought out and also was damaging. For instance, the group of sixteen Late Period reliefs from the tomb of Mentuemhat came to the museum in two groups (in 1949 and 1951) already restored (Berman et al. 1999, 393ff). A feature of both groups of restored fragments were systems of invasive reinforcement and mounting that did little to support joints (Berman and Griffin 1999). These support systems were cumbersome, heavy, and physically attached to the stone by a myriad of metal fittings secured by copious amounts of plaster poured into and around a series of drilled holes. For the larger Mentuemhat reliefs, as many as fifty holes had been drilled into the reverse to house the metal support system. [1]

It should be noted that there was one aspect of the previous installation that was fortuitous if not well planned. The reliefs - all housed in wooden frames - had been installed in the galleries into wooden niches (Fig. 9) or openwork lattices, formed by interlocked sections of wood (2 x 4" planks), by a series of wooden wedges, bolts and screws. Once installed, contoured plywood or particle board was fitted around them and painted to match the plastered structural walls, giving the impression that the reliefs had been recessed within the gallery walls. This arrangement

proved easy to reverse, requiring only screwdrivers, hammers, sufficient manpower and prefabricated padded wooden palettes to support the reliefs once they had been deinstalled.

### **Current Approach to Treatment: Stabilization and Mounting**

The goals of the current treatment campaign were to stabilize the reliefs and create visual coherence within each assembled group of fragments. The majority of reliefs did not exhibit structural problems; for these reliefs, the current treatments were limited to addressing aesthetic problems introduced by the previous treatments and mounting. However, a third of the reliefs did have structural problems requiring stabilization.

These reliefs belonged to one of two groups: the problematic Old Kingdom reliefs from the tomb of Nyankhnesut, and several of the reliefs from the Late Period tomb of Mentuemhat. It was clear that the structural problems in these two groups arose as a result of previous treatment. The problematic support systems that riddled the Late Period reliefs from the tomb of Mentuemhat (described above) had caused many of the old repairs to fail, and new cracks to form in several of the reliefs. The failed joints were reversed and readhered, and cracks were stabilized by introducing adhesive into them (Rhoplex AC33 and/or Acryloid B-72 in acetone). Cracks and breaks were reinforced using thin, rigid patches of bulked epoxy putty (Milliput or Pliacre) over a thick, strong isolating layer of Acryloid B-72 lightly bulked with glass microballoons (Scotchlite, 3M) and cellulose fiber (Whatman CF 11). The old support systems were adjusted to fit the actual contours of the stone, reducing their weight a little. However, these heavy metal systems were mostly left intact because they could not be safely removed. Therefore, mounting was an integral part of treatment; the new mounts, although visually unobtrusive (Figs. 12-14), were designed to support both the relief and the heavy support systems (Figs. 10-11).

As previously noted, the systems employed by the previous restorers to reinforce joints was invasive, heavy and cumbersome (Berman and Griffin 1999). Most joints appeared stable. It was feared that removing the plaster and metal supports would damage the reliefs. In addition to the stresses from reversing so many invasive repairs, the limestone used in many of the reliefs contained thin clay lamellae that responded unfavorably to prolonged contact with moisture or solvents, a common geological feature of some Egyptian limestones (Bradley and Middleton 1988, Rodriguez-Navarro et al. 1997). Therefore, these systems were left in place, and the new mounts were designed to support both the heavy rod-channel-pin-plaster armatures of the old mounting system as well as reliefs themselves. This in and of itself was a vast improvement towards their preservation, as previously the reliefs were bearing the weight of their supports. Most mounts consisted of a steel backplate with a continuous shelf along the bottom edge that supported the relief and any pre-existing support structure attached to the relief. This shelf was contoured to match the contours of the relief using bulked epoxy putty cast on the shelf with a Mylar separator protecting the stone. A series of brass and/or steel brackets, padded to fit the contours of the stone, secured the relief on all sides (Figs. 2, 4, 10).

The series of six Old Kingdom reliefs from the tomb of Nyankhnesut were also structurally unstable, with visible cracking of plaster within joints (Berman et al., 135ff). These reliefs previously had been thinned to less than 3 cm in thickness and had been reassembled by casting the fragments in plaster of Paris within wooden frames without the benefit of an adhesive. These reliefs were easily disassembled after deinstallation, and most extraneous plaster was carefully cleaned from the stone surfaces.

Re-assembly of the larger, multiblock reliefs was not straightforward. Most joints were heavily eroded leaving adjoining fragments with little or no purchase. The thinness of the fragments precluded pinning. Therefore, it was decided to mount the blocks separately and rely on carefully designed mounts to hold them in proper position. A few smaller fragments with tighter joints were reassembled using adhesive (Acryloid B-72 in acetone) prior to mounting, to form larger, regularly contoured blocks. These joints were reinforced on their reverses using a thin layer of bulked epoxy putty (Milliput or Pliacre) spackled over patches of woven fiberglass fabric adhered with B-72.

The mounts were designed and fabricated as described above, except for the largest relief that exhibited two tiers of blocks (Berman et al., 137-138). For this mount an internal shelf with short pins on both sides to aid in alignment was added, so that both tiers of blocks were supported (Figs. 11). The shelves and backplate were contoured as needed to match the contours of the relief using bulked epoxy putty (Pliacre) cast onto the mount with a Mylar separator protecting the stone. Rigid, stationary spacers were cast onto the backplate of the mount to prevent lateral movement of the individual blocks, using the same method. Fills were executed in one of two ways depending on the individual conservators. Cellulosic spackle (Polyfilla) was applied over a subfill made by adhering sections of polyethylene foam (Ethafoam) to the backplate; or B-72 putty bulked with glass microballoons (Scotchlite, 3M) and cellulose fiber (Whatman CF 11), was applied onto the surfaces of the Pliacre spacers. All fills were slightly recessed and most were finished to a flat neutral surface toned to closely match the color of the stone using watercolors and gouache (Pelikan, Winsor & Newton), or acrylic emulsion paints (Liquitex, Golden), depending on the individual conservator. After removal of plaster, careful consideration of structural needs and careful consideration of filling strategy- these reliefs have never looked better. The eye easily glides over losses without calling attention to them (Figs. 8, 11).

### **Current Approach to Treatment: Aesthetics and Loss Compensation**

The conservation treatment of the reliefs was the most important factor for achieving our aesthetic goals. The most important steps towards restoring aesthetic qualities to the reliefs were the successful reversal of previous treatments and a carefully considered and executed approach to loss compensation. All loss compensation was removed from around the edges of fragments. Poorly executed or unstable fills were removed or resurfaced. Loss compensation was developed on an individual basis. The aesthetic goals were to unify the fragments comprising

each relief as a cohesive image; and to enable the surviving carving and pigmentation to be the focus for the viewer. The fragile and fragmentary nature of the reliefs was accepted, not disguised; however, it was important that the surviving decorated surfaces be the focus for viewing. The successful treatments needed to accomplish these goals without distracting the viewer from the distinct style and beauty of individual reliefs. Each image had to shine.

A major step in this conservation project was removing the old plaster repairs to expose the jagged outlines consistent with the relief's fragmentary state. Conservators devoted many months to the painstaking tasks of freeing the images from the layers of plaster, as well as treating the reliefs to make them safe for display and more coherent to the viewer. Removing the plaster restorations to reveal the jagged outlines of fragments had a profound effect. Both context and the play of flat and undulating surfaces were often restored through this single step (Figs. 3-4).

Considerable thought went towards developing the approaches to filling and toning losses. In general, it was found that some level of fill compensation was necessary for most relief fragments composed of multiple pieces. Fill compensation ranged from none to full integration of missing elements. Decisions were on a case by case basis with curatorial consultation. Upon close inspection, all restorations are readily visible. Typical of conservation treatments performed today, the materials used for filling and inpainting were chosen for stability, good aging properties and reversibility. The results of this approach have restored both meaning and vitality to the reliefs, resurrecting them as masterpieces within a museum context. The following objects on display in our recently renovated Egyptian galleries illustrate the complexities of treatment decisions. All are carved and painted stone; however, differing approaches to compensation were key towards their presentation. They are organized according the degree of aesthetic compensation that was required; the execution of loss compensation is the focus of discussion for each example. However, other aspects of treatment that were performed to ensure the relief's continued preservation (consolidation, re-assembly and structural reinforcements) will also be mentioned. An overview of this project which describes aspects beyond the approach to loss compensation has been published elsewhere (Berman and Griffin 1999).

1. No loss compensation: Mentuemhat as Priest with Staff and Sceptor (1949.492) and Female Offering Bearer (1949.496).

Two reliefs dated to the Late period depict the deceased and a female offering bearer. Both belong to a group of sixteen in the museum's collection from the tomb of Mentuemhat (Berman et al. 1999, 393ff) mentioned above because of structural and aesthetic problems introduced by the previous restorations. Although the tomb was unfinished, the Cleveland reliefs were well executed in a fine-grained limestone using both raised and sunk relief, and both exhibiting finely sculpted and incised details. Reliefs that were completed - those in raised relief - were finely finished with abrasives and exhibit traces of polychromy and a resinous varnish (Berman et al., 393ff). Unfinished reliefs - those executed in sunk relief - exhibit painted guidelines, numerous

chisel marks, and rougher appearing surfaces overall. On all, the compositions were tightly organized with overlapped or interconnecting elements. All of the Cleveland reliefs are characterized by the extraordinary fineness and clarity of the carved depictions (Figs. 1-2, 15-24, 26).

All of the reliefs in this series were unframed by carefully prying apart the frame members and removing wooden wedges used to secure the irregular shaped stone edges of the reliefs within the straight edged frames. On most of the reliefs, compensation for losses around the edges had consisted of wooden recessed wooden inserts attached to the frame. Therefore, the goal of displaying the reliefs as true fragments, with ragged, broken edges, was simply and efficiently accomplished. However, the majority of reliefs required some degree of loss compensation to unify the finely sculpted, complex pictorial images which relied on the successful play of subtle raised and sunken relief, and incised elements. The shattering of most reliefs into numerous fragments, and the poorly conceived, haphazard application of previous fills often comprised pictorial legibility.

The two reliefs discussed here were exceptions; it was found that removing the obtrusive framing elements was enough to bring the images together (Flotte 1999a). Given the quality and level of damage to either one, it was clear that loss compensation would provide a visual distraction rather than enable losses to recede from the viewer's awareness.

A relief depicting Mentuemhat as a Priest with Staff and Sceptor (Fig. 15) exhibited three large and sharp-edged losses to the edges and a series of wide, shallow, and scalloped losses along the horizontal block line traversing the torso. Some losses had been partially filled previously with toned plaster. In addition, there were several sharp-edged breaks between adjoining fragments. Despite these damages, the fineness of the carving became the focus for viewing once the wooden frame and toned wooden inserts along the edges were removed (Fig. 16).

The surface of the Female Offering Bearer is rough overall; the relief was not finely finished and the surface retains many chisel marks and miscarvings which have not been removed or disguised. The relief is comprised of four adhered fragments. Joints are relatively tight with some small associated erosion and chipping. Again, removing the framing device and one insert to the bottom proper right edge had a profound effect for viewing. No other treatment was required for visual integration of the carved image (Figs. 17-18).

## 2. Selective Loss Compensation: Male Offering Bearer (1949.497) and Mentuemhat in Ecclesiastical Dress (1951.281).

Two different reliefs in the Mentuemhat series depicting a Male Offering Bearer and Mentuemhat in ecclesiastical dress required selective loss compensation to unify the images and render them more legible (Flotte 1999b and Flotte 1999c). The relief depicting the Male Offering Bearer was unfinished and its appearance and condition was much as was noted for the

Female Offering Bearer described above. However, the relief was reassembled from at least eighteen fragments, instead of four, making a much more prominent crack pattern (Fig. 19). There are several small, sharp-edged losses in addition to chipping and abrasion of break edges. These losses in combination with the numerous breaks provide visual competition with the delicate sunk relief carving. In order to make the heavily fractured relief read more easily, it was decided, with curatorial consultation, to selectively fill the larger losses in the main part of the relief and tone them to closely blend with the stone. No attempt was made, however, to fill the extensive network of cracks (Fig. 20). Where cracks crossed the fill, lines were incised at the edge of the fills to visually complete the cracks. Losses were filled with a B-72 putty bulked with glass microballoons (Scotchlite). The fills were toned to match the surrounding stone (Fig. 21) with acrylic emulsion paints (Liquitex and Golden).

The figure and background on the relief entitled Mentuemhat in Ecclesiastical Dress were finely finished despite the fact that the relief was never completed. For instance, the curls were shaped but the individual tresses were not carved or drilled, and the hieroglyphs were painted in yellow, with detailed red overpainting rather than carved. The carved and painted surfaces exhibit little wear and are very well preserved (Fig. 22). Unfortunately, the relief was badly broken and was reassembled from at least thirty-four fragments. Most losses were previously filled and toned a neutral hue. In general fills between adjoining fragments were filled flush with the adjacent stone surface and larger fills within losses were recessed. Losses along the bottom edge had been compensated by attaching painted wooden wedges to the frame. A piece of stone had been inserted as a "dutchman" into a loss below the belt of the figure, and carved to match the topography of the relief. Treatment of this relief involved stabilization and adaptation of the cumbersome support system to reduce the risk of further damage- the general methodology for which has been outlined above.

The old mounting system had caused serious damage to the relief. The reverse was riddled with internal ?brass pins, brass staples, an aluminum "strainer"(inset slightly from the edges of the relief, created using four sections of aluminum channel), short strips of twisted aluminum, and heavy threaded ?steel rods and an aluminum backing board, all secured with copious amounts of plaster. Similar systems have been described and illustrated elsewhere. (Berman and Griffin 1999, 6-7). A number of apparent new cracks developed in the stone, as well as in the previous repairs. The extensive cracks at the old joints were consolidated using an acrylic emulsion (Rhoplex AC-33), and reinforced with woven fiberglass adhered with adhesive (B-72). The aluminum back plate and channels were cut down to the shape of the fragment. A new mount was designed to support fully the weights of both the relief and the old mount- taking considerable strain off of the joints.

Cosmetic treatment included toning the extraneous "dutchman" to more closely blend to the original stone and resurfacing fills to restore legibility to the image (Fig. 23). Deeply recessed fills were brought flush to the level of the stone in several areas where it was difficult to understand the topography of the relief, such as the proper right arm and shoulder. Other areas were left slightly recessed. Fills were executed using a B-72 and glass microballoons (Scotchlite)

putty below a fine surface fill made with a cellulosic spackling compound (Fine Surface Polyfilla). Fills were toned to closely blend with the surrounding stone using watercolors and gouaches (Winsor & Newton) over a base coat of acrylic emulsion paints (Liquitex, Golden).

### 3. Overall Loss Compensation with Complete Reintegration of Losses: Marsh Scene with Cat and Birds (1949.498).

Another relief in the Mentuemhat series depicting a Marsh Scene with Cat and Birds is fragmentary; however, the carved surface is well preserved and many traces of pigment remain. Despite earlier treatment involving re-assembly and filling of small losses, several large diagonal losses had been left unfilled (Fig. 24). These were highly disfiguring and marred the beautifully conceived and executed scene.

Treatment of this delicately carved image involved re-assembly of the upper right side from a number of small fragments and chips; reinforcement of the old repairs on the reverse (fig. 25); and creation of faux break faces on the sides to disguise the old support system (fig. 10). The fragment group on the upper proper right was exhibiting cracks in old joints. The old repairs carefully were reversed with acetone, and the fragments were reassembled using B-72 in acetone. The support system on the back was reinforced as previously described for other reliefs in this series. An additional step was taken to disguise the support system so it was not visible from the side. This was accomplished by adhering overlapped patches of Japanese tissue to the bottom edge of the stone along the sides using B-72 in acetone, floating it over the support system and adhering it to the aluminum backplate on the reverse of the support system. The tissue was spackled using a pigmented putty consisting of glass microballoons (Scotchlite), cellulose fiber (Whatman C 11), dry pigments and B-72 in acetone. The spackle was sculpted wet, and carved and sanded dry to mimic the rough worn edges of the stone. The faux stone surfaces were toned to blend using watercolors (Pelikan).

Gap filling and inpainting of the decorated surface disguised the extent of breaks and losses so they would not detract from the charm of the highly detailed scene. Although care was taken to fully integrate fills with the surrounding stone, no attempt to replace the missing paint was attempted. A filling putty was manufactured to be a sympathetic match in texture and tone to the original stone surface, as described above for the surface treatment of the faux sides. Fills were inpainted to closely blend using watercolors and gouaches (Pelikan, Winsor & Newton). Three filled areas retaining fragmentary paint remains appear to be original, including an area on the cat's torso and two areas on lotuses (Berman and Griffin 1999); these are probably manufacturing flaws left from carving that were repaired using gesso and carved prior to painting. These areas were left untouched. The final result is a unified image that showcases both the strong verticality of the composition and the precise and naturalistic rendering of the fauna (Fig. 26).



#### 4. Overall Loss Compensation with Partial Reintegration: Tomb Relief of the Chief Physician Amenhotep and Family (1963.100).

Whereas full integration was appropriate on the Marsh Scene describe above, a more restrained approach was used on a large relief from the Ramesside period depicting the Chief Physician Amenhotep and his family. This relief is a masterpiece from the 19<sup>th</sup> dynasty. The figures were carved in raised relief with many areas articulated in subtle sculptural relief and/or finely incised details, such as the hair, headdresses and hieroglyphs (carved in sunk relief). Enough traces of the original polychromy remain on the upper portion to indicate how the relief originally appeared. The background was yellow. The lines separating the columns of hieroglyphs were painted in blue, while the hieroglyphs were painted in blue, red, orange-red, yellow and green. The hair, cosmetic lines, brows and pupils were painted black. The skin of the women was painted orange-red and the skin of the men red. Pigment identifications are published elsewhere (Berman et al. 1999, 251).

Previously, losses along the edges were filled with plaster and painted a flat beige color except on the upper proper right where a stone insert was used, all effectively squaring relief (Fig. 27). Most of the interior fills were flat and featureless, interfering with the legibility and composition of the image; the exception being some of the fills associated with the figures. In this case, the old plaster fills also recreated missing details of the figures in gaps or losses; however, the quality of the carving of these fills was coarse as compared to the original carving of the stone. Furthermore, some of these areas were reconstructed inaccurately, as is apparent by comparing these details to an earlier photo in which the stone surface was less eroded and much better (Berman et al. 1999, 251). Overall, the restorations diminished the quality of the work of art, and obscured the masterful and detailed carving.

Treatment included the careful removal of all fills and inserts, refilling of interior losses, and creating faux stone edges to disguise the plywood support backing (Figs. 28-29). The fill material was prepared as described above for the Marsh Scene to provide a sympathetic texture and tone. The new fills were constructed using as a guide the photograph of the relief prior to the additional surface damage (Berman et al. 1999, 251). Minimal reconstruction of missing decorative elements was carried out with the idea of unifying the fragments. In general, only the outlines of figures and major internal contours were recreated in order to carry the eye across losses; finer details such as the pleats within garments were not recreated. Except for the narrow horizontal fill traversing the upper torsos of the figures, fills were toned a flat beige similar to that of the unpainted stone. Because the narrow fill across the figures' torsos created a sharp horizontal it was necessary to more closely blend its tone to match the pigmentation of the surrounding stone, which varied due to pigment residues, dirt and staining. At a slight distance the fragments pull together upon viewing and losses do not register. However, upon close inspection restorations are readily visible. The results of this approach have restored both meaning and vitality to the relief; the masterful carving can once again be appreciated (fig. 30).

5. Cosmetic Intervention to Visually Integrate Losses: Nome Gods Bearing Offerings (1961.205/1976.51).

The New Kingdom relief of the Nome Gods Bearing Offerings is one of the masterpieces of the CMA's collection. It is dated to the late 18<sup>th</sup> dynasty to the reign of Amenhotep III and is remarkable for both its degree of preservation and its detailed painted and varnished decoration (Griffin 2001, Griffin 1999, Berman et al. 1999). The carving in subtle raised relief is exquisitely detailed and the polychromy is rendered with extreme precision. Even the individual hieroglyphs were carved and painted to be highly detailed and decorative. Fine details such as the plumage and fur are meticulously described by masterful layering of strokes of pigment in related hues.

The palette of pigments was extensive, with more than 14 different hues visually identified and confirmed as different pigments or pigment mixtures by analysis (Griffin 1999, Griffin 2001 and Berman et al., 1999). In addition to the extensive palette, colors were layered to achieve specific effects. For instance, an overall ground layer was not used; however, white pigment was applied as an underpaint in some areas. An additional element of the complicated polychromy was the use of selectively applied coatings or varnishes with specific areas left in reserve. Examination of the surface of the relief using normal light and magnification suggests three visually distinctive varnishes: a colorless waxy layer, a pale yellow matte layer, and a yellow glossy layer. The deliberate manner in which the three visually different coatings were employed suggests their use was deliberate.

Fifteen years after the museum acquired the first larger block with three Nome Gods in procession, another adjoining block with an additional Nome and fragments of an upper became available. Once purchased, conservators had the task of reintegrating the two blocks. Each block was independently mounted within an aluminum box using iron pins set into their reverses. The gap between the two blocks was filled with plaster toned a flat neutral tone (Fig. 31). This system proved problematic for two reasons. First, the two fragments were of different weights and moved independently from each other within the mount. In contrast, the plaster bridging the gap between the fragments was rigid. These factors eventually led to cracking of the original, weaker stone along the joint. In addition, the use of iron bolts set into the stone with plaster was of great concern because the hygroscopic plaster creates an environment conducive to rust. Heavy rusting could cause iron staining, or cracking and splitting of the stone as the pins expanded with corrosion.

These issues were addressed by conservation treatment in preparation for the 1996 Pharaohs exhibition (Christman and Griffin 1995). The iron pins were replaced with stainless steel pins; and the plaster fill was removed and replaced with a flexible synthetic fill (B-72 bulked with glass microballoons applied over strips of compressed, closed cell polyethylene foam worked into the joint). This fill was designed to be weaker than the stone and more flexible, to prevent further damage from movement. The fill was toned to closely blend with the surrounding stone; its appearance was similar to that of the earlier plaster fill.

This solution worked well in terms of preventing further damage to the relief; however, it was unsatisfactory from an aesthetic standpoint. The fill attempted to provide an unobtrusive joint between the adjacent carved and painted surfaces by providing a flat bridge. Instead, it took on a life of its own and was a visual focus for several reasons. First, the two blocks, both rectangular, do not match, and as a whole the relief has an odd shape. Second, the surfaces are not perfectly aligned. The smaller block on the proper left side is approximately a millimeter or more higher in some areas; therefore, the surface of the fill is uneven. Also, the level of the fill had been matched to the level of carving in many areas which made it more noticeable. Finally, the attempt to mask the fills by toning it to closely blend with the surrounding stone made it appear “painted” and therefore, more rather than less obvious.

With these factors in mind the fill was reworked in 1999 in preparation for the reinstallation of the Egyptian galleries. The goal for the treatment was to make the fill as unobtrusive as possible, to carry the eye over the gap without calling attention to the loss. A new flexible and soft fill was prepared, using the same materials as described above for the Marsh Scene and the Ramesside relief. The fill was made similar in texture and tone to the fine-grained limestone. Dry pigments were added to create a neutral beige color, similar, but not identical to, the color of the unpainted limestone. The fill was slightly recessed from the relief to read as a relatively flat, eroded surface. Finally, the demarcation between the blocks was cut into the fill. They now read as two blocks, side by side, with some losses to the decorated surfaces at the block edges (Fig. 32). This fill approach is very successful at disguising the extent of losses and the added material is barely discernible with close inspection. It improves upon the previous flexible fill in that it is not damaged or destroyed when the relief is moved. The fill successfully allows the masterfully carved and painted surfaces to be the focus of viewing, and they shine.

To create the illusion of a fragment floating on the wall, consistent with the mounting of the other reliefs, the heavy aluminum box that housed the fragments was cut back and disguised with a panel fitted over the relief. The box is mounted on the wall, and the surrounding surface was built up in wood disguising the thickness of the box and pins. The effect of the edges of the relief rising slightly above the display panel promotes the illusion of fragments mounted onto a wall (Fig. 32).

## **Conclusion**

The recent reinstallation of the Cleveland Museum of Art’s Egyptian collection was successful because of the close collaboration between the essential departments within the institution. However, the time and consideration that was taken for the conservation component of the work had the most far-reaching effect on the presentation and aesthetic appreciation of the collection of carved limestone reliefs. The materials and conservation techniques used during this project were standard. However, the detailed thinking that guided their use was not. This careful thinking and considered approach to the compensation of losses had a profound effect on the way the individual reliefs are seen by scholars and the general public. Freeing these reliefs from

## *Griffin*

their plaster and wooden prisons has restored their magic and vitality. Subtle details in carving, color and composition can once again be appreciated. Although fragmentary and worn, the appearance and meaning of these archaeological artifacts was enhanced immeasurably by not applying a standardized “archaeological” approach of minimal reconstructions to their treatment. These objects are archaeological fragments, and they are also masterpieces. These treatments emphasize both of these characteristics. The importance of the conservation treatments towards revealing these masterpieces- recently hidden by previous restorations- was recognized within the museum and without; and was duly noted as part of the publicity and fanfare surrounding the reinstallation (Apollo 1999, Berman and Griffin 1999). It was a collection reborn (Figs. 12-14). Despite the ravages of time and early restoration, these rich depictions thrive once again in a noble afterlife, and continue to dazzle with their tantalizing glimpses to the past.

## **Acknowledgments**

The success of this project is due to the many minds, hearts and hands that participated. I would like to thank Larry Berman and Ken Bohac, the curatorial forces behind the project, for their extraordinary intelligence, insight, collegiality and support. Contract conservator Jack Flotte beautifully executed many of the treatments, several of which were discussed in the body of this text. The conservation work could not have been completed without the help of chief conservator Bruce Christman, conservation intern Beth Adler, and art handlers Beth Wolfe and Joe Ionna. The design and mounting work of the Design and Facilities division was crucial to achieving our aesthetic and preservation goals. In particular I would like to mention Rusty Culp, Jeffrey Streat, Jeff Falsgraf, Dave Geiger, Brian Ulrich, Joe Blazer and Carlo Maggiora. Essential photographic support was provided by Joan Neubecker, Janet Burke, Bruce Shewitz and Dave Brichford. It is impossible to complete any project well without the help of Judy Devere.

## **Endnote**

1. The series of reliefs have been illustrated and described before treatment (Berman et al. 1999, 393ff). Please note, however, that the extent of instability of several of the reliefs as well as the cumbersome and invasive support systems were not apparent until after the reliefs were deinstalled. Therefore, the extent of condition problems is not reflected in the earlier publication.

## **Materials**

Acryloid B-72 (Rohm and Haas, Philadelphia, PA)  
Talas (212-219-0770, [www.talasonline.com](http://www.talasonline.com)), Conservator's Emporium (775-852-0404,

*Griffin*

[www.consemp.com](http://www.consemp.com)), Conservation Support Systems (800-482-6299,  
[www.silcom.com/~css/](http://www.silcom.com/~css/))

Dap Vinyl Spackling Paste (Philadelphia Resins, Montgomery, PA)  
Hardware stores, K-Mart, Home Depot, etc.

Ethafoam HS 600 polyethylene compressed closed cell foam (Dow Chemical Co., Midland, MI)  
American Foam, Painesville, Ohio (440-352-3434)

Golden acrylic emulsion paints (Golden Artist Colors, Inc., New Berlin, NY)  
Conservation Support Systems, Talas, art supply stores including Dick Blick (800-447-8192, [www.dickblick.com](http://www.dickblick.com)), Pearl Art (800-451-PEARL, [www.pearlpaint.com](http://www.pearlpaint.com))

Liquitex acrylic emulsion paints (Binney and Smith, Easton PA)  
Art supply stores

Milliput epoxy putty (The Milliput Co., Dolgellau, Gwynedd, UK)  
Conservator's Emporium

Pelikan watercolors (Pelikan Vertriebsgesellschaft mbH & Co. KG, Hannover Germany)  
Art supply stores

Pliacre epoxy putty (Philadelphia Resins, Montgomery, PA)  
Conservation Support Systems

Fine Surface Polyfilla (Polycell Products, Welwyn Garden City, England)  
Conservator's Emporium

Rhoplex AC33 (Rohm and Haas, Philadelphia, PA)  
Talas, Conservator's Emporium, Conservation Support Systems

Scotchlite™ Glass Bubbles (3M, St. Paul, MN)  
Conservation Support Systems

Whatman Fibrous Cellulose Powder (CF 11) (Whatman Inc., Clifton, NJ)  
Fisher Scientific (800-766-7000, [www.fisherscientific.com](http://www.fisherscientific.com))

Winsor & Newton gouache paints, watercolors (Winsor & Newton, London, England)  
Art supply stores

## References

- Apollo*, December 1999. Reinstallations and Renovations of the Year. *Apollo: The International Magazine for the Arts* 150 (154 n.s.) 59, 61, fig. 25.
- Berman, L.M. (ed.) with K. Bohac, P.S. Griffin, B. Christman and A. P. Kozloff 1999. *Catalogue of Egyptian Art*. Cleveland: The Cleveland Museum of Art.
- Berman, L.M. and P.S. Griffin 1999. New Egyptian Galleries, *The Cleveland Museum of Art Members Magazine* (Oct 1999, 4-7). Cleveland: The Cleveland Museum of Art.
- Bradley, S.M. and A.P. Middleton 1988. A study of the deterioration of Egyptian limestone sculpture. *Journal of the American Institute for Conservation* 27(2): 64-86.
- Christman, B. and P.S. Griffin 1995. The Nome Gods Bearing Offerings (1961.205/1976.51). unpublished examination report and treatment proposal (Nov. 1995). Cleveland: The Cleveland Museum of Art.
- Flotte, J. 1999a. Stone relief from the tomb of Prince Mentuemhat - Female Offering Bearer (1949.496). Unpublished treatment report, (March 26, 1999). Cleveland: The Cleveland Museum of Art.
- Flotte, J. 1999b. Stone relief from the tomb of Prince Mentuemhat - Male Offering Bearer (1949.497). Unpublished Treatment Report (June 16, 1999). Cleveland: The Cleveland Museum of Art.
- Flotte, J. 1999c. Stone relief from the tomb of Prince Mentuemhat - Mentuemhat in Ecclesiastical Dress (1951.281). Unpublished treatment report (Oct. 16, 1999). Cleveland: The Cleveland Museum of Art.
- Griffin, P.S. 1999. Observations on the Use of Surface Coatings and Varnishes in Egyptian Art from the late 18th Dynasty. In *The Materials, Technology and Art of Conservation - Studies in Honor of Lawrence J. Majewski*, ed. R.A. Rushfield and M.W. Ballard. New York: Conservation Center of the Institute of Fine Arts, NYU. 30-64.
- Griffin, P.S. 2000. The Selective Use of Gilding on Egyptian Polychromed Bronzes. *Gilded Metals*, ed. Terry Drayman Weisser. London: Archetype Books. 30-64.
- Griffin, P. S. 2001. Nome Gods Bearing Offerings: A Relief in Pieces. Website: [www.clevelandart.org/ConsExhib/html/index.html](http://www.clevelandart.org/ConsExhib/html/index.html)
- Kozloff, Arielle P. 1999. Introduction: History of the Collection. In *Catalogue of Egyptian Art*, ed. L. M. Berman. Cleveland: The Cleveland Museum of Art. 1-30.

*Griffin*

Rodriguez-Navarro, C., E. Hansen, E. Sebastian, and W.S. Ginell. The role of clays in the decay of ancient Egyptian limestone sculptures. *Journal of the American Institute for Conservation* 36:2, 1997, 151-163.

**Author's Address**

Patricia Griffin, Conservation Department, The Cleveland Museum of Art, 11150 East Blvd., Cleveland, OH 44106

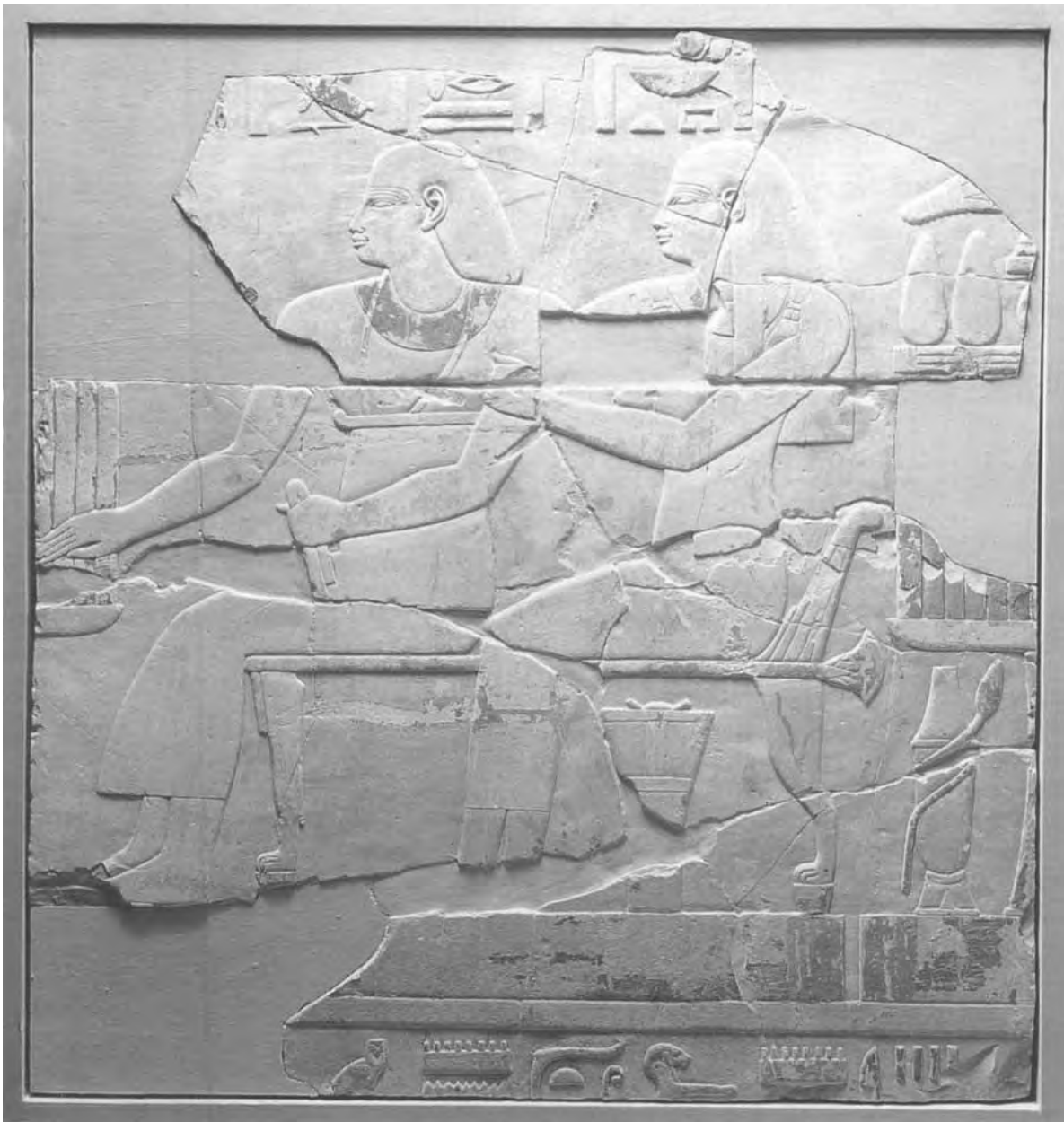


Figure 1. Seated Couple: Mentuemhat Ancestors. Limestone. H. 57.3, W. 53 cm. Late Dynasty 25 to early Dynasty 26. © The Cleveland Museum of Art, Gift of Hanna Fund, 1949.493. Before Treatment Photo. The relief previously was reassembled from at least eighteen fragments. Most losses were compensated with recessed fills toned a flat beige; however, the numerous losses remained visually distracting- the eroded breaks and recessed fills created a competing play of light and shadow.





Figure 2. Seated Couple: Mentuemhat Ancestors. Limestone. H. 57.3, W. 53 cm. Late Dynasty 25 to early Dynasty 26. © The Cleveland Museum of Art, Gift of Hanna Fund, 1949.493. After Treatment Photo. Most areas were filled to be flush with the carved stone surface using a bulked B-72 putty (glass microballoons/dry cellulose/dry pigments) mixed to match the texture and tone of the stone. Sculpted forms were completed when possible by making obvious connections; one loss in the figures was left flat and slightly recessed because the original contours were unknown. Treatment has restored the play of light and dark and enables the finely carved composition to be appreciated.



Figure 3. Talatat: Portrait of Nefertiti. Painted sandstone. H. 21.5, W. 24.3 cm. Dynasty 18, reign of Amenhotep IV. © The Cleveland Museum of Art, Purchase from the J.H. Wade Fund, 1976.4. Before Treatment Photograph. This group of reliefs previously had been cast into cumbersome plaster blocks, put in heavy wooden frames, and sunk into the wall. This treatment and display philosophy made viewing difficult- deadening the images and dulling the characteristic features of their innovative carving.



Figure 4. Talatat: Portrait of Nefertiti. Painted sandstone. H. 21.5, W. 24.3 cm. Dynasty 18, reign of Amenhotep IV. © The Cleveland Museum of Art, Purchase from the J.H. Wade Fund, 1976.4. After Treatment Photograph. Removal of the surrounding plaster and new inobtrusive mounts enable the reliefs to be properly lit and viewed. The subtle play of flat surfaces and raised and sunk relief were successfully restored.

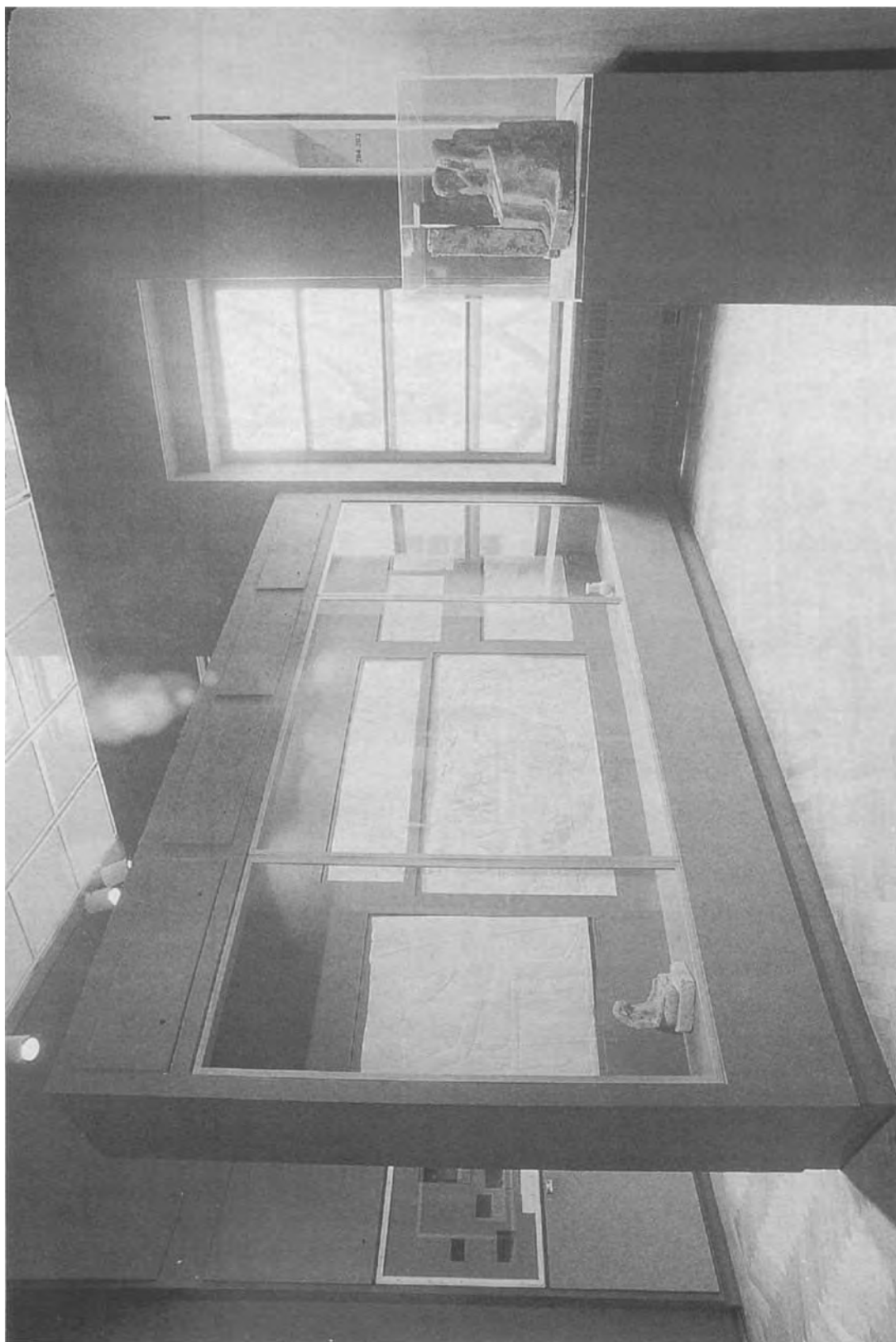


Figure 5. View of gallery 204 before reinstatement. The Old Kingdom reliefs of Nyankhnesut are centered in the picture. The old presentation and restoration approach interferes with the viewer's appreciation of compositional details and the quality of the workmanship. The arrangement of squares and rectangles on the wall is what focuses the eye.

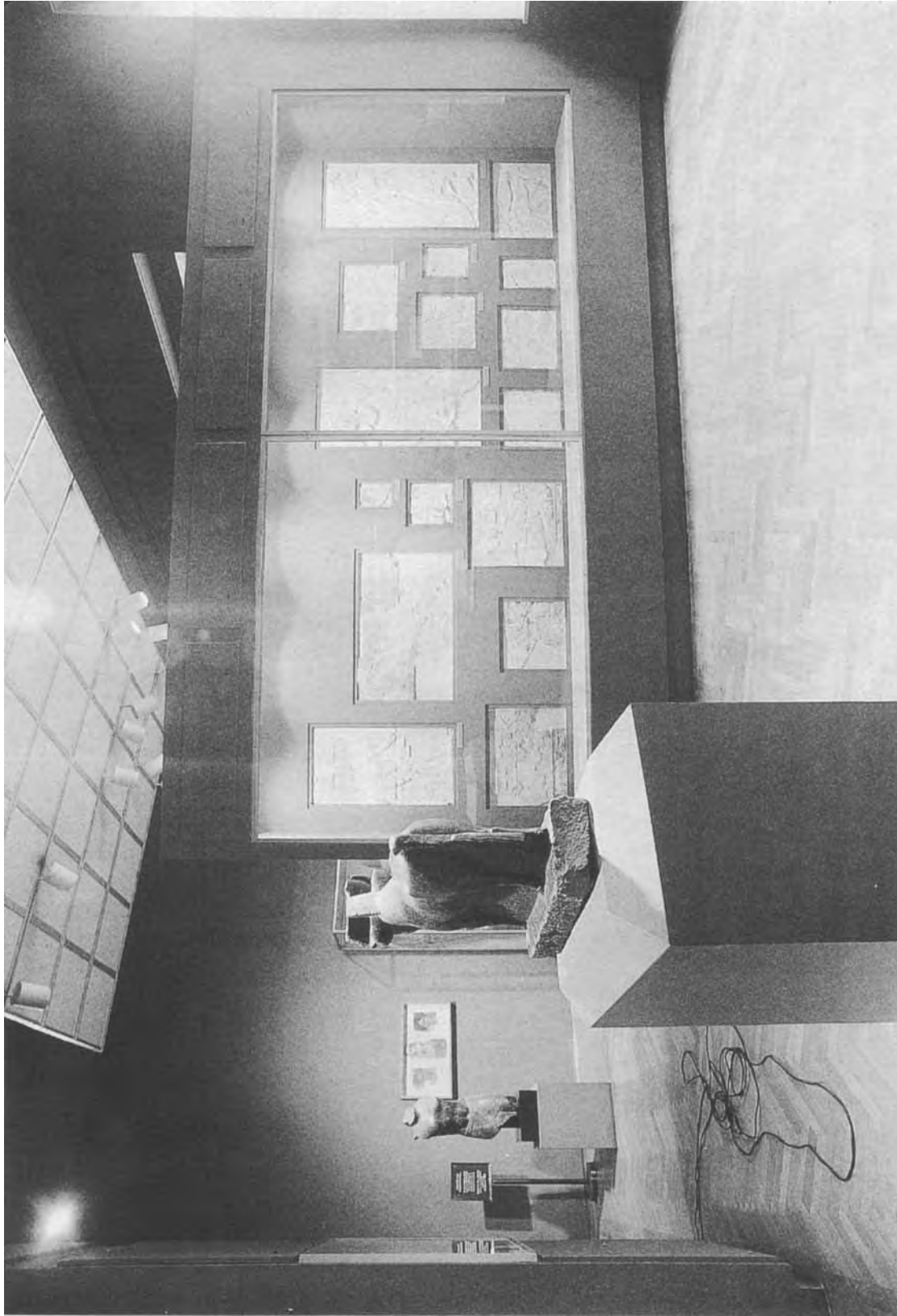


Figure 6. View of gallery 205 before reinstalation. The Late Period reliefs of Mentuemhat are centered in the picture. As noted for figure 5, the instalation does not promote the study nor visual appreciation of these works.



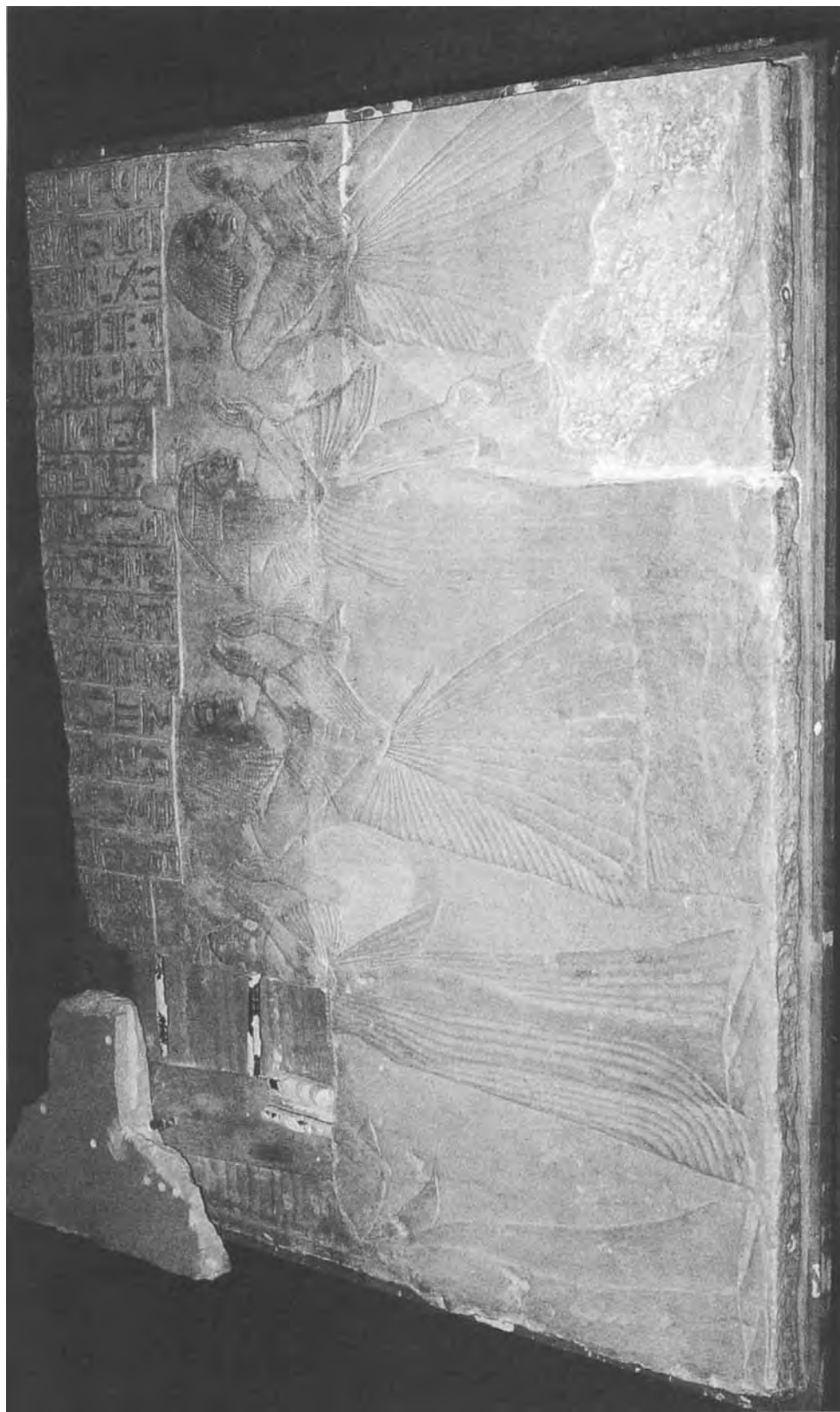


Figure 7. Tomb Relief of the Chief Physician Amenhotep and Family. Limestone with traces of paint. H. 128, W. 199.5 cm. Dynasty 19, early reign of Ramesses II. © The Cleveland Museum of Art, Leonard D. Hanna, Jr., Fund, 1963.100. During Treatment Photo. The laborious and painstaking task of removing the plaster revealed numerous flat chisel marks on the lower proper left suggesting that the area had been retooled after the surface was damaged, probably to create a better surface for filling. In addition, details in dress on the two female figures were inaccurately reconstructed.



Figure 8. Relief of Agricultural Scenes. Painted limestone. H 92.5, W. 173.8 cm. Early Dynasty 6. Gift of the John Huntington Art and Polytechnic Trust, 1930.736. After treatment photograph. Please note that a block on the lower right appears to be misaligned based on the position of the register line and the figure's feet. This is not the case. The block was misaligned previously and the surface was recarved to compensate for the previous mounting. The recarved areas no longer match up when the block is correctly positioned. Due to the large losses between fragments fills were finished to be slightly recessed, smooth and matched in tone.

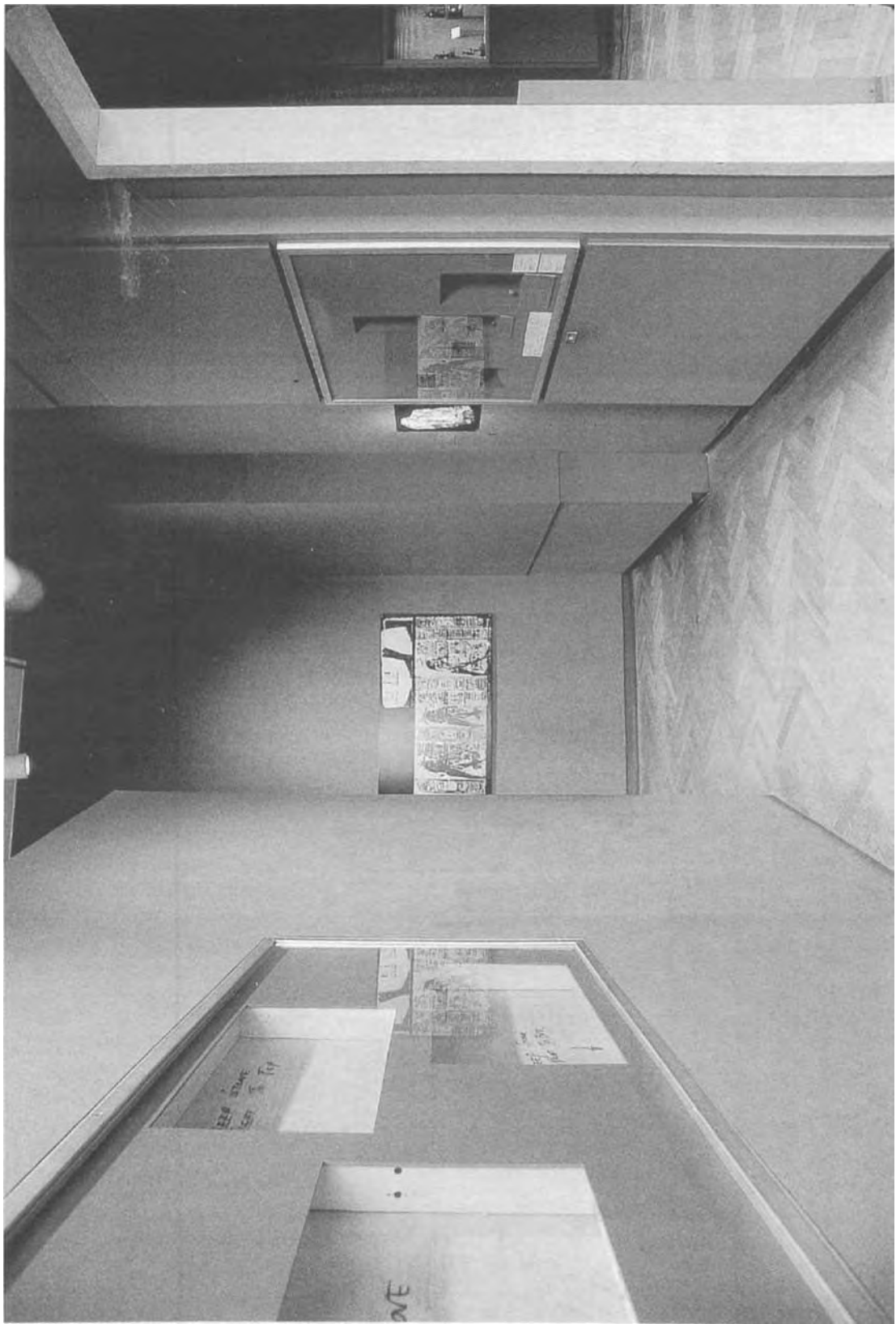


Figure 9. View of gallery 203 before reinstallation. The empty wooden niches once held a series of four sandstone reliefs from Amarna (fig. 3-4), attached within the niches by screws in their surrounding wooden frames.



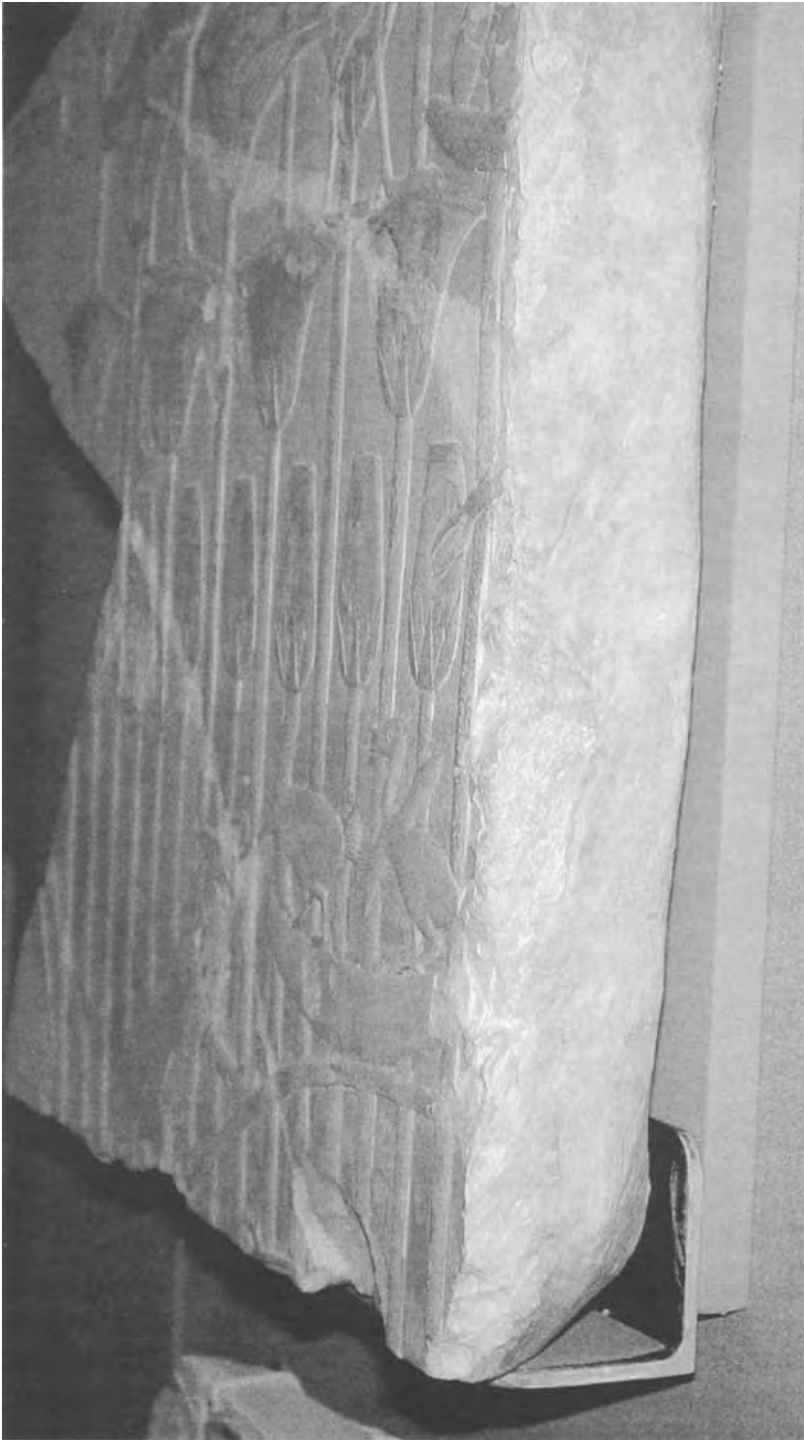


Figure 10. Marsh Scene with Cat and Birds. Limestone.

H. 38, W. 41.7 cm. Late Dynasty 25 to early Dynasty 26. © The Cleveland Museum of Art, Gift of Hanna Fund, 1949.498.

After Treatment Photo. This detail shows the side after treatment to disguise the old mounting system. Gaps on the reverse were consolidated with adhesive (B-72), filled with B-72 putty (glass microballoons/cellulose fiber), and reinforced with thin patches of bulked epoxy putty (Pliacre). The aluminum backplate was cut down and reattached. The gap between the stone and the backplate, ranging from 1-3 cm, was bridged with tissue, spackled with bulked B-72 putty and painted with watercolors. The new mount fully supports both the fragment and the old support system by way of a complete backplate, contoured lower support shelf, and brackets around all edges.



Figure 11. View of gallery 205 after reinstallation. The wall case on the right contains the series of Old Kingdom reliefs from the tomb of Nyankhnesut. The large Agricultural Scene (fig. 6) hangs above the ceramic. The new inobtrusive mount is visible on the side.



Figure 12. View of gallery 203 after reinstallation. This gallery is thematically arranged around the subject of "Pharaohs and Deities". The Nome Gods Bearing Offerings (fig. 31-32) and the four reliefs from Amarna (fig. 3-4) can be seen in the far corner.

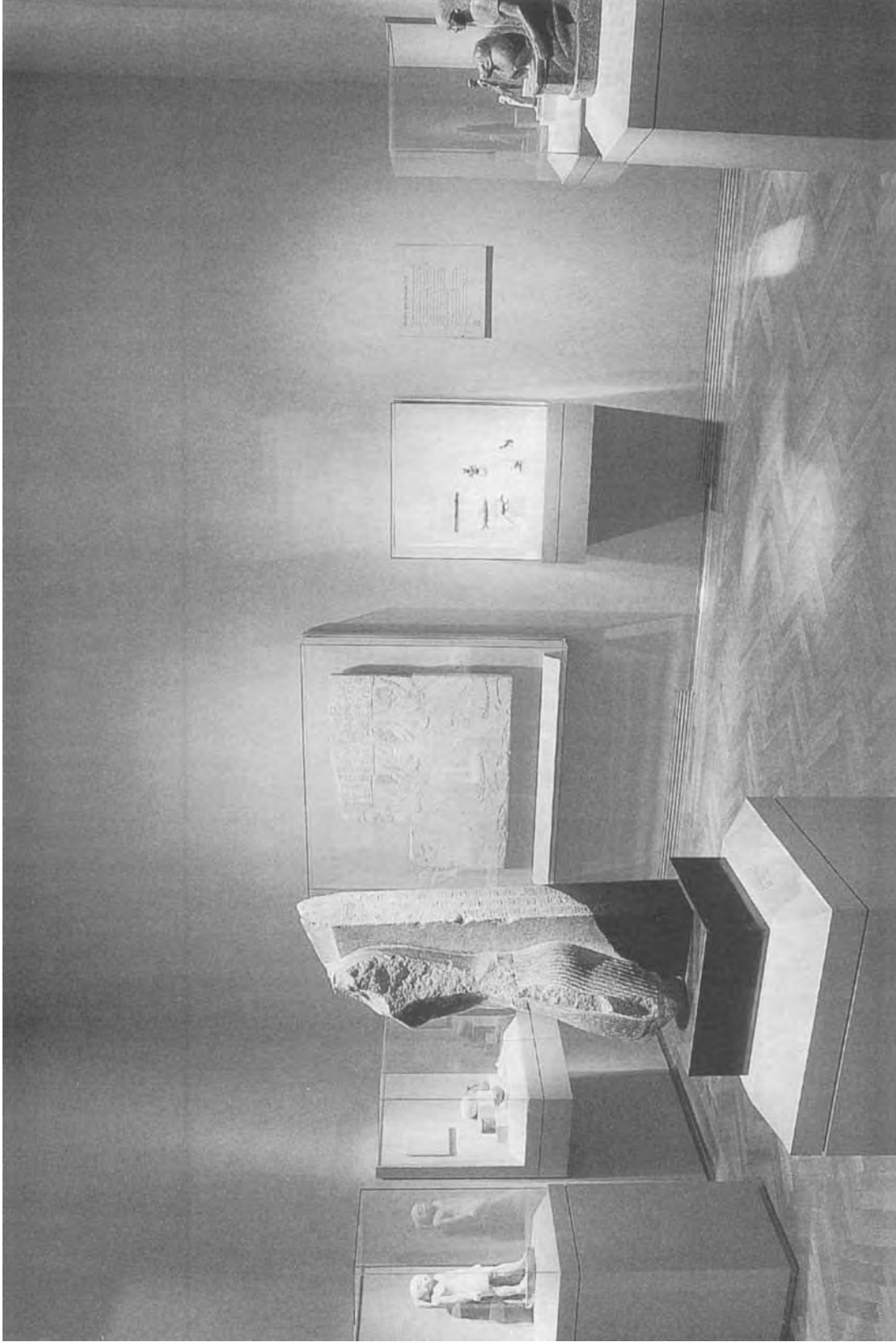


Figure 13. View of gallery 204 after reinstallation. This gallery is thematically arranged around the subject of “Daily Life”. The Tomb relief of the Physician Amenhotep and his Family (fig. 27-30) is visible on the far wall. The new inobtrusive mounts allow the art to be the focus of the room.

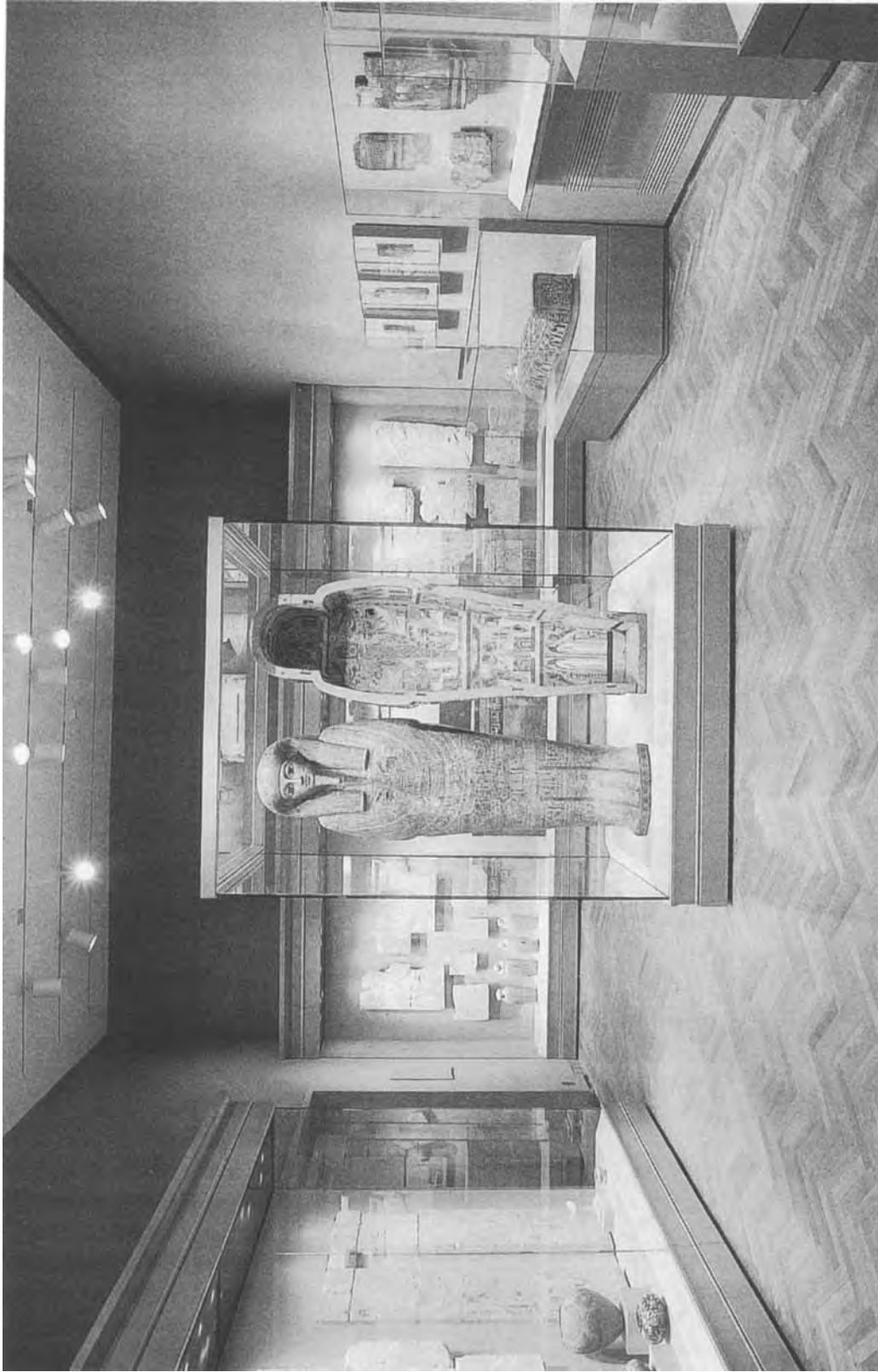


Figure 14. View of gallery 205 after reinstallation. This gallery is thematically arranged around the subject of “Afterlife”. The sixteen reliefs from the Tomb of Mentuemhat are visible on the far wall (fig. 1-2, 10, 15-26). The new inobtrusive mounts allow the art to be the focus of the room; and allow for deliberately harsh lighting to bring out every subtlety of the carving.



Figure 15. Mentuemhat as a Priest with Staff and Sceptor. Limestone. H. 85.2, W. 46 cm. Late Dynasty 25 to early Dynasty 26. © The Cleveland Museum of Art, Gift of Hanna Fund, 1949.492. Before Treatment Photo. The relief previously was reassembled from at least twenty fragments. Several of the adjoined edges of fragments are straight and appear to correspond to the original dressed edges of individual stone blocks; these can be seen running horizontally through the relief.





Figure 16. Mentuemhat as a Priest with Staff and Sceptor. Limestone. H. 85.2, W. 46 cm. Late Dynasty 25 to early Dynasty 26. © The Cleveland Museum of Art, Gift of Hanna Fund, 1949.492. After Treatment Photo. The carving on this relief is extremely fine; for instance, the curls of the wig were also drilled using one of two different drill bits depending on the size of the area. Traces of red and blue pigments remain from the original polychromy.



Figure 17. Female Offering Bearer. Limestone. H. 28, W. 21.4 cm. Dynasty 26. © The Cleveland Museum of Art, Gift of Hanna Fund, 1949.496. Before Treatment Photo. The relief is fragmentary and has been reassembled from four fragments. The surface is pitted and eroded with some random scratches.





Figure 18. Female Offering Bearer. Limestone. H. 28, W. 21.4 cm. Dynasty 26. Gift of Hanna Fund, 1949.496. © The Cleveland Museum of Art, Gift of Hanna Fund, 1949.496. After Treatment Photo. The relief is unfinished and was never polychromed. Chatter marks from planing the background using a point chisel are visible in many areas, as well miscarvings. There is no evidence of a corrective gesso layer to disguise miscarvings, as present on the Marsh Scene with Cat and Birds from the same tomb (Figs. 10, 24-26).

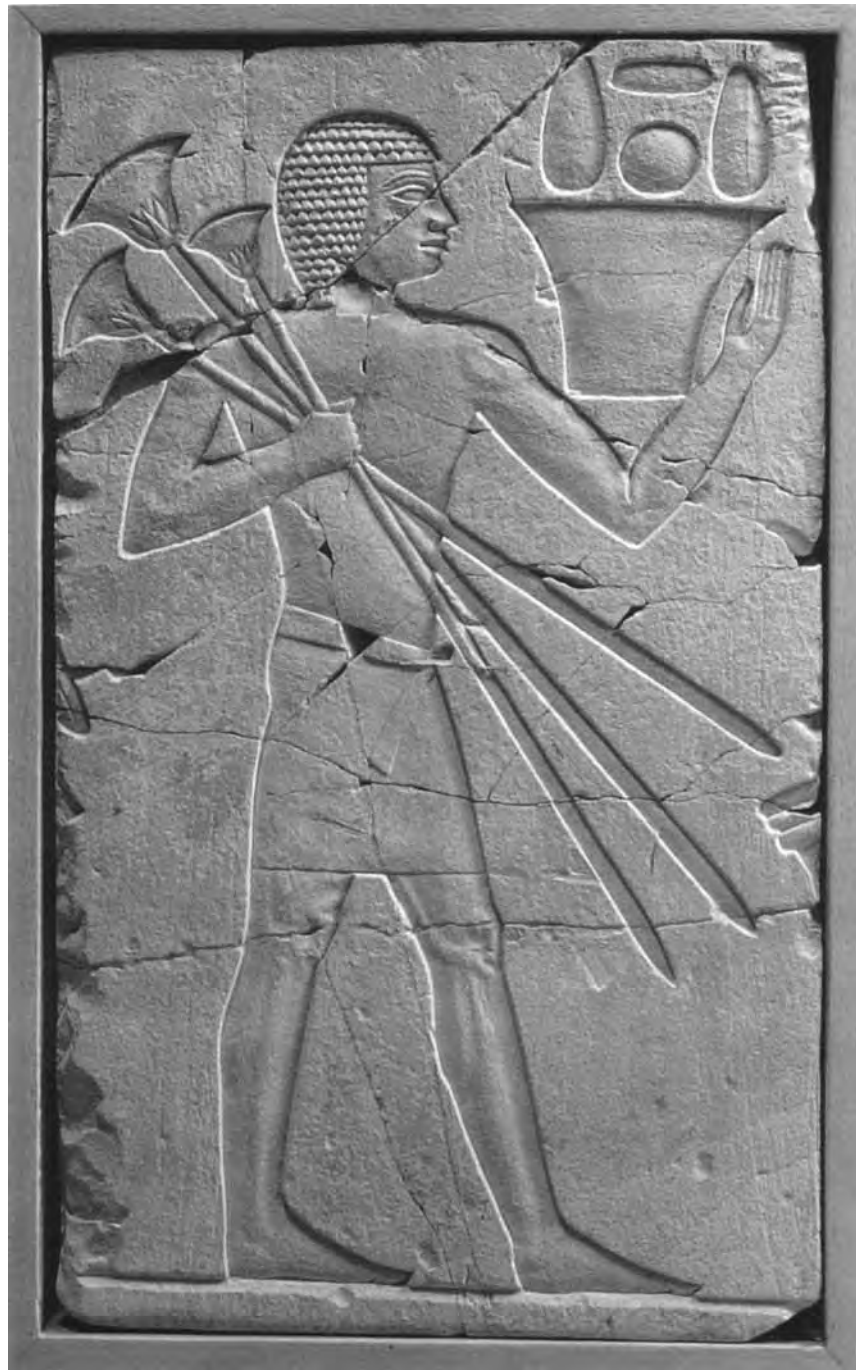


Figure 19. Male Offering Bearer. Limestone. H. 35.3, W. 21.1 cm. Dynasty 26. © The Cleveland Museum of Art, Gift of Hanna Fund, 1949.497 Before Treatment Photo. The relief is fragmentary and has been reassembled from at least eighteen fragments, with a pitted, eroded and scratched surface. The relief is unfinished and was never polychromed. Chatter marks from planing the background using a point chisel are visible in many areas.



Figure 20. Male Offering Bearer. Limestone. H. 35.3, W. 21.1 cm. Dynasty 26. © The Cleveland Museum of Art, Gift of Hanna Fund, 1949.497 During Treatment Photo. The selectively applied fills are readily visible prior to inpainting.



Figure 21. Male Offering Bearer. Limestone. H. 35.3, W. 21.1 cm. Dynasty 26. © The Cleveland Museum of Art, Gift of Hanna Fund, 1949.497 After Treatment Photo.



Figure 22. Mentuemhat in Ecclesiastical Dress. Limestone. H. 132, W. 51.8 cm. Dynasty 26. © The Cleveland Museum of Art, Gift of Hanna Fund, 1951.281. Before Treatment Photo. The relief is fragmentary and has been reassembled from at least thirty-four fragments. Despite this degree of fragmentation, the carved surfaces and painted hieroglyphic text exhibit little wear and are very well preserved.





Figure 23. Mentuemhat in Ecclesiastical Dress. Limestone. H. 132, W. 51.8 cm. Dynasty 26. © The Cleveland Museum of Art, Gift of Hanna Fund, 1951.281. After Treatment Photo. The relief was carved in sunk relief with many areas articulated in subtle sculptural relief with finely incised details. The relief was left unfinished and was not originally polychromed except for the finely painted hieroglyphic columns which exhibit a solid yellow underdrawing painted over in considerable detail using red pigment.

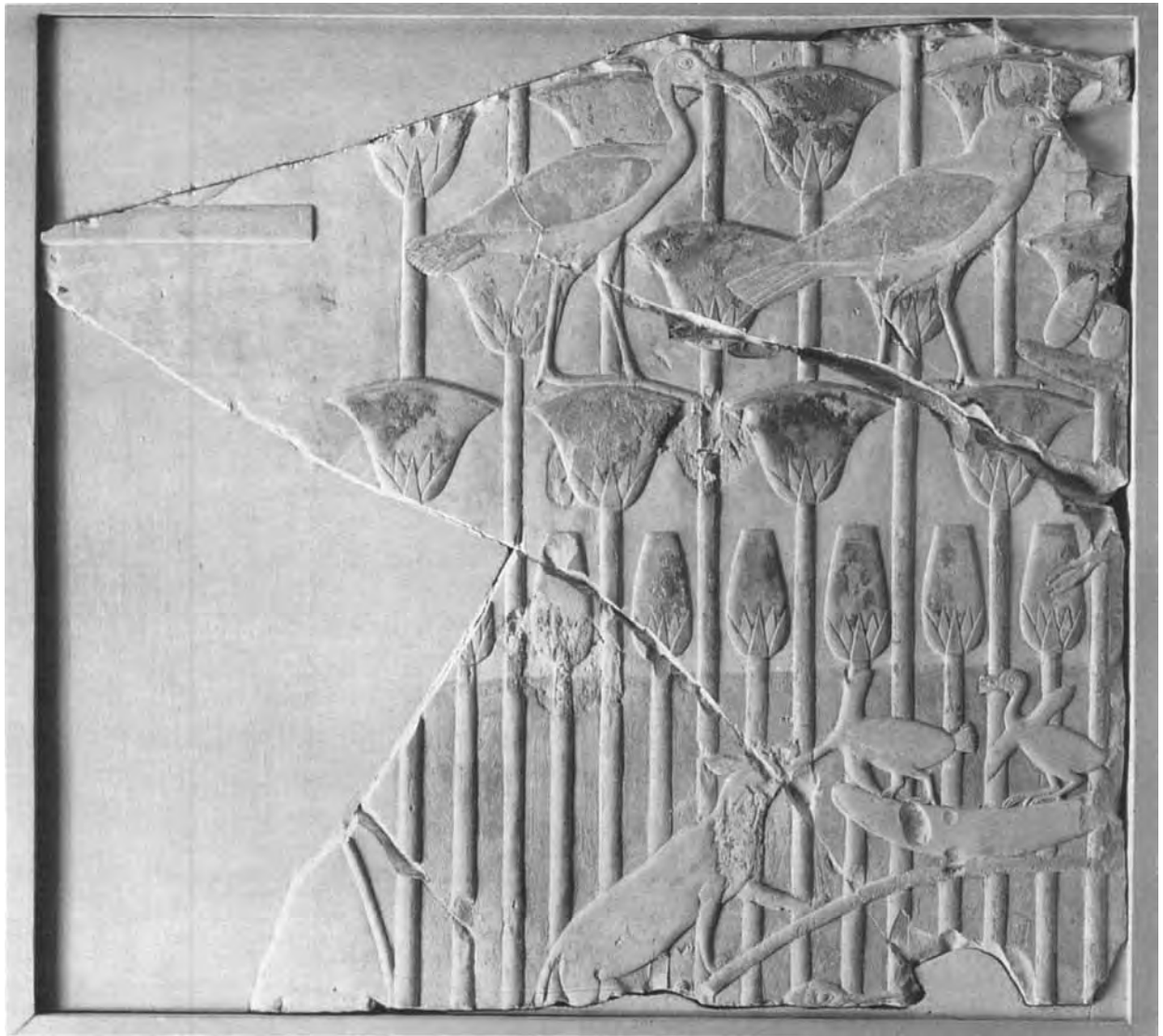


Figure 24. Marsh Scene with Cat and Birds. Limestone. H. 38, W. 41.7 cm. Late Dynasty 25 to early Dynasty 26. © The Cleveland Museum of Art, Gift of Hanna Fund, 1949.498. Before Treatment Photo. It was reassembled from eight fragments with several additional surface chips, using an unknown adhesive. Some of the smaller gaps between fragments had been filled with plaster of Paris and toned to blend with the unpainted stone. Losses at the corners had been compensated with painted wooden wedges, attached to a wooden frame surrounding the relief.

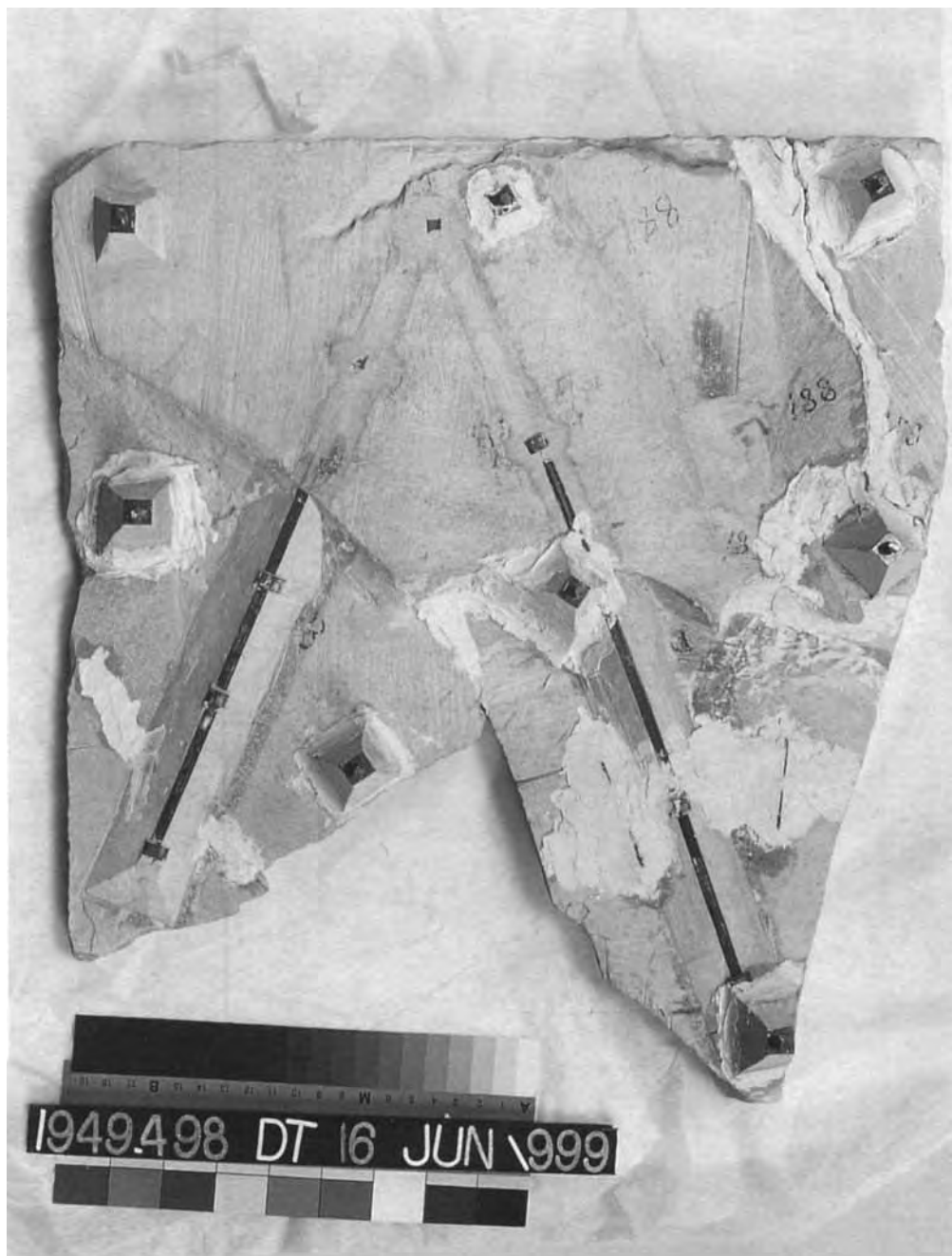


Figure 25. Marsh Scene with Cat and Birds. Limestone. H. 38, W. 41.7 cm. Late Dynasty 25 to early Dynasty 26. © The Cleveland Museum of Art, Gift of Hanna Fund, 1949.498. During Treatment Photo. This photo shows a small version of the invasive metal support system that afflicts this series of reliefs. In this case bent lengths of brass stock were adhered to the reverse using a series of brass staples set into drillholes with an excess of heavy plaster. More invasive systems are illustrated elsewhere (Berman and Griffin, 1999).



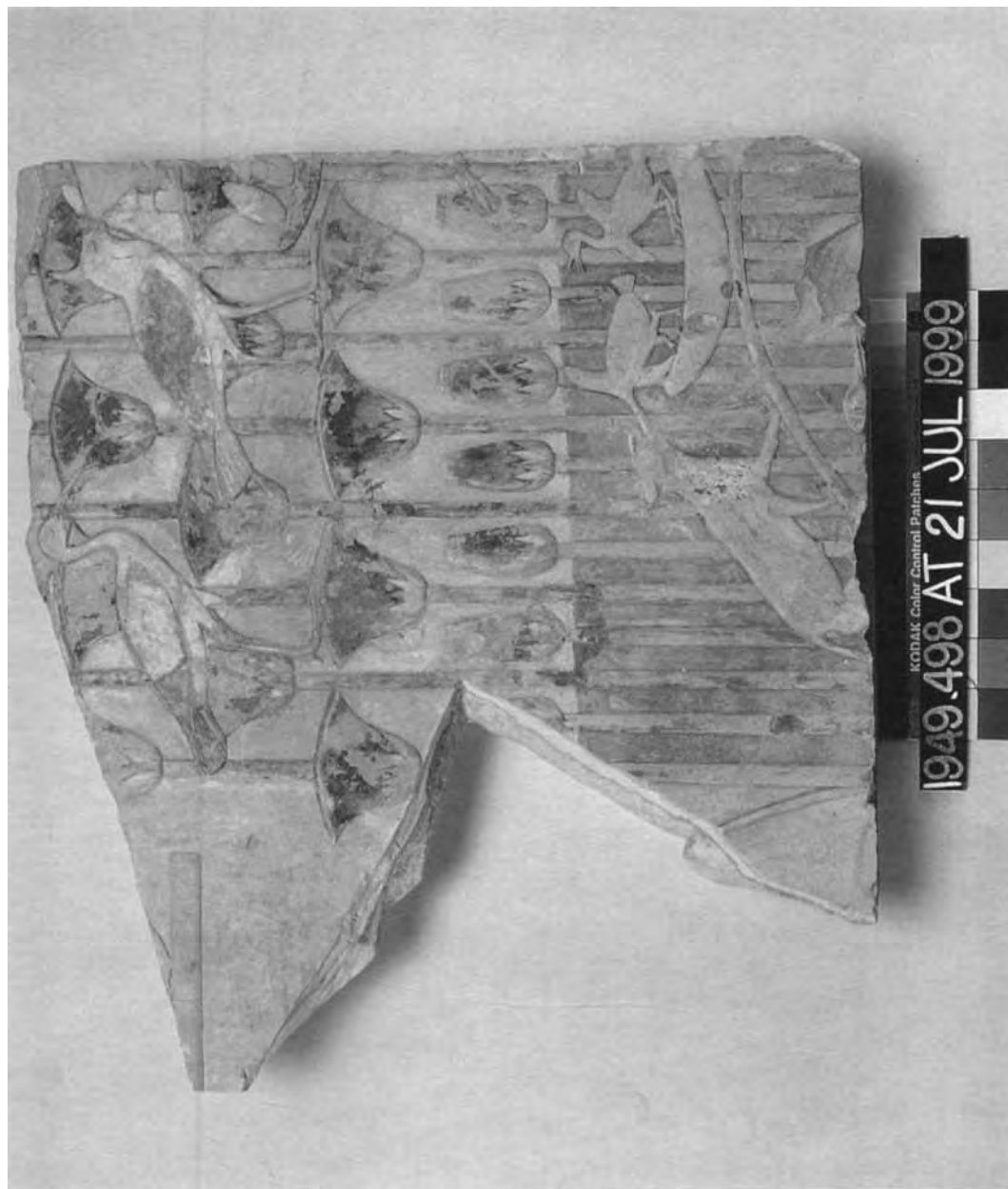


Figure 26. Marsh Scene with Cat and Birds. Limestone. H. 38, W. 41.7 cm. Late Dynasty 25 to early Dynasty 26. © The Cleveland Museum of Art, Gift of Hanna Fund, 1949.498. After Treatment Photo. Pigment traces, generally preserved as a thin wash of color, are visible in many areas. Traces of two reds, blue, green and yellow were noted. A more complete discussion appears elsewhere (Berman et al. 1999, 412).



Figure 27. Tomb Relief of the Chief Physician Amenhotep and Family. Limestone with traces of paint. H. 128, W. 199.5 cm. Dynasty 19, early reign of Ramesses II. © The Cleveland Museum of Art, Leonard D. Hanna, Jr., Fund, 1963.100. Before Treatment Photo. The relief previously was reassembled from seven fragments. Losses had been filled with plaster of Paris, roughly carved and/or sanded and toned a flat beige. A poorly fitted stone block was inserted to fill a loss on the upper proper right, with plaster poured around to fill in the gaps. In general, the old fills exhibited some deterioration, with visible erosion, chipping, and cracking.



Figure 28. Tomb Relief of the Chief Physician Amenhotep and Family© The Cleveland Museum of Art, Leonard D. Hanna, Jr., Fund, 1963.100. During Treatment Photo. After extraneous material around the edges was removed, the plywood backing was cut and sanded to match the contours of the relief and was inset slightly. A bulked adhesive (Rhoplex AC 33 with Scotchlite glass microballoons) was injected into the approx. 1 cm gap between the stone and the backing board; Tyvek tubing and a pastry bag was used to deliver the putty deep within the crevice. The edges of the plywood backing and the filled gap between the stone was disguised using overlapped patches of sturdy Japanese tissue adhered to and covering the plywood. The tissue was floated over the gap and adhered to the bottom edge of the stone (B-72 in acetone).



Figure 29. Tomb Relief of the Chief Physician Amenhotep and Family© The Cleveland Museum of Art, Leonard D. Hanna, Jr., Fund, 1963.100. After Treatment Photo. The tissue was spackled using a pigmented B-72 putty (glass microballoons, cellulose fiber and dry pigments), sculpted, sanded and toned.



Figure 30. Tomb Relief of the Chief Physician Amenhotep and Family. Limestone with traces of paint. H. 128, W. 199.5 cm. Dynasty 19, early reign of Ramesses II. © The Cleveland Museum of Art, Leonard D. Hanna, Jr., Fund, 1963.100. After Treatment Photo. New fills were constructed using existing photodocumentation as a guide. Decorative elements were minimally to unify fragments. Outlines and major internal contours were recreated; finer details such as pleats were not. Fills were executed using a similar pigmented, bulked B-72 putty and toned with watercolors

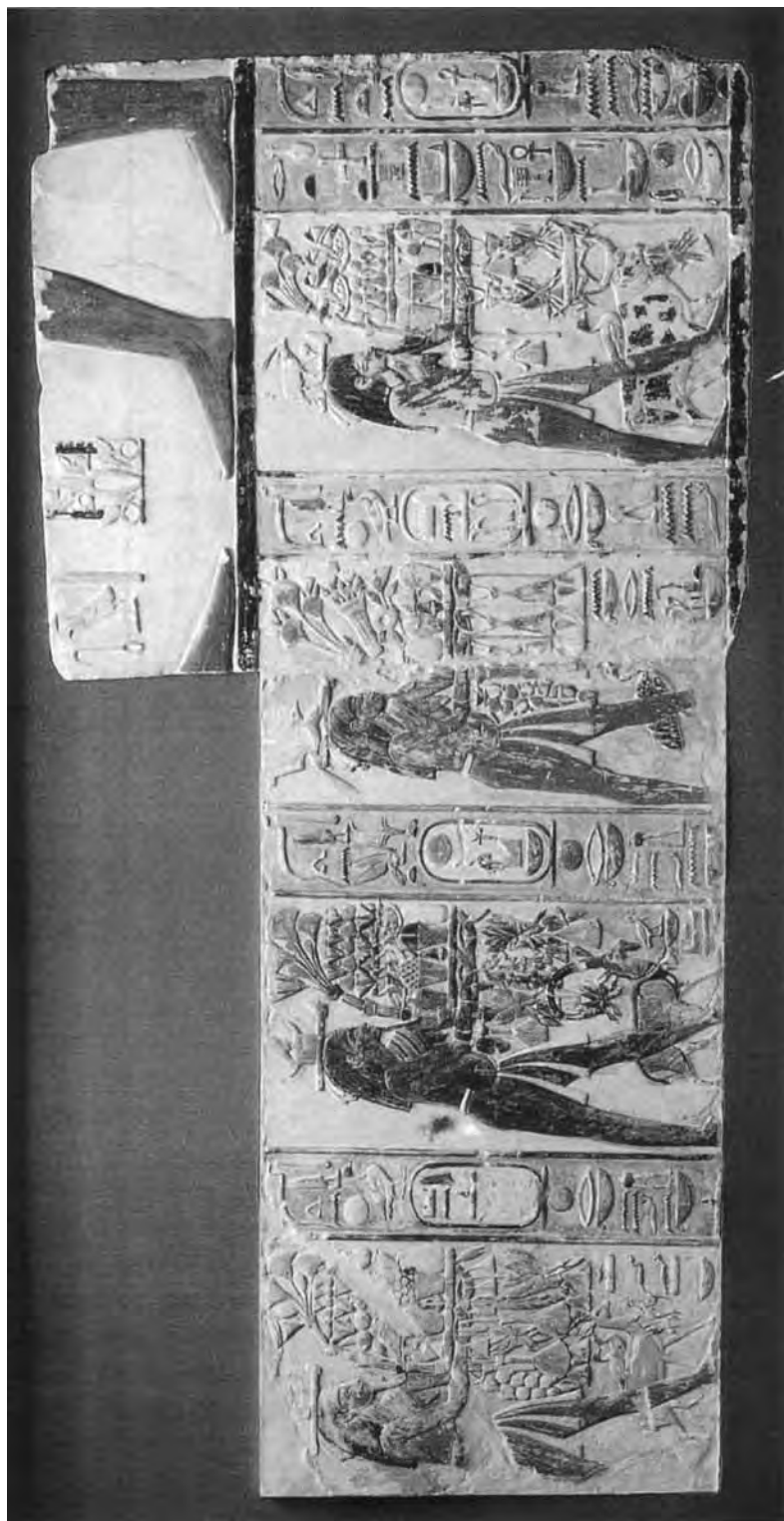


Figure 31. Nome Gods Bearing Offerings. Painted Limestone. H. 66, L. 133 cm. Dynasty 18, Reign of Amenhotep III. © The Cleveland Museum of Art, John L. Severance Fund, 1961.205, 1976.51. Photo taken after first treatment campaign. The relief is composed of two limestone fragments. Fragment 1976.51 (proper left fragment) is approximately 60 cm square and nearly uniform in thickness (approx. 4 cm). Fragment 1961.205 (proper right fragment) is roughly rectangular and measures approximately 20 x 60 cm. It varies in thickness, ranging from 9 cm to 10.5 cm. Plaster fills are found in both lower corners and the upper proper right .





Figure 32. Nome Gods Bearing Offerings. Painted Limestone. H. 66, L. 133 cm. Dynasty 18, Reign of Amenhotep III. © The Cleveland Museum of Art, John L. Severance Fund, 1961.205, 1976.51. After Treatment Photo. The new fill between the blocks extends the eroded break-faces so that they nearly touch but does not attempt to disguise the damage or the joint. This approach makes the fill unapparent and they viewer instead focuses on the marvelous carved and painted details.

# CONSIDERATIONS FOR THE STRUCTURAL STABILIZATION OF DETERIORATED INDUSTRIAL RUBBER

Julie Wolfe and Eleonora Nagy

## Introduction

Many contemporary artists have used rubber for its resilient properties as a medium for artistic expression. However, rubber artworks weaken in elastic strength as they age. Conservators are left with a serious concern for their structural integrity, especially when the strength of a sculpture is contingent on the elasticity of rubber. The Solomon R. Guggenheim Museum in New York includes several artworks that are composed of rubber. The subject of this article revolves around one particular piece created by Richard Serra in 1966-67, entitled *Belts* (Fig. 1). The sculpture includes nine sections of belt that are composed of different types of black, red and tan colored industrial sheet rubber. The sheets are firm, a quarter-inch thick, and 2 to 3 inches wide. Several six-foot long strips of the sheet rubber are tangled together and attached using sharp iron staples. Each of the nine belts weighs approximately 40 pounds. The belts hang in a row from spikes in the wall, and the top strip of rubber in each grouping supports all the weight. A neon element is also attached to the first piece. Guiseppe Panza, an Italian collector, originally purchased *Belts* from Leo Castelli in 1971. Twenty years later, the Guggenheim Museum acquired *Belts*, along with a large group of other conceptual artworks from the Panza collection. The curators at the Guggenheim consider this sculpture to be an important part of the collection, and it was included in the Panza exhibition that opened at the Guggenheim Bilbao in November 2000.

The artist, Richard Serra, completed a series of sculptures in the late sixties made out of strips of industrial sheet rubber (Serra 1978). In an interview, Serra explained these works, "I started working with rubber after I went down to Canal Street and saw all the rubber there. I found more in the rubber than in anything else – a sort of private language going on – and felt if you could only get that language, you could reinforce your art by using that" (Serra 1994, 209). In a conversation between Ms. Nagy and Serra's assistant, we learned that he came across a large stock of rubber from a rubber manufacturer going out of business near his studio (Serra 2000). The belts have been described by an art historian, Clara Weyergraph, "the flexible material becomes subject to gravity: it falls" (Weyergraph 1978, 210). At present, when we consider the belt's preservation – these keywords, "gravity", "hanging" and "falling" seem to linger in our minds as sources for concern as the rubber deteriorates.

The nine belts were stored in crates since the Guggenheim acquired the Panza collection in 1991. Each belt was tucked into a tight compartment, causing it to lie with its edges curled up. They were stored for several years, and the distortion of the belts became permanent due to the oxidation of the rubber. The results of this can be seen in the curve of belt #7 pictured hanging in Fig. 2. Not only are they awkwardly shaped, but the belts no longer hang completely flush against the wall. Furthermore, the rubber strips that hang from the spikes on the wall have become fatigued and three of them are cracking. The cracks widen as they are laid to rest on the



spike. The cracking on the top section of belt #4 penetrates halfway through the thickness of the sheet (Fig. 3). Belt #5, which has a cotton cloth interlayer, starts cracking at the back and the separating is moving forward (Fig. 4). These serious cracking conditions give rise to our primary concern that the most severely deteriorated rubber pieces may fail during installation.

Anticipating a 3-6 month display time for the upcoming exhibition, the belts were vulnerable to failing without structural support or repair. The artwork was not considered to be in exhibitable condition.

### **Three Phase Conservation Program Richard Serra, *Belts*, 1966-67**

I. Preservation	II. Structural Repair	III. Replacement
mounting	adhesive testing	collecting rubber
crating	solvent testing	that matches <i>Belts</i>
storage	apply strip linings	replacing cracked strips

Serra's studio was contacted about these different treatment options. The artist did not want the piece modified, preferring that our actions involve minimal intervention. Based on our discussions, a long-term conservation plan has been worked out starting with the least interventive approach and gradually moving to future replacement if necessary. The first steps taken are non-intrusive preventative measures that include supporting mounts and a new crating system. The second step is to research the methods and materials for a local strip lining to repair the cracking rubber. The authors have carried out several mock-up treatments that involve using a toned fabric lining adhered to the inner curve of the belting for structural support. A support lining would be a short-term structural repair to extend the life of the *Belts* in its original form. The third step may involve the eventual replacement of these supporting rubber strips. The artist has agreed to collaborate with the Guggenheim conservators when and if the time for replacements arrives.

#### **Preservation: Mounting**

In the original display of *Belts*, each belt section was hung on a spike nailed to the wall. There have been several variations in the positioning and type of hardware for assembling the belts, as documented in past photographs. It is essential that the belts continue to be hung as the artist originally intended, with casual display on spikes. This has been a defined guideline despite the fact that the rubber has become less pliable. The original hardware for hanging the belts has been lost and replacement spikes were purchased. Early installation photographs were used for this purpose. In order to maintain the artist's original intent to hang the belts on spikes, these had to be modified slightly in order to compensate for the fact that the *Belts* do not hang flush against the wall any more. The belts have stiffened in varying configurations, requiring that each spike

be positioned on the wall at a slightly different angle. In order to find the best angle for each spike, a mock-up wall was constructed with a hole drilled where the spike could be inserted and adjusted up and down. The belts were hung one by one, and the ideal angle of the spike was measured.

A complex mounting system was designed for the Bilbao installation in order to more safely hang each belt on a spike. Fig. 5 shows a diagram of the mount as it attaches to the spike. The spike was secured into a metal back plate made of steel. The plate screwed into the wall and held the spikes at the correct angles. To prevent the spike from rotating, the spike was locked in position with a tightening screw on the steel tubing. This screw allowed easy installation and small adjustments if necessary. Each back plate is stamped with the identification number of the belt since they cannot be interchanged. The back plates were made invisible by inseting them a quarter inch into the wall so they could be covered with plaster and paint (Fig 6).

The cracked and stiff rubber strips were bending too sharply over the top of the spikes. To compensate, each spike had a custom fabricated thin sheet of steel welded onto the shoulder of the spike to soften the angle of bend (Fig. 7). Also, the steel support helped to distribute the weight of the belt over a larger area, and reduced the strain on the cracked areas. The plate was camouflaged by toning with a thick layer of Beva® D-8 and dry pigments. The thick layer of paint also served to cushion the metal plate that was in contact with the rubber surface. Fig. 8 shows one of the belts installed on its mount after inpainting to match the tone of the rubber.

### **Preservation: Crating, Storage**

New crates for transportation and storage were fabricated to mitigate ongoing, irreversible distortion. When the belts hang on the wall, they stretch vertically and expand in length, holding a position quite different from when they are lying down. The belts must lie in a horizontal position when they are stored. However, they should not be allowed to slump in shape as the form relaxes and widens. The belts are stapled together so loosely, that they move around freely when handled. It is important to hold the belts in their elongated “hanging” position even when they are lying down in storage. Ideally, the belts should harden as they age in the “hanging” position, in other words, the position they hold when they are hanging from the spikes. The rubber no longer has the elastic strength to be repeatedly stretched during installation and deinstallation.

Anoxia was considered as an option for long-term preservation. Studies published in the conservation literature have shown anoxia to be a successful means for slowing down the deterioration process of rubbers (Shashoua 1999; Shashoua 1993). There were a number of reasons why anoxia for the Serra *Belts* was not found to be a viable option. First, the large scale of each belt made it difficult to prepare individually sealed and effective enclosures. The extremely sharp iron staples were an added risk for tearing barrier films. Second, a tremendous amount of Ageless (oxygen scavenger) and possibly a constant nitrogen stream would be

required, making the cost and maintenance time high. Finally, a failed system would most likely create a worse environment for the rubber.

The new crating system was designed with three functions in mind: to house the sculpture during storage, to aid in the installation, and to provide a safe environment for transportation. Each belt is stored on its own tray made out of plywood lined with Marvelseal. The inside of the crate has been lined with Corrosion Intercept to absorb the rubber's off-gassing and to prevent contamination of the storage environment. A wooden block screwed into the plywood to support the top strip of each belt. The block has been carved and padded with Ethafoam to mimic its interior curve of the belt strip. With the belt resting on the tray, the entire tray can be raised to a vertical position and the belt would hang from the piece of supporting wood. Additional supporting pieces of wood were cut to conform to the shape of the belt along its length. A cage of padded plywood cauls holds the belt in the ideal position even when it is resting horizontally (Fig. 9). The trays can also be used for installation to carry the belts to the wall. After tilting the tray and leaning it against the wall, the plywood supports can be removed and the belt can be directly transferred to the spike on the wall. The installation trays have been used with great success during the 2000 installation of the *Belts* in Bilbao.

### **Structural Repair: Strip Lining**

Methods have been tested for structural repair to determine whether a strip lining can be adhered to the rubber for support. The limited time frame before the exhibition in November 2000 resulted in adhesive testing that began prior to the completion of analytical identification of the rubbers. As the belts could have consisted of several different types, a small selection of elastomers was collected. Products that would have been available to Serra in the 1960's were EPDM, neoprene, and butyl rubber. These types were also visually comparable to Serra's sculpture. It was thought that by choosing three types of rubber, applicable information for the Serra *Belts* would be obtained. All of the lining tests using solvents and adhesives were done using new sheets of rubber, with known compositions, purchased from McMaster-Carr.

### **Solvent Cleaning Tests on New Rubber**

Solvent effects have to be considered when testing adhesives. The published literature on this topic shows that exposing rubber to solvents has long-term detrimental effects causing swelling and the removal of surface crusts containing oxidized rubber and migrating plasticizers. It is possible that surface crusts may in fact be protective (Sale 1988; Loadman 1993). Studies have not included the vast array of different industrial rubber types, nor do we know how short-term solvent exposure affects the surface. The question must also be asked whether there are cleaning systems that would remove surface contaminants to facilitate adhesion. Technical references stress the importance of surface preparation prior to adhesive bonding (Shields 1984). Solvents are recommended for pre-cleaning to remove grease or lubrication from the original fabrication

process, and studies have shown that weak bonding can be linked to surface contamination of plasticizers that have migrated to the surface (Fust 1966).

A very strong adhesive bond is required for a strip lining, since each belt weighs approximately 40 pounds. The 3" x 1" area of rubber on the top strip bears the entire weight of the sculpture as it curved over the spike; this is the intended area for a possible surface lining. The surface of this area may need solvent cleaning in order to obtain a strong adhesion between the rubber and fabric lining. The effects of swabbing solvents onto the three rubber types, EPDM, neoprene and butyl rubber, were tested. The list of solvents used on each includes: water, isopropanol, ethanol, toluene, acetone, Shell mineral spirits 135, and Duro-Clean®. Duro-Clean® is a proprietary rubber cleaning product, the primary contents of which include water and butyl cellosolve (US Chemical 1995). Visual observations as well as viewing under a reflective microscope at 6X magnification were used to monitor immediate swelling or rubber dissolution. Afterwards, the solvent test strips were attached to a piece of mat board and each area was labeled. The writing was protected with a sheet of Marvelseal, and they have been exposed to sunlight for one and a half years. The test strips were re-examined periodically, and no additional changes from the original observations, such as cracking or deterioration, have been observed on the areas that received short-term exposure to solvents. It is important to note that re-testing using the same list of solvents on untreated rubber sections show that the rubbers have deteriorated to the point that they are now more sensitive to solvents. All of the solvents caused the cotton swabs to turn black, indicating surface dissolution. Therefore, the results of the solvent testing presented in this paper are only relevant to new, unaged rubbers.

EPDM rubber, an ethylene-propylene diene monomer, was first produced on a large scale in 1963 and was used in the belting industry (Morton 1987; Hofmann 1989). The black, ¼" thick EPDM had a smooth surface and a durometer hardness of Shore A60. The EPDM rubbers have been purported to be very resistance to chemicals, and they are only moderately attacked by acetone, alcohol, dilute acids and alkalis. Due to its non-polarity, EPDM swells in aliphatic, aromatic or chlorinated hydrocarbons (Hofmann 1989). Using the solvents listed previously, areas were swabbed with each solvent. Isopropanol and ethanol appeared to change the surface the least. The other solvents caused the surface of the rubber to become abraded in raking light and therefore appear more matte. Acetone and toluene showed dissolution and swelling of the rubber and the swabs turned black.

A black neoprene sample was purchased as a commercial-grade rubber with a durometer hardness of Shore A: 45-55. Neoprene was considered one of the first synthetic rubbers and was developed in the 1930's. It was a typical elastomer used for belting (Brady 1991). Overall, the surface exhibited a typical whitish bloom that may be a layer of microcrystalline wax. Waxes were commonly used as short-term antidegradants, and they were added to the bulk rubber in concentrations high enough to cause migration at the surface. The recommended surface degreasers in Shields' Adhesives Handbook are toluene, methanol, and isopropanol. All of the solvents listed above for testing removed the whitish surface bloom. The isopropanol and Duro-clean® showed the least change in surface and caused no visible swelling in the neoprene.

The third rubber for testing was a black butyl sheeting with a durometer hardness of Shore A: 55-65. Butyl rubbers are an inexpensive synthetic rubber composed of isobutylene-isoprene copolymers. As with the neoprene, it had a whitish bloom on the surface that is slightly metallic in appearance. The surface bloom did not adhere to the surface well, and it could be removed with the soft scratch of a fingernail. Shields' Adhesives Handbook states that toluene is a recommended surface degreaser prior to adhesion. All of the solvents listed above for testing remove the whitish bloom. The butyl rubber showed the least surface change when exposed to water and DuroClean®. The rubber appeared to be resistant to swelling from the short-term exposure all of the tested solvents.

### **Solvent Cleaning Tests on Aged Rubber**

It should be noted that no extensive testing has been performed on the artwork itself. From the series of belt sections, the black belt #9 was predicted to need a support lining in the future. The top rubber section began cracking and the rubber feels stiffer than the others. The surface of the rubber has a whitish bloom and the black color has faded to a chocolate brown. The edges appear greenish in color due to abrasion. Surface cleaning tests on belt #9 were carried out using the same solvents listed before. As anticipated, the rubber was found to be much more sensitive to solvents. Water immediately turned the rubber a matte brown, rust color. Isopropanol did not cause any visual change to the surface. However, by the next day the area tested had turned brown. Mineral Spirits 135 and odorless mineral spirits did not cause any visible change until several days later. Application of ethanol resulted in no visual change in the surface other than moderate surface cleaning. Several months later, the area tested with ethanol still did not show any changes. It is important to note that the solvents did not always show immediate effects, and that changes often took several days to occur.

### **Adhesive Testing**

A large group of adhesives ranging from proprietary products to well-known conservation adhesives were tested for adhesion. Several Scotch Grip™ contact adhesives containing a range of rubber bases were recommended by 3M. The ScotchWeld™ DP8005 has recently come onto the market and was recommended by 3M for adhering rubber. Other adhesives such as Beva® D-8, Beva® Film, hide glue, and acrylic emulsions were recommended for testing by other conservation professionals (Bruno 2000, Landgrebe 2000, Blank 2000). The adhesives were tested on the same three rubbers: EPDM, neoprene and butyl. A complete list of adhesives is shown below with results categorized as poor, fair, or good. The adhesive testing involved gluing strips of fabric onto the sample rubber giving a 1 inch square simple lap join. Also, there is a list below of different lining fabrics that were compared against each other as being poor, fair or good.

<u>Primary list of adhesives tried:</u>	<u>Results:</u>
Beva® D-8 Dispersion	good
Beva® 371 Film	good
Hide Glue	good
3M Scotch™ 300LSE tape	good
3M™ High Temperature Aluminum Foil Tape 433	poor
3M™ Glass Cloth Tape 361	poor
3M Scotch Grip™ 1300	poor
3M Scotch Grip™ 847	fair
3M Scotch Grip™ 4799	poor
3M Pronto™ CA-40H	good
3M Pronto™ CA-5	good
3M ScotchWeld™ DP8005	good
Pliobond 20	poor
Jade 403	fair

<u>Lining fabrics tested:</u>	
Goretex	fair
Woven polyester fabric	good
Tyvek	fair
Thera-Band natural rubber sheeting	poor
Polyester/Linen fabric	good

The shear strength of the adhesives and lining materials was initially tested using a simple, manual pull test. As testing proceeded, five adhesives that appeared the strongest were selected. This group was retested using the polyester/linen fabric to provide direct comparisons. The table in Fig. 10 shows the testing results for the three rubbers using Beva® D-8, Beva® Film, ScotchWeld™ DP8005, Scotch Grip™ 847 and Scotch™ 300LSE tape. For the Beva® D-8, one layer of undiluted adhesive was brushed onto the fabric and allowed to dry prior to the reapplication of Beva® D-8 before adhesion. Two layers of Beva® Film were heat set onto the fabric prior to heat setting the fabric onto the rubber. The other adhesives had only one layer added prior to clamping onto the rubber. Shear strength testing was performed using a homemade device with a spring-loaded pressure gauge, vices and clamps (Fig. 11). The join was slowly strained by manually increasing 1 pound per 20 seconds until the join eventually failed. Also, since ethanol showed minimal swelling of the three rubbers and showed the least change in the surface of Serra belt #9, the adhesive strengths with and without surface cleaning using ethanol was compared (abbreviated in the table as EtOH prep).

The strength of a particular adhesive varied depending on the rubber type. The strongest adhesive for EPDM was the Beva® D-8 dispersion on an uncleaned rubber surface. The Beva®

Film on uncleaned rubber was second, yet almost half as strong when compared with the Beva® D-8. The third strongest join was the 300LSE tape on an ethanol cleaned surface. The Scotch Grip™ 847 was weaker still, and the ScotchWeld™ DP8005 failed almost instantly.

For neoprene, the strongest adhesive was the Beva® D-8 dispersion, followed closely by the Beva® Film. The spring gauge was limited to 28 pounds, consequently the full strength of the neoprene/ Beva® D-8 could not be completely measured - it sustained 28 pounds. The Scotch™ 300LSE tape was the third strongest join with the ethanol pre-cleaning. The fourth strongest adhesive was the ScotchWeld™ DP8005, however it is important to note that the product was difficult to use as it is heavily bulked and difficult to spread over the surface evenly. The weakest join was the Scotch Grip™ 847.

The strongest adhesive for butyl rubber was the Beva® Film after ethanol pre-cleaning. The second strongest was the 300LSE tape pressed onto an ethanol cleaned surface. The Beva® D-8 (uncleaned) and the Scotch Grip™ 847(cleaned) were the same in strength after the tape. The weakest adhesive was the ScotchWeld™ DP8005.

It cannot be stated conclusively whether the ethanol pre-cleaning of the rubber surface aided in the strength of the adhesive join. Some of the tests showed that the join was stronger with the ethanol pre-cleaning. For example, the Beva® Film strength more than doubled for neoprene cleaned with ethanol. However, the data show that this is not always the case and the results are random. The Beva® D-8 strength on EPDM was actually weaker when it was pre-cleaned with ethanol. Retesting is required in order to make any conclusions on the necessity for surface preparation using solvents.

### **Clamping Rubber During Adhesion**

While carrying out the adhesive testing, it was noted that the rubber easily becomes distorted during clamping. It was not uncommon for the mock-ups to have a dimple in the rubber where the clamp jaws were attached. This can be avoided by using Plexiglas plates on flat surfaces. However, adhering a lining to a curved section on the belts would require making a caul to support the patch during clamping. The caul needs to have an identical shape to the inside and outside curve of each individual belt as it hangs on the spike. Evenly distributed pressure is extremely important to avoid distortions during clamping. Tests on a mock-up using a caul made from a moldable polycaprolactone sheeting called Klarity™ showed promising results. The Klarity™ sheeting could be cut on the table saw, and softened in hot water. It turns transparent when it becomes moldable. Mylar was used as a barrier while the softened Klarity™ could be molded to the inside of the belt, and a second piece molded to the outside of the belt. Easily and accurately, two shaped cauls were made for a mock-up strip of curved rubber. A lining was adhered to the inside curve and was clamped using cauls. No distortions were observed in the rubber after the mock-up treatment.

## **Toning Fabric**

Toning the fabric would be required because the location for a strip lining is visible to the viewer's eye. Several layers of Beva® D-8 toned with dry pigments could create an excellent likeness to rubber. At least eight or more thin layers were brushed on and each layer was sanded prior to the next application of Beva in order to reduce brush strokes. While experimenting with pigmented Beva® D-8, it was discovered that by bulking with Scotchlite™ H50 glass bubbles, a thick putty could be made. The putty was easy to manipulate and it held its shape during drying. When dry, it has the appearance of rubber and it remains slightly elastic. Using a scrap of distressed rubber, it was possible to fill thick gaps with the putty, maintaining minimal shrinkage upon drying. It should be noted, however, that when the piece of rubber was stretched, the join at the fill would fail. With more testing, and consideration for reversibility, bulked Beva® D-8 may be a useful fill material for losses in rubber.

## **Replacement**

The final phase of the conservation program for the Serra *Belts* was to begin collecting samples of rubber that match the various colors of each individual belt. Eventually, the top strips of rubber on each belt section will become too weak and brittle to support the weight of the belt, and in order to exhibit the artwork, the only solution would be to replace the top strip with a new piece of rubber. This would involve opening up a few iron staples, removing the approximately six foot long section, inserting a new replacement piece, and re-closing the staples. This operation will only be carried out with the consultation of the artist's studio, and when all other options have been exhausted. A complete set of replacement rubbers have been purchased from several rubber suppliers within New York and are stored for future use.

## **Summary**

A major work by a prominent artist was successfully stabilized for the installation in Guggenheim Bilbao using minimum intervention. The authors hope that the improved crating and installation system will extend the lifetime of this sculpture. The second phase exploring structural repairs has been researched and is ongoing. Due to the lack of published work in the area of repairing rubber, basic groundbreaking experiments and research was carried out. After completing tests to the degree presented in this paper, identification of the rubbers were received from James Martin of Orion Analytical. Using FTIR microscopy, he identified belts #4 and #5 as natural rubber, while the remaining seven are composed of neoprene (Martin 2000). Fortunately, we have already gained some knowledge about the adhesive properties of neoprene, and Beva® D-8 seems to be promising. Solvent cleaning prior to the structural reinforcement appears to be beneficial, however that still needs to be confirmed. We have also resolved a successful technique for clamping the linings using formed Klarity™ sheeting. More testing is required on natural rubber as well as artificially aged rubber samples before any treatment can be



*Wolfe and Nagy*

done on the Serra *Belts*. The final phase of the conservation involving partial replacement is on going and the conservators at the Guggenheim Museum continue to collect rubbers that resemble the Serra *Belts*.

## **Acknowledgments**

The authors would like to thank James Martin of Orion Analytical for his generous contribution to this project and the identification of the rubber types. This work began when Julie Wolfe assumed the position of a Getty Fellow at the Guggenheim in 1999. The authors would like to thank the Getty Grant Program for their support.

## **Materials**

### Crating:

Corrosion Intercept

Engineered Materials, Inc., 113 McHenry Road, Suite 179, Buffalo Grove, IL 60089,  
(847) 215-1725, (847) 215-1743

Marvelseal

Benchmark, (609) 397-1131

### Solvents:

Acetone, ethanol, isopropanol, toluene

Fisher Scientific, Fair Lawn, New Jersey, 07410

Duro-Clean®, concentrated detergent cleaner

Advanced Products Distributors, Inc., 601A Lofstrand Lane, Rockville, MD 20850,  
(800) 421-1048

Mineral Spirits 135 (15% aromatic content), Shell hydrocarbon solvents

Conservators Emporium, 18124 Wedge Parkway, Ste. 458, Reno, Nevada, 89511,  
(775) 852-0404, fax (775) 852-3737

### Linings:

Goretex, Tyvek, woven polyester fabric

Talas, 568 Broadway, New York, NY 10012, (212) 219-0770.

Thera-Band

Canal Rubber, 329 Canal St., New York, NY 10013, (800) 444-6483

*Wolfe and Nagy*

Polyester/Linen fabric, 220 g/m

Art et Conservation, 33 avenue Trudaine, 75009 Paris, France, [artetco@aol.com](mailto:artetco@aol.com), +33 1 48749582, Fax: 33 1 42803538

Rubbers: all from McMaster-Carr Supply Company, [www.mcmaster.com](http://www.mcmaster.com)

Butyl rubber, for solvent and adhesive testing, Shore A: 55-65, part number 8609K19

EPDM, for solvent and adhesive testing, part number 8610 K86

Neoprene, for solvent testing, reinforced commercial-grade, Shore A: 45-55, part number 8698K75

Neoprene, for adhesive testing, commercial-grade, part number 9455K15

Adhesives:

3M Scotch™ 300LSE tape, double sided, acrylic adhesive base

Construction Products Corporation, 3M distr., 305 W. Torrance Blvd., Unit D, Culver City, CA, (310)323-1104

the following eight samples from 3M Adhesives Division, St. Paul, MN 55144-1000, (800) 364-3577:

3M Scotch Grip™ 1300, polychloroprene base, yellow colored

3M Scotch Grip™ 847, nitrile rubber base, dark brown color

3M Scotch Grip™ 4799, SBR rubber base, black color

3M™ High Temperature Aluminum Foil Tape 433, silicone adhesive base

3M™ Glass Cloth Tape 361, silicone adhesive base

3M Pronto™ CA-40H, ethyl cyanoacrylate, poly(methyl methacrylate), hydroquinone

3M Pronto™ CA-5, ethyl cyanoacrylate

3M Scotch-Weld™ DP-8005, methacrylate – ABS resin copolymer

*Wolfe and Nagy*

Beva® D-8 Dispersion, vinyl acetate/ethylene copolymer with vinyl alcohol/vinyl acetate and soap

Conservator's Products Company, P.O. Box 411, Chatham, N. J., 07928, (973) 927-4855.

Beva® 371 Film, vinyl acetate/ethylene copolymer with paraffin wax

Conservator's Products Company

Hide Glue, Kremer Pigments Inc., 228 Elizabeth Street, New York, NY 10012, (212) 219-2394

Jade 403, vinyl alcohol/vinyl acetate copolymer with vinyl acetate/ethylene copolymer and soap

Talas, 568 Broadway, New York, NY 10012, (212) 219-0770.

Klarity™, polycaprolactone sheeting, thermoplastic splinting materials

Larson Products, Inc., 2844 Banwick Rd., Columbus, OH, 43232, (614) 235-9100

Pliobond 20, nitrile rubber, thermosetting phenolic

McMaster-Carr Supply Company, [www.mcmaster.com](http://www.mcmaster.com)

Scotchlite™ H50, soda-lime-borosilicate glass bubbles, 20-60 micron particle sizes

3M Specialty Additives, 3M Center Bldg. 220-8E-04, St. Paul, MN 55144-1000,  
(800) 367-8905

## References

Brady, G., and H. Clauser 1991. *Materials handbook*, 13th ed. New York: McGraw-Hill, Inc. 286.

Blank, S. 2000. Personal communication. Objects conservator, Private Practice, Santa Monica, CA.

Blank, S. 1990. An introduction to plastics and rubbers in collections. *Studies in Conservation* 35: 53-63.

Blank, S. 1989. Rubber in museums: a conservation problem. *Australian Institute for the Conservation of Cultural Material Bulletin* 14 (3 & 4): 53-93.

Bruno, L. 2000. Personal communication. Objects conservator, Brooklyn Museum of Art, Brooklyn, New York.

Fust, G., and A. Kays. 1966. Adhesives for bonding of insulation in solid propellant rocket motors. *Applied Polymer Symposia* 3: 228-229.

Hofmann, W. 1989. *Rubber technology handbook*. Munich: Hanser Publishers. 93.

Landgrebe, B. 2000. Personal communication. Objects conservator, Donald Judd Estate, Marfa, Texas.

Loadman, M.J.R. 1993. Rubber: Its history, composition and prospects for conservation. In *Symposium '91: Saving the twentieth century: the conservation of modern materials*, ed. D. Grattan. Ottawa: Canadian Conservation Institute. 59-80.

Mark, J., et al., eds. 1994. *Science and Technology of Rubber*, 2nd ed. San Diego: Academic Press.

Martin, James 2001. Laboratory analyses of Serra rubber samples: project 884. Unpublished report. Williamstown: Orion Analytical, LLC.

Morton, M. 1987. *Rubber Technology*. 3<sup>rd</sup> ed. New York: Van Nostrand Reinhold Company. 260-269.

Sale, D. 1988. The effects of solvents on four plastics found in museum collections: a treatment dilemma. In *Modern Organic Materials*. Edinburgh: The Scottish Society for Conservation and Restoration. 105-114.

Serra, R. 1994. *Writings: interviews*. Chicago: University of Chicago Press.

Serra, R. 2000. Personal communication. Artist. New York City.

Serra, R., ed. 1978. *Richard Serra: arbeiten 66-77*. Tübingen: Kunsthalle.

Shashoua, Y. 1999. Ageless® oxygen absorber: from theory to practice. In *ICOM Committee for Conservation triennial meeting (12<sup>th</sup>), Lyon, 29 August-3 September 1999: preprints*. Vol II. London: James & James. 881-887.

Shashoua, Y. 1993. A field trial for the use of Ageless® in the preservation of rubber in museum collections. In *Symposium '91: Saving the twentieth century: the conservation of modern materials*, ed. D. Grattan. Ottawa: Canadian Conservation Institute. 363-372.

Shields, J. 1984. *Adhesives Handbook*, 3rd ed. London: Butterworths.

U.S. Chemical. 1995. Material safety data sheet US95100 707Z XX. August 19, 1995.

Weyergraf, C. 1978. From 'trough pieces' to 'terminal' study of a development. In *Richard Serra: arbeiten 66-77*. Tübingen: Kunsthalle. 206-217.

*Wolfe and Nagy*

**Authors' Addresses**

Julie Wolfe, Assistant Conservator, J. Paul Getty Museum, Decorative Arts and Sculpture Conservation, 1200 Getty Center Drive, Suite 1000, Los Angeles, CA 90049 (310) 440-7266 (jwolfe@getty.edu)

Eleonora Nagy, Associate Conservator, Solomon R. Guggenheim Museum, Sculpture Conservation, 620 W. 47<sup>th</sup> Street, New York, NY 10036, (212) 423-3730 (enagy@guggenheim.org)

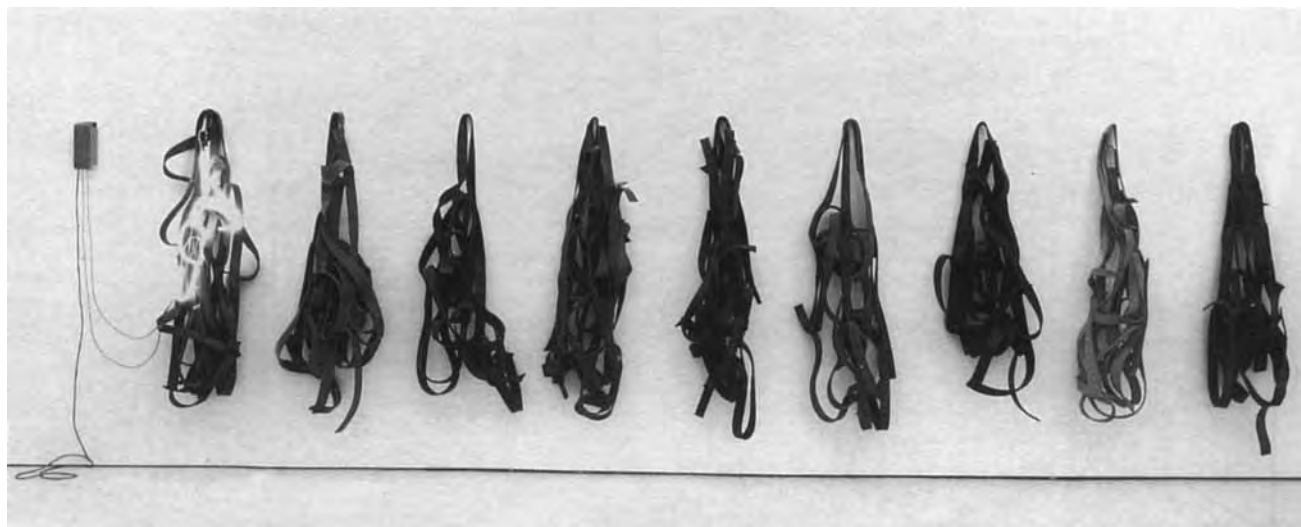


Figure 1. Serra, *Belts*, 1966-67, rubber, neon, iron staples.



Figure 2. Serra's belt #7 having a mount prepared on a temporary wall.

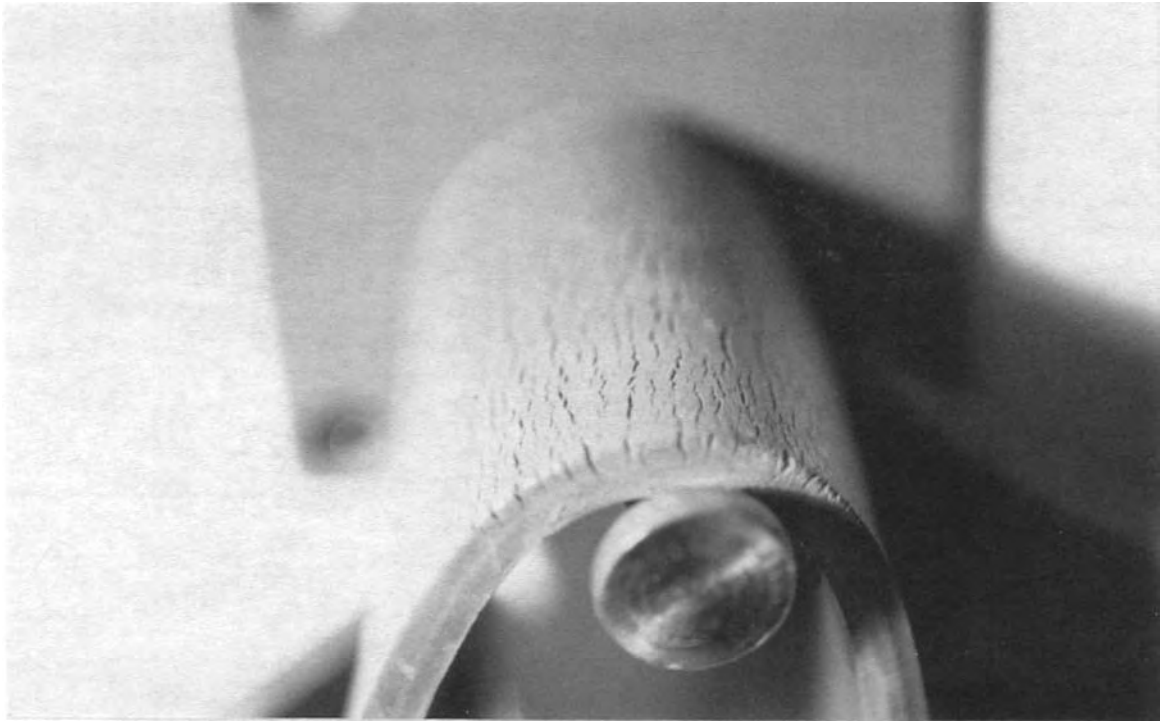


Figure 3. Cracking rubber on belt #4.

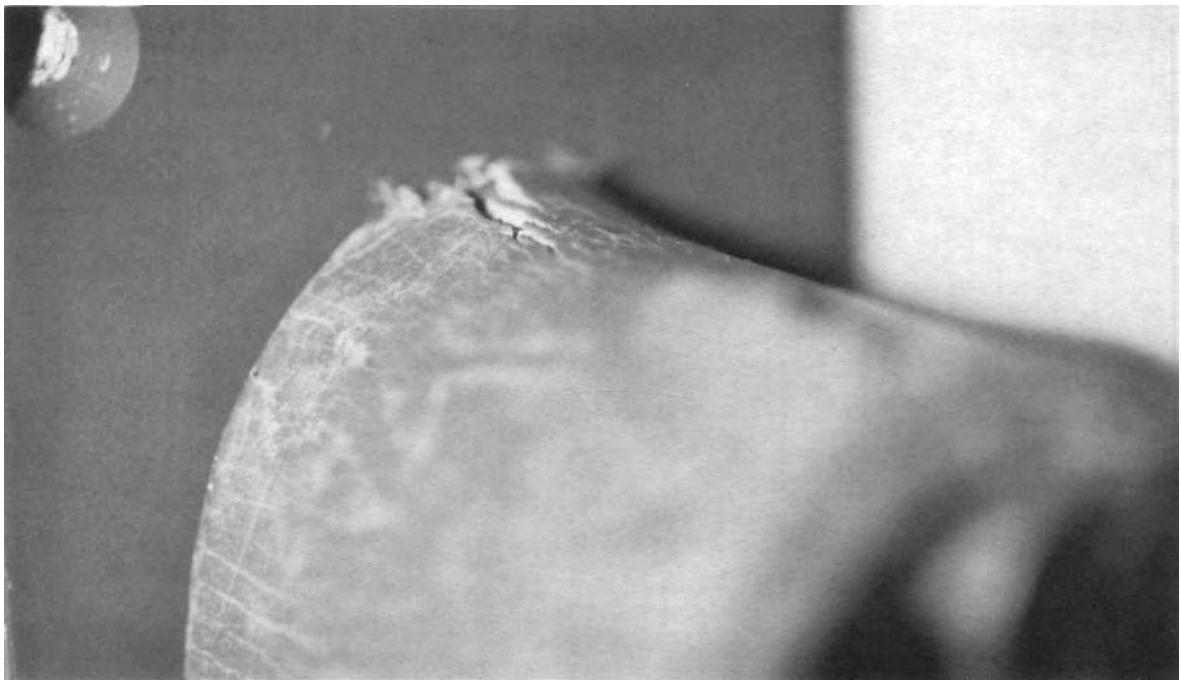


Figure 4. Cracking rubber on belt #5.

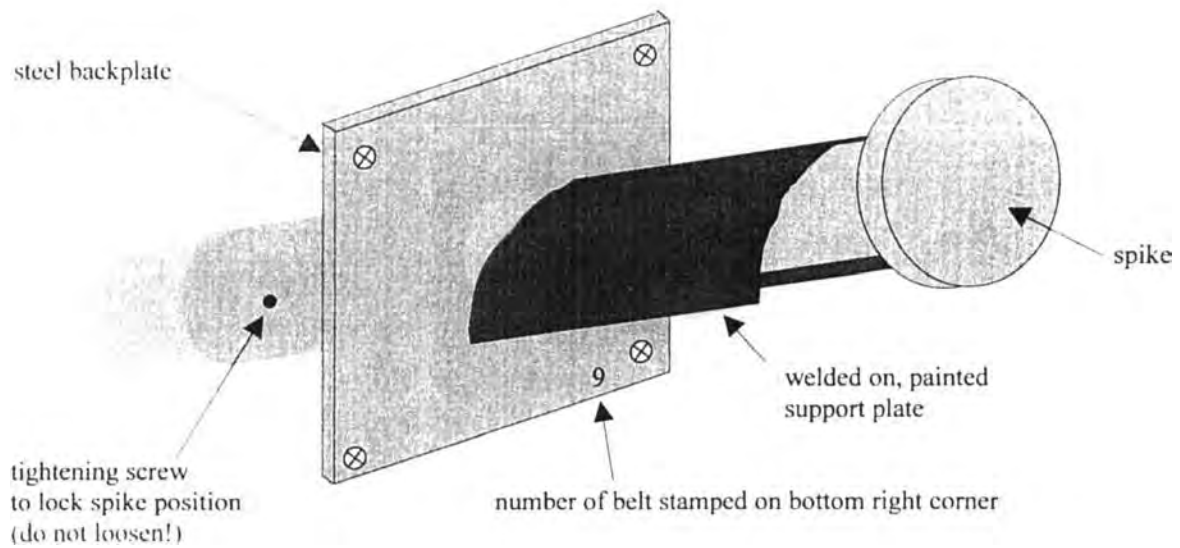


Figure 5. Mount diagram for wall spikes that hang the Serra belts.

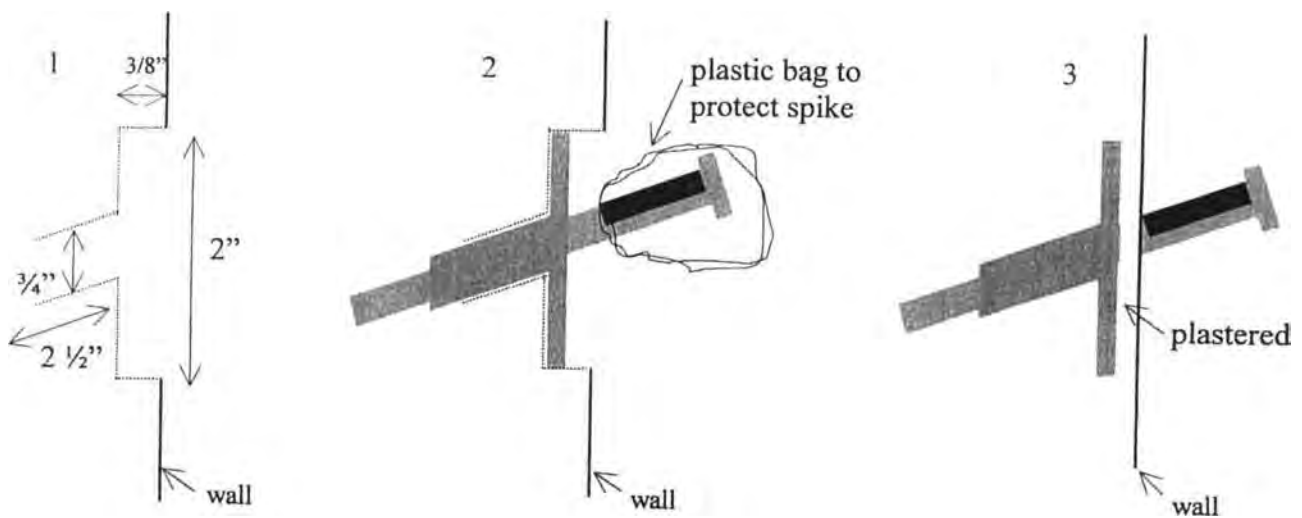


Figure 6. Diagram for installing the mounted spikes.



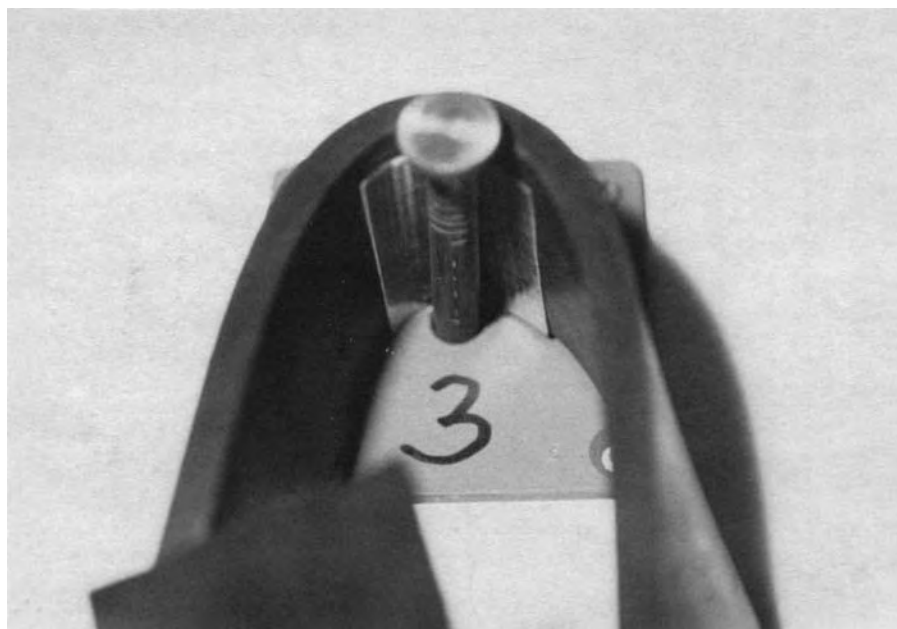


Figure 7. Detail of the steel support plate welded onto the spike for belt #1, before toning.

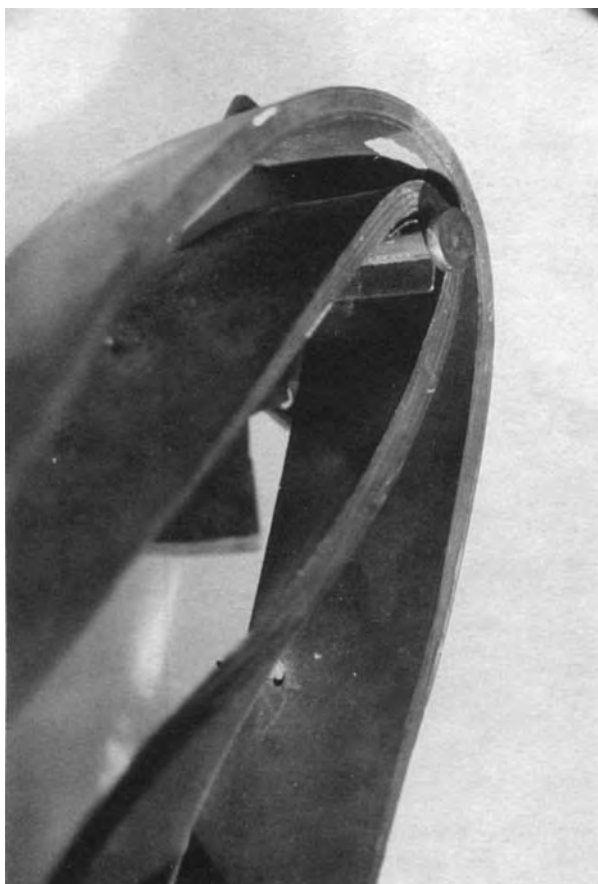


Figure 8. Detail of spike after installation of belt #1, support plate has been toned.

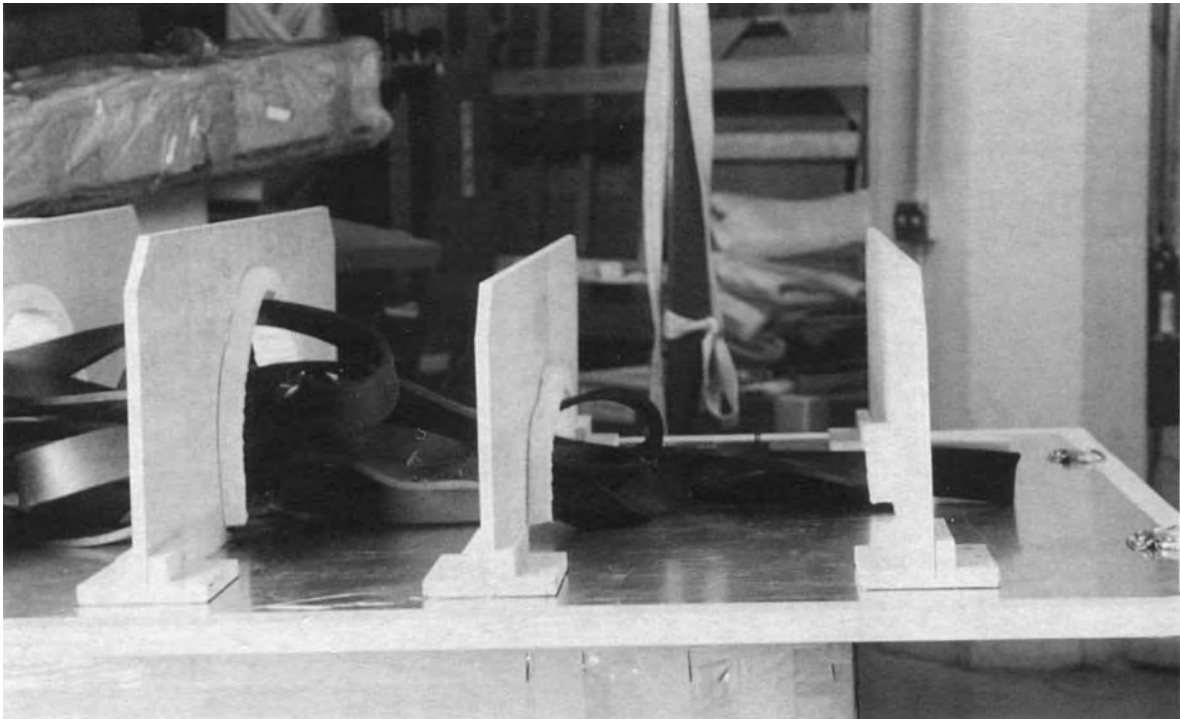


Figure 9. Mounting system for the belts on a cradled tray for crating and storage.

ADHESION SHEAR STRENGTH RUBBER/POLYESTER-LINEN FABRIC (psi)						
Adhesive	NEOPRENE		EPDM		BUTYL	
	uncleaned	EtOH prep	uncleaned	EtOH prep	uncleaned	EtOH prep
Beva® D-8	10	>28	27	11	11	6
Beva® 371 Film	11	26	16	12	16	20
ScotchWeld™ DP8005	4	16	1	2	8	8
Scotch Grip™ 847	13	11	7	8	3	11
Scotch™ 300LSE tape	6, 13	18	9	12	10	14

Figure 10. Table of results for the adhesion shear strength testing.

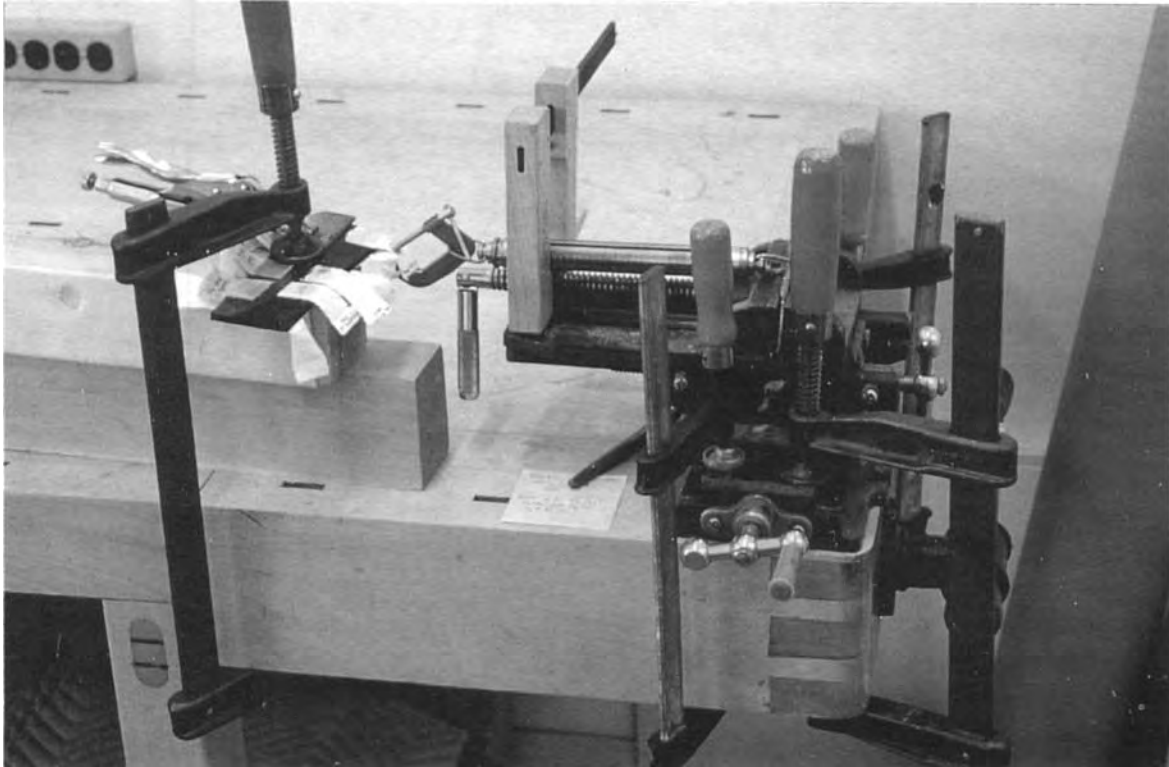


Figure 11. System for testing shear strength of adhesives using a spring gauge, vices and clamps.

## **RESPONSIBILITIES, REALITIES AND RANKING: HOW A COLLECTIONS TIRING POLICY AIDS CONSERVATORS IN ETHICAL DECISION MAKING AND JUDICIOUS RESOURCE ALLOCATION AT THE HENRY FORD MUSEUM AND DEERFIELD VILLAGE**

Mary Fahey and Clara Deck

### **Henry Ford Museum & Greenfield Village**

Automobile mogul Henry Ford founded Henry Ford Museum & Greenfield Village in 1929. Starting with Ford's personal collection, his agents amassed huge collections of artifacts for his museum with an emphasis on transportation, agriculture and manufacturing. Collections of familiar objects set in historic houses in the village were intended to appeal to all. Some collections came to be used to support the curriculum of the elementary school that resided in Greenfield Village. Ford was a strong advocate of a curriculum of "learning by doing" and he viewed all of the collections as tools that were to be used for educational purposes.

Over the past 70 years, the large collections that were established by Ford have grown to an estimated 26 million archival documents and one million objects. The collections, which highlight American innovations, inventors and the ordinary people whose daily lives were affected by advances in technology include; furniture, paintings, decorative arts, home arts, industrial equipment, automobiles, airplanes, locomotives and agricultural equipment. Approximately 20% of the collections are currently on display; the remainder are housed in 50 different storage areas.

Henry Ford Museum presents 12 acres of traditional museum exhibitions that include "The Automobile in American Life", which highlights the influence of automobile technology on every day life; "Clockwork", a chronology of clock making in America; "Made in America", which presents an overview of the industrial era in the United States and "Your Place in Time", which documents change, progress and popular culture in America during the last century. A variety of older displays that date to the 1970's have been slated for replacement in the near future include home arts, lighting, communication and flight.

In Greenfield Village, Henry Ford assembled buildings associated with several of his American heroes, including the Wright brother's home and bicycle shop, Thomas Edison's Menlo Park Complex and the home of Noah Webster. To this day, visitors to Greenfield Village can view operating historic artifacts as they make their way through the 80-acre village. Among the attractions are an operating 1914 era machine shop and an 1880's working farm. Visitors are invited to take a ride on a 1913 Hershell Spillman Carousel, an authentic steam locomotive and thirteen operational antique vehicles. Approximately one half of Greenfield village's 78 historic structures are furnished with original collection artifacts.

## **The Current Trend in Exhibitions at Henry Ford Museum & Greenfield Village**

In recent years administrators and exhibit planners at Henry Ford Museum & Greenfield village have moved towards the creation of new highly engaging interactive exhibits that are intended to capture the attention and imagination of visitors. In general these exhibits include an increased number of “hands-on” activities. In January 2001 the president of the museum announced to staff that they would be entering “a new era of simultaneity” in exhibit production. He explained his interest in producing more exhibits, with smaller budgets and shorter “turn around times”. In an article that appeared in the November/ December 2000 issue of Museum News, Ron Chew wrote, “why can’t a museum change its exhibitions as swiftly and as often as a department store changes its floor displays?” (Chew 2000:47). He identified an awakening among many museums to their potential “to become more than simply repositories for cultural and scientific artifacts”. He looked towards libraries and universities as examples of how museums could produce exhibits in a timely manner responding to current events. It was evident that Henry Ford Museum & Greenfield Village was not alone in its desire to produce more updated exhibitions at a faster and more responsive pace. To the conservation staff whose yearly workload included an average of two new exhibitions, ten major loans, the care of over 45 operational collection items, two annual collection condition surveys, an average of six temporary exhibits and the routine treatment of hundreds of artifacts, this presented a point of concern.

## **The Need for a System of Prioritization**

The idea of tiering collections at Henry Ford Museum & Greenfield Village first arose during an effort to conserve thousands of artifacts in preparation for the “Automobile in American Life” exhibit which opened in 1987. Many of the paper artifacts that were included in this exhibit were considered to be ephemera by curatorial and archives staff. According to the curators and archivists who were assigned to work on this project, there was a real push by administrators to display “the real thing” rather than reproductions. Minoo Larson, who was then a part-time paper conservator, knew that there was insufficient time to conserve all of the artifacts and that the internally illuminated exhibit display cases, which had already been constructed, would prove to be detrimental to the collections. In order to address this problem she requested that the archivists and curators provide information to her concerning the relative value of each artifact. She saw the need for a system that could inform conservators about the collection artifacts and serve as a guide in determining extent of treatment and mode of display. Working in conjunction with curators and archivists she began to use an informal shorthand system for planning her work.

## **Testing the Tiering System**

In 1992 museum curators, conservators and registrarial staff drafted the first version of a formal tiering policy that was to be tested and debated for the next seven years. The tiering or “ranking policy” as it came to be called required that curators and archivists assign a numerical rank,

ranging from 1 to 4, to all newly acquired artifacts and to items that required examination or treatment by a conservator. Historically significant artifacts were to be assigned a code of 1 whereas common items that could be easily and inexpensively acquired would be assigned a rank 4. Rank 2 and 3 would follow criteria that placed them somewhere in between. In the first draft of the policy, the criteria for rank included: historical significance or rarity, monetary value, preservation sensitivity, and an assessment of the degree to which the educational value of artifact might be enhanced by hands-on use. Later drafts incorporated exhibit, handling, treatment and documentation guidelines. The chair in which Abraham Lincoln was sitting when he was assassinated was assigned a rank 1 based upon historical significance, fragile nature and irreplaceability. Rank 4 artifacts were first identified as items that could be easily replaced, and that were appropriate for hands-on use in living history sites. These included tools or kitchen utensils that were readily available for purchase at local antique shops. Artifacts that have been heavily restored or altered might also be included in this category.

During this time various interpretations of the policy were tested in new exhibits and existing programs. Museum staff engaged in intense discussions about the practical application of the policy. Although there was general agreement that rank would be based upon the historical significance of individual artifacts, the questions that posed the greatest obstacles to policy ratification included: Would rank determine the appropriateness of an artifact for hands-on use or operation? Could the policy be applied consistently to a wide variety of collections? Was it appropriate to include monetary value in the ranking criteria? Since it was proposed that rank 4 items would be viewed as dispensable who would maintain them? Was it appropriate to ask curators to assign rank based upon the “preservation sensitivity” which was being used to designate fragile artifacts?

### **The Operation and Hands-on Use of Artifacts**

As the ranking policy developed, attempts were made to correlate rank with the appropriateness of an artifact for hands-on use. In an attempt to insure that valuable artifacts would be protected from damage during use or operation, conservators put forth the proposal that rank 1 or 2 artifacts not be used for hands-on programs. Practically speaking not all requests for hands-on collections fell into the rank 3 or 4 category. Periodic requests to use rare and historically significant artifacts such as musical instruments, clocks and automobiles were cited. This became a point of particular concern to conservators. Qualms arose when it became evident that the pressure to use artifacts in programs might necessitate that they be given a low rank despite their historical significance. In the end conservators and curators were forced to admit the dichotomy that rare artifacts might occasionally be used or operated thus jeopardizing their long-term preservation. Therefore, in the interest of ensuring the best compromise conservators considered whether rank could designate who ought to be authorized to handle or operate artifacts and under what circumstances.

The acquisition of the 1906 Locomobile race car in 1997 intensified the urgency to finalize the

policy. The automobile, which is unique, original and of national historical importance, was purchased by the museum and immediately assigned a rank 1 by the curator. The significance of the car is enhanced by the fact that it has been maintained in operational condition but never fully restored or repainted since 1906. Not only was the car expected to be run at least yearly in the village, it was to become the focal point of a new prominently placed exhibit that would include a documentary film. The highlight of the film would be footage of the automobile being driven by actor Paul Newman.

Shortly after the filming the criteria that referred to the appropriateness of artifacts for use was removed from the policy. While ostensibly allowing for the potential consumptive use of an irreplaceable artifact, this decision proved fruitful because it clarified key issues and moved ratification of the policy forward. It affirmed the concept that curators ought to objectively assess the historical value of artifacts independent of the desire to use them. It acknowledged that all potential uses of items could not be dictated and would require assessment on an individual basis. An agreement was made with the Collections Committee that all rank 1 items that were to be considered for “hands-on” use or operation would be brought to a vote of the Collections Committee that includes curators, administrators and program developers. The Committee would determine the appropriate number of times the item could be used and details concerning duration based upon recommendations from the appropriate curator and conservator. This agreement was incorporated into the institutional preservation policy.

### **Fragile Artifacts**

The creation of a systematic method for designating an artifact as appropriate for hands-on use became complicated when the inherently fragile nature of some artifacts was considered. Conservators and curators shared the concern that the same criteria that applied to objects did not suit fragile materials such as paper and textiles. Whereas regular operation of cast iron machinery seemed reasonable, neither could envision a situation where extended hands-on use of textile or paper materials could be employed on a regular basis. Even rare books were used only periodically under staff supervision.

The ranking policy debate raised issue with the criteria that linked historical significance and preservation sensitivity. Why might artifacts of low historical significance be given a high rank merely because they are fragile? One suggestion included the creation of a separate ranking system for archival collections. The creation of separate systems was abandoned in the interest of the creating of one simple inclusive policy that was applicable to all collections. Conservators had reservations about the inclusion of “preservation sensitivity” as a value judgment that curators would need to make. Ultimately the reference was removed in order to allow curators to focus on significance rather than how the item would be cared for or displayed.

## **Consistent Application of Ranking to a Wide Variety of Collections**

Whether the ranking criteria could be applied consistently to a copious variety of collections was the subject of much debate. The stewardship of agricultural implements is rationalized using different qualifying factors from decorative arts. In most cases Henry Ford Museum & Greenfield Village bears the legacy of 75 years of collecting ethnographic, technological, archival and personal artifacts both antique and modern. With a desire to collect 20th century artifacts just as Ford had collected the artifacts of his era, museum staff began to recognize the difficulty of assigning rank to contemporary collections. Certainly a recently acquired collection of McDonald's "Happy Meals" would not be ranked 1 but the question still concerned staff who foresaw the possibility that today's rank 4 artifacts could in time become a rank 3 or 2. For conservators the realization that some artifacts that are currently receiving a minimal level of care could one day require their attention was disconcerting. Ultimately the decision was made to rank artifacts relative to current mission and collecting plan accepting that the rank may change in the future.

## **Monetary Value**

The inclusion of monetary value in discussions regarding museum collections seemed inappropriate to some museum staff members. However a few specific items such as a collection of Stradivarius and Guinari violins and a Bugatti Royale automobile warranted consideration even though they do not fit the museum's mission nor collecting plan. The decision was made by members of senior museum management to retain monetary value in the ranking guidelines.

## **The Care of Rank 4 Artifacts**

Since it had been proposed that rank 4 items should be viewed as dispensable, would their care be beyond the scope of conservators' responsibilities? The desire to develop a policy that could aid conservators in determining the best use of their limited time and expertise posed the question: Should museum conservators only care for the elite rank 1 and 2 collections or should they remain essential participants in the care of all collections? An early draft of the ranking policy proposed that conservators would not be involved in the treatment or care of ranked 4 artifacts. This raised alarms among program staff who knew they did not have the resources or the expertise to maintain artifacts themselves. Curators pointed out that many of the artifacts that were chosen for programs were indeed integral to the story being told and that none were truly disposable in the program sense. The notion that rank 4 collections could be minimally cared for or "used up" represented both a practical and ethical quandary. Whereas conservators might delegate the tasks required to care for artifacts in use, it became apparent that conservators could not and should not relinquish their responsibility to any collection artifact. Carl Schlichting addressed this issue in his talk at the Association for Living History and Farm



Museums annual meeting in 1989. He advocated the need for planned maintenance programs and good training for program staff that would be handling artifacts. He noted plainly: "One can not actively use a collection artifact and expect to keep its historical integrity" (Schlichting 1989:209). Within the context of the AIC code of ethics, the conservators' obligation to reduce damage to artifacts constitutes a real challenge when artifacts are being actively used. The decision was made that conservators would remain involved in the care of all collections. While the extent of active involvement by conservators in the treatment of low ranked artifacts might be reduced to documentation, the examination report or treatment proposal would include a record of the decision- making process whereby the determination to use the artifacts was made. Museum conservators would be increasingly involved in the management of staff and volunteers who maintain operational collections. They also would develop training programs for program staff who operate artifacts such as machine tools, cars and automobiles.

### **Ranking in Practice**

In the spring of 2001 the ranking policy was finally approved by the leadership of Henry Ford Museum & Greenfield Village (Fig. 1). Management guidelines (Fig. 2) were separated from the ranking policy itself. This conduces curators to weigh the historical significance of the individual artifact most heavily in the determination of its rank. Additional criteria considered whether similar artifacts are preserved in other collections enhances the ethical underpinning of the policy. The management guidelines were developed to aid conservators in setting priorities based upon rank. Both the ranking policy and management guidelines have been appended to the institutions preservation policy.

Conservation work requests that are received from curators through a computerized collections management system include recent ranking information. The daily application of the policy facilitates the dialogue between curators and conservators by allowing conservators to assess the workload develop schedules and determine the appropriate level of documentation and treatment for many items. It also serves as a guide during exhibit development when limited financial resources require that choices must be made concerning the exhibit case construction and methods of display. Yearly conservation surveys utilize ranking to aid in setting long term storage and treatment priorities for individual collections of artifacts. Ultimately the plan may be expanded to aid in the planning of storage upgrades.

### **Conclusion**

The raking policy that was recently adopted by HFM&GV attempts to address the judicious allocation of resources by providing a framework for both ethical and practical decision making. The professional staff throughout the institution including curators, conservators, exhibit developers and program personnel generally consider ranking to be a provocative series of guidelines that assist them in thinking about what the museum collects, why it collects and how

the collections ought to be cared for and employed. Although most recognize that there cannot be an orthodox consistency in how it is applied across incredibly varied collection types, they generally see it as a valuable communication tool. While it must be recognized that a formal policy cannot be applicable to all situations it can provide a forum for discussions that benefit both decision making and preservation concerns. The policy recognizes the longstanding tradition of the institution to employ artifacts in innovative ways for educational purposes while giving this tradition a new ethical foundation.

## **References**

- Chew, R. 2000. Toward a More Agile Model of Exhibition-Making. *Museum News* 79 (6):47-48.
- Schlichting, C. 1989. Tiering Collections: From a Conservation Point of View. In Proceedings of the 1989 Annual Meeting, The Association for Living Historical Farms and Agricultural Museums. Indianapolis. 209-212.

## **Authors' Addresses**

Mary Fahey, Conservation Department, Henry Ford Museum & Greenfield Village, 20900 Oakwood Avenue, Dearborn, Michigan 48121 (Maryf@hfmvgv.org)

Clara Deck, Conservation Department, Henry Ford Museum & Greenfield Village, 20900 Oakwood Avenue, Dearborn, Michigan 48121 (Clarad@hfmvgv.org)

- All new acquisitions are ranked.
- All artifacts requested for conservation treatment should be ranked.
- All artifacts processed for documentation projects should be ranked.

**Criteria for Ranking Artifacts:**

<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Nationally or internationally significant	Significant historical value	Historical value	Historical value
Few, if any duplicates in this or other collections	Few similar examples in this or other collections	Similar examples are held in this or other collections	Common in this or other collections
Rare, likely irreplaceable	Uncommon and difficult to replace	Moderately difficult to replace	Can be easily replaced
And/or of high monetary value			

Figure 1. Collections Ranking

	Storage and Display	Documentation	Treatment	Handling and Operation
Rank 1	Every effort will be made to store and display artifacts in an environmentally controlled and secured area	Complete curatorial and conservation documentation, including research and photographic records will be maintained	-Original materials will be preserved -Treatment will be carried out or strictly supervised by conservator -Stable materials and reversible treatments will be employed	-Formal exhibition only. -Requests to use or operate must be brought to collection committee for approval -Must be handled and moved by historical resources staff with approval of collection manager
Rank 2	Reasonable effort will be made to store and display artifacts in an environmentally controlled and secured area	Complete curatorial and conservation documentation, including research and photographic records will be maintained	-Original materials will be preserved -Treatment will be carried out or strictly supervised by conservator -Stable materials and reversible treatments will be employed	-Formal exhibition only. -Requests to use or operate must be brought to collection operations team for approval -Must be handled and moved by historical resources staff with approval of collection manager
Rank 3	Reasonable effort will be made to store and display artifacts in a secure area out of direct access of the public	Curatorial and conservation documentation, research and photographic records will be maintained. Complete maintenance records of all modifications and repairs will be kept.	-Conservation or Restoration treatment will be carried out under the guidance of a conservator. -Original materials will be preserved whenever possible	-May be used for exhibits and/or interpreted operational use by properly trained staff. -May be handled by trained Historical Resources staff or other authorized program staff. -Moves within a program site may be carried out by trained program staff -Moves beyond the authorized program areas must be coordinated by Collections manager
Rank 4	Reasonable effort will be made to store and display the artifacts in a careful manner that will not accelerate deterioration unduly.	Minimal curatorial and conservation artifact record will be created. Minimal documentation, research and photographic records of modifications and repairs will be maintained at the discretion of the use team.	-Conservation or Restoration treatment will be carried out under the guidance of a conservator or appropriate historical resources staff -Maintenance programs will be carried out under the direction of a conservator or appropriate Historical resources staff -Original materials will be preserved, when practical or appropriate	-May be used for exhibits and/or interpreted operational use by adequately trained staff. -May be used for hands-on activities with visitors --May be handled by trained Historical Resources staff or other authorized program staff -Moves within a program site may be carried out by trained program staff -Moves beyond the authorized program areas must be coordinated by Collections manager

Figure 2: Management Guidelines for Ranked Collections

# **THE ROLE OF CONSERVATION IN THE MOVE OF COLLECTIONS OF THE SMITHSONIAN NATIONAL MUSEUM OF THE AMERICAN INDIAN**

Leslie Williamson and Emily Kaplan

## **Introduction**

The collection of the Smithsonian National Museum of the American Indian (NMAI) comprises approximately 800,000 archaeological and ethnographic artifacts from native cultures throughout the Western Hemisphere. We are in the process of transporting the collection from the museum's Research Branch in the Bronx, NY to the new Cultural Resources facility in Suitland, MD. It is anticipated that the move, which began in June 1999, will take five years.

There are 27 term positions dedicated to this project on each end of the move. The structure of the collections move roughly parallels that of the museum. The move "departments" - Conservation, Registration, Collections Management, Photography, and Administration - work in close technical consultation with the corresponding museum departments but are dedicated to the move project, with separate management and budget. Move management includes seven assistant move coordinators: two for conservation (one on each end), two for registration, two for collections and one for photography (in NY only). Within this structure, conservation responsibilities tend to be the most varied and subjective. Often, conservators are problem solvers for anything that falls outside of the normal routine. Because we work at both ends of the move, and as equal members of the move team rather than as consultants from the larger museum, we are able to have daily on-site influence on move activities, and to institute standards for the care of the collection during and after the move. This daily conservation involvement in the move simplifies and ensures the implementation of procedures for preservation.

## **Research Branch, Bronx, NY**

Prior to the move, the museum conducted a full registration inventory and a concurrent collection-wide survey to assess conservation needs. Five conservators and technicians were hired on a temporary basis. The goal of this survey was to identify all condition problems severe enough that the object would require treatment in order to safely transport it to Suitland. Numerous minor stabilization treatments - such as tying off a thread of loose beads - were conducted on the spot during the survey. For objects that would require more involved treatments, comments about condition were entered into a database and the objects were re-shelved for later attention. We began by using designations #1, #2, and #3 to indicate the priority level for each object, #1 meaning "needs treatment prior to moving," #2 meaning "re-evaluate after move" and #3 meaning "stable, nothing needed". For ethnographic objects, we also used the descriptive categories "minor surface repair", "major surface repair", "minor structural repair", and "major structural repair" to indicate the expected scope of treatment that would be needed. Only the objects designated as #1's are being addressed as part of the move project.

This structure seemed reasonable when we first developed it, but in fact it became difficult to manage. First, space and equipment didn't allow for computers in the collections areas, so all of this information had to be recorded on paper and the data entered into the database later on. Second, in an attempt to ensure the longevity and accessibility of our data, we decided to integrate this information into the collections database the museum was using at the time, rather than making a stand-alone conservation database. We assumed that this would be easier to keep upgraded and be more likely to keep pace with the museum's needs. Unfortunately, the museum's database was in transition and changed systems twice during the life of the survey, actually making our record keeping rather scattered. Currently the data is being maintained, but it is still not in one single format together

We also found that with the changing databases, objects designated as #2's (such as minor glass disease or efflorescing but stable salty ceramics), became very difficult to track. Therefore, this information probably won't be used for planning future treatments as we had been originally envisioned. The data for the #1's, though, does serve now as a planning tool for work to be done ahead of the move process proper. We are moving the collection by cultural groupings (i.e. geographic area and tribe) so prior to moving a given group, we search the data for all the #1's, pull them from the shelves, and take them to the conservation laboratory for treatment. We have a staff of six in the conservation department at the Research Branch and are completing the expected treatments for each group several months in advance of their scheduled move.

Inevitably, as each group is processed we identify more unstable objects, those overlooked during the survey or those with new conditions. These objects are treated as rapidly as possible, with the minimum treatment necessary to stabilize the object for transport. Every effort is made to try to keep the objects moving together with the rest of their cultural grouping. This is important because the compactor storage at the Cultural Resources Center has very little extra room. There, we re-sort the collection by group, provenience, and object type for storage, before shelving them using the minimum space possible. This makes it important for the Research Branch to send entire cultural groups together, to ensure that adequate space is allotted for all objects, and that no unnecessary space is wasted as we work our way through the compactors.

Along with our space constraints, the move project has severe time constraints. At the Research Branch, this means that the day-to-day conservation tasks require fast decision-making so that the flow is kept constant. Figure 1 is an oversimplified flow chart of the move process. Conservation work is done immediately after the objects are pulled from the shelves and bar-coded by the members of our Registration Department. Therefore, the imaging and packing that follow conservation are dependent on our efficiency. Although time is an issue, all objects pulled for treatment in the laboratory receive complete written and photo documentation.

Conservation tasks at the Research Branch include determining the stability of the artifacts, and performing stabilization treatments, surface cleaning, determining pest management procedures, and constructing specialized packing mounts as necessary. For surface cleaning we use only

HEPA (high-efficiency particulate filter) vacuums, and wear protective clothing and gloves. Our goal with cleaning is twofold: first, to remove loose grime that could cause damage to the artifacts during transit, and second, to remove all evidence of old pest infestations so that in the future it will be easier to identify any new infestations. We attach a label to the barcode for each object indicating the appropriate pest management procedure. Our labels include: “freeze”, “do not freeze”, “needs IPM,” “Vikane” and (soon) “CO<sub>2</sub>.” In this way we communicate the needs of each artifact to the people working farther down the line, as this will affect each stage of the process at the Research Branch and the Cultural Resources Center. Figure 2 shows the Integrated Pest Management (IPM) labels and the standardized notes that conservation sends with individual objects, with directions for the Cultural Resources Center staff. Figure 3 describes each of the IPM designations.

In sum, conservation handles much of the irregular work so that the flow of the rest of the move won't be impeded. At any one time, about half of the conservation staff is cleaning artifacts, leaving the rest to do treatments and work with other problems. For example, oversized packing was done in the conservation laboratory until enough space was freed up in collections storage - this took about two years. Conservation packs most of the very fragile objects and many of the treated objects to minimize handling.

Other ongoing conservation responsibilities include coordinating testing of environmental hazards within the collection areas, advising on materials and packing systems, monitoring and documenting damage, and object handling training.

### **Collections-based hazards**

Museums all over the United States are now forced to deal with the possible presence of contamination from past pesticide treatments in their respective collections. The responsibility of repatriating objects back to native communities has made this long-time concern urgent. At NMAI, testing is done as a matter of course for objects being repatriated. But in the course of this move, each object is handled a number of times by a number of people, so we are of course concerned about staff exposure to contaminants. Therefore we designed and undertook a testing project as one part of the work the museum is doing in this area.

Conservators at the Research Branch wiped a designated area on each storage bank in the building, and then analyzed the wipes using a rented portable X-ray fluorescence unit to look for lead, arsenic and mercury. The results gave us a broad “map” of contamination by these metals in the settled dust in the collection. Based on this “map,” we can schedule personal breathing zone monitoring and hand wipe testing to correspond with times when we are working in known “hot spots”. This way, we monitor staff at the times of highest risk to exposure so that we can feel confident that no one is experiencing any unacceptable exposures. Lead, arsenic, and mercury have been found throughout the Research Branch but in amounts consistently below hazardous levels.

The Cultural Resources Center (Cultural Resources Center) opened in 1999. The building was designed to house the collection, and to serve as a center for research, for community services and outreach and to support the NMAI public facilities on the National Mall and in New York City. The museum on the Mall will open in 2004.

The carefully choreographed flow of objects from station to station at the Research Branch is mirrored, approximately, at the Cultural Resources Center. At the Research Branch, after conservation the objects are digitally imaged, packed into boxes, frozen if appropriate, packed into our modular crates, loaded onto a truck and sent to the Cultural Resources Center in Suitland. In brief, the process is this: upon arrival at the Cultural Resources Center, the move team unloads crates from the truck and puts them in a temporary holding area in collections storage. As each object, box, crate, and truck are bar-coded and scanned; registration staff can generate detailed lists of the contents of each crate and box. From this data, we are able to establish an unpacking order, which depends on the content of the shipment and often by the needs of other departments, including repatriation and curatorial for exhibitions.

Crates and boxes are brought to unpacking stations, and once unpacked and scanned out of their respective boxes and crates, the artifacts are moved and scanned into another station, where move technicians construct custom storage mounts, and sort the objects on carts by culture or geographic area. Finally the objects are shelved, a process requiring ingenuity, agility, brute strength, and no fear of heights.

### **Registration and the collections database**

The NMAI registration system of object tracking should be noted at this point, as it is an integral part of the move. In brief, each object receives a unique barcode at the Research Branch, as does each box, crate, and truck. The object is scanned into the box, the box into the crate, and the crate onto the truck. At the Cultural Resources Center, the reverse happens: the crates are scanned off the truck, the box out of the crate, and the object out of the box. Then the object is scanned into a temporary location at the mounting station, and finally it is scanned into a shelf or drawer – which will in turn indicate the exact location in storage. The data from scanners is uploaded daily to the collection database, and from there our registration staff can (among other things) track the object's movement history, access the respective digital images, and sort according to a number of variables to aid in the shelving process.

Conservation is incorporated throughout the move process on both ends, but at the Cultural Resources Center there is no single designated place such as the cleaning and inspection station on the move line for conservation. One full-time conservator is dedicated to the collections move at the Cultural Resources Center. We rely on training and communication with the rest of the move team and with our counterparts at the Research Branch. For example, a formal condition assessment of each object on unpacking (such as we would do for loans) would be impossible.

Conservation conducts object handling training for all NMAI staff who will be handling



collections, to members of the move team including contractors, and of course volunteers and interns. During handling training we emphasize the importance of communication and asking questions: we instruct team members to alert the conservator immediately upon encountering any objects that have been flagged by the Research Branch, any pest management concerns, damage or potential for damage, handling questions, anything that is at all questionable. With some experience, members of the move team become familiar with different materials and potential problems. Conservators and packers at the Research Branch attach notes to crates, boxes, and objects, to alert conservation at the Cultural Resources Center to particular condition concerns, and to special or new packing systems that will need evaluation and documentation on unpacking. We use digital images often, which help us provide timely feedback to the Research Branch. Conservation is alerted immediately if damage - which occurs very, very rarely - happens or is discovered. If there is damage, we complete a formal damage report.

The move conservator deals with minor treatments that can be done in situ. Anything more complex will be sent to the laboratory if it can't wait, otherwise, objects with damage or other problems are documented and remain in storage until they become a priority.

### **Integrated Pest Management**

Conservation is responsible for pest management on both ends of the move. In tandem with the sticker system above, we have identified several pest management categories (see figures 2 and 3). Registration staff created barcodes for each of these categories and conservation scans the information. This means that the category and the date are attached to the object's record. For example, organic objects that cannot be frozen safely are flagged for inspection by conservation upon unpacking. If the object appears uncompromised - there is no recent frass or insect-related damage, and thorough inspection is possible - it will be scanned as "Inspected Deemed Okay." If the condition is at all questionable, the object will be scanned as "Bag and Monitor." We search the database periodically for bagged objects and their respective locations in storage. In addition, sometimes we may choose to freeze an object that was not frozen at the Research Branch, or to put the object in a low oxygen environment.

### **Storage Mounts**

At this point, time is our greatest pressure: this means our short-term, weekly goals of keeping up with the trucks from New York, our relatively long term deadline of five years to complete the move, and our very long-term goal: permanent storage of a collection we expect will be much used. The move is our one chance to organize and rehouse the collection so that it is both safe and accessible. Because a conservator has been dedicated to the move team from the beginning we have been able to have complete oversight of the design, construction, and materials used for storage mounts. We evaluate and document innovations as our techniques have gotten better and faster. The storage mounts must be safe but must not obscure the object,

they must be as small as possible but still allow access, they must be aesthetically pleasing. And overall, economy of time, materials, and space is essential.

## **Conclusion**

The Research Branch and the Cultural Resources Center are physically very different and face different problems but the move staff at both ends must function smoothly together. Both ends work with the same restraints of time, space, scheduling, and resources in different configurations. Communication is essential. Move-related conservation work - whether it is stabilization treatments before packing, or storage systems on the receiving end - must integrate the immediate with the long-term needs of the collection.

## **Authors' addresses**

Leslie Williamson, Smithsonian National Museum of the American Indian - Research Branch, 3401 Bruckner Blvd, Bronx, NY 10461 (williamsonL@si.edu).

Emily Kaplan, Smithsonian National Museum of the American Indian - Cultural Resources Center, 4220 Silver Hill Rd., Suitland, MD 20746 (kaplaneE@nmaircr.si.edu).

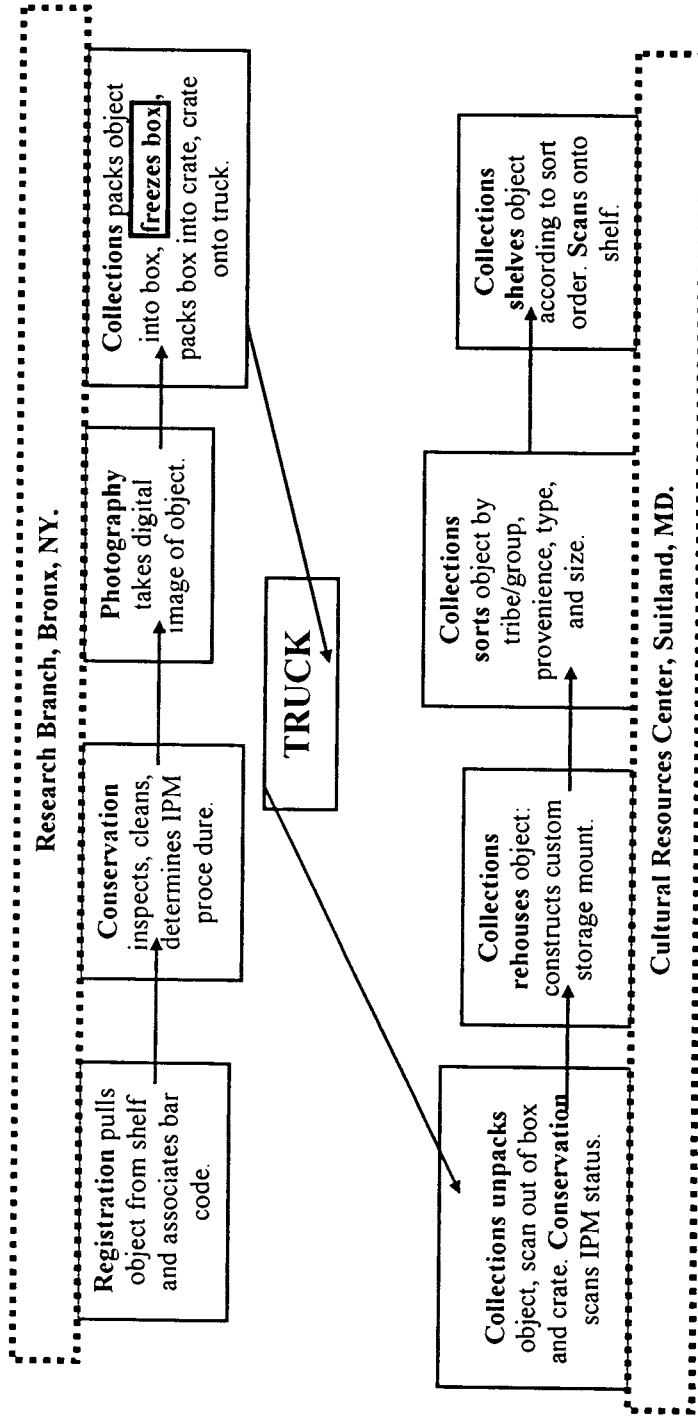


Figure 1. A vastly oversimplified plan of the NMAI move line.

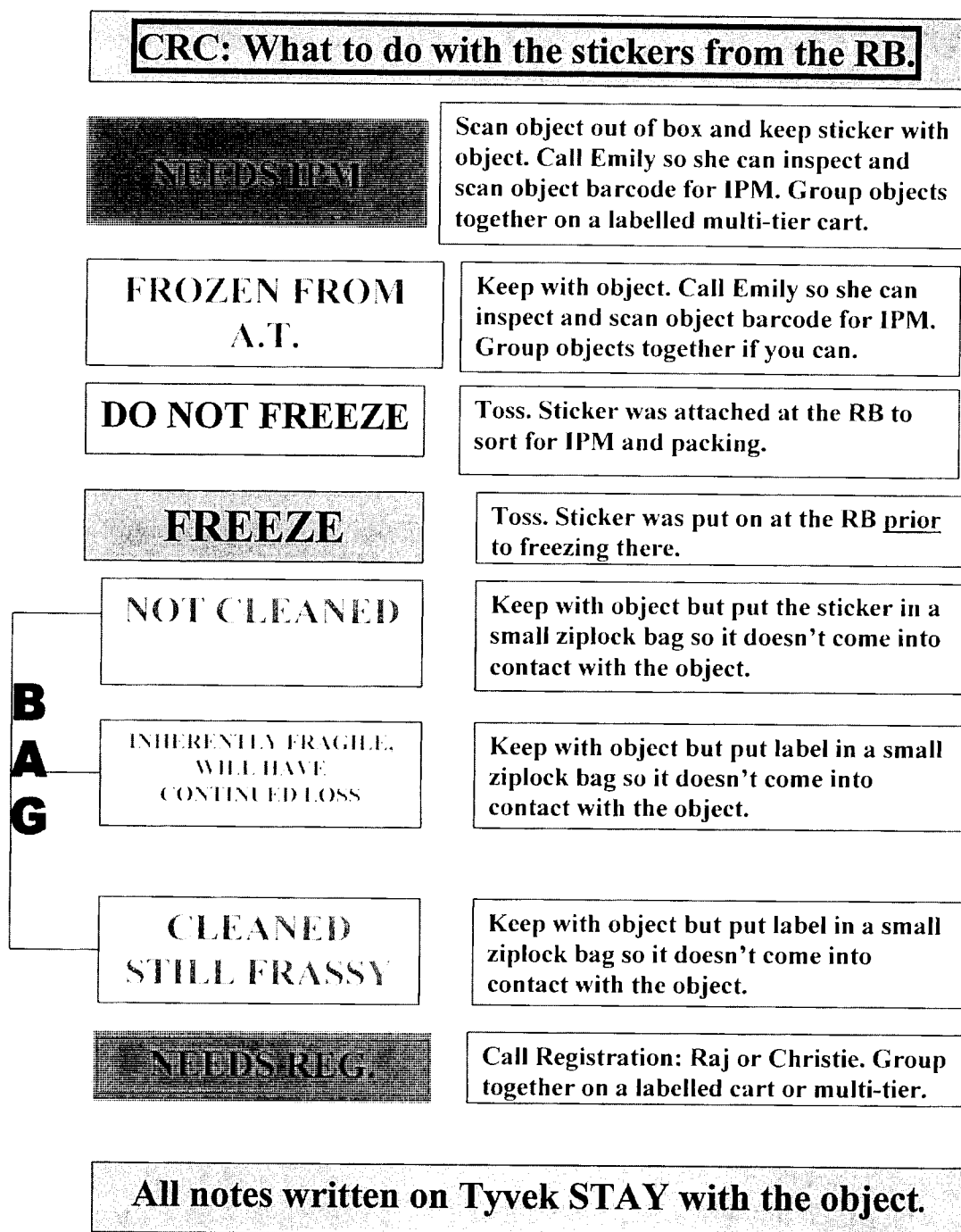


Figure 2. Labels attached by Research Branch conservation staff to object barcodes. This alerts the conservator at the Cultural Resources Center. The original labels include color coding which cannot be reproduced here.

**Inspected, deemed OK.**

Denotes an object that was 1) not frozen at the RB to avoid potential damage from freezing and 2) inspected upon unpacking at CRC, and deemed to be pest-free. This includes objects like ivory and bone, which are not readily infestable, but for which we want to have a record of not freezing. This category also includes objects (like drums) that have a structure that can be seen from all sides. An object that has “hidden” areas would not be in this category.

**Frozen from Audubon Terrace.**

Denotes an object we would not usually freeze, but which was frozen at the RB after it was moved from the old museum at Audubon Terrace in 1994/5. The notation is used in case there is a condition problem that might be related to freezing.

**Bag and monitor: possible active.**

Denotes an object that was 1) not frozen at the RB to avoid potential damage from freezing and 2) inspected upon unpacking at CRC, and found to have suspicious evidence of insects, or more commonly cannot be fully inspected due to the structure and/or materials. Examples include a fur bag with decorations of claws and teeth: one cannot fully inspect the interior or the fur, and we usually do not freeze claws and teeth due to their laminar composite structure. These objects are shelved along with the rest of the culture. Registration can create a spreadsheet from the database of all objects scanned as needing monitoring, their respective locations, and date of bagging. This spreadsheet can be used to locate and monitor these objects.

**Bagged and monitored, OK.**

Denotes an object that shows no evidence of pest activity after being bagged and monitored for several months.

**Needs low O2 – active.**

Denotes an infested object that we don’t typically freeze. The method of low O2 is not specified here. (We will add a barcode for **CO2 – Needs CO2 –preventive and active and done.**) This barcode also serves as a sort of back-up documentation, so that the date of infestation becomes part of the object’s record in the CIS database.

Figure 3a. Integrated Pest Management labels used for National Museum of the American Indian collections move

**Needs low O2 – preventive.**

Denotes an object that we don't typically freeze and for which pest activity is not apparent. This barcode may not always be used. For logistical reasons, it is more likely that the object will get scanned only after the treatment is done.

**Low O2 done.**

Denotes an object we don't typically freeze, that was infested, and was treated with a low oxygen method. The method of low O2 is not specified here. We will add a barcode for **CO2 - Needs CO2 –preventive and active and done.**

**Freeze – active.**

Denotes an infested object that can safely be frozen. This barcode also serves as a sort of back-up documentation, so that the date of infestation becomes part of the object's record in the CIS database.

**Freeze – preventive.**

Denotes an object which can safely be frozen, and for which pest activity is not apparent. For logistical reasons, it is more likely that the object will get scanned only after the treatment is done.

**Frozen.**

Denotes an object that was frozen. As of this writing, the only objects that get scanned as "Frozen" are those frozen at the CRC. The large quantity of objects frozen at the RB precludes scanning each one, and at this time we are not able to do a batch scan.

**To Be Vikaned.**

Denotes an object that cannot be safely frozen or is too big to fit in one of the NMAI walk-in freezers. This barcode is rarely used, as objects are Vikaned at the RB.

**Vikaned.**

Denotes an object that has been treated with Vikane. Most often such an object will only be scanned after treatment.

**NOTE:** The term "**preventive**" here, somewhat misleading, describes pest management treatments that are done even though pest activity is not apparent. NMAI policy mandates that every infestable object that comes into the CRC gets some kind of preventive treatment in case of infestation

Figure 3b. Integrated Pest Management labels used for National Museum of the American Indian collections move

## **DILEMMAS IN TRANSPORTING UNSTABLE CERAMICS: A LOOK AT CYCLODODECANE**

Sara Caspi and Emily Kaplan

### **Introduction**

The National Museum of the American Indian (NMAI) is in the process of transporting its collection of over 800,000 artifacts from the museum's Research Branch (RB) in the Bronx, NY, to the new Cultural Resources Center (CRC) in Suitland, MD. The move began in mid-1999 and is projected to take five years in all. This article focuses on research into the transport of a group of unstable ceramics, using cyclododecane as a temporary consolidant.

### **Background**

In 1997, NMAI conservation staff began a collection-wide survey to assess conservation needs prior to the move. The conservators created a database that listed the condition of the objects in the collection with keywords, along with an indication of treatment priorities. Priority #1 was assigned to objects in need of stabilization before transport; #2 designated an object that was stable but needed re-evaluation after the move; and #3 was assigned to stable objects that could be cleaned and packed without further treatment. For ceramics, keywords included "efflorescence," "powdery paste," and "spalling surface." These conditions were suspected to be associated with a soluble salt problem, and these vessels were flagged as #1's - in need of stabilization before transport. As stabilizing these vessels was anticipated to be a time-consuming and complex process, the project was earmarked for Sara Caspi and Joanne Boyer, Andrew W. Mellon Fellows in Conservation who would be stationed at the RB starting in 1998.

### **The Project**

All of the ceramic objects listed in the survey as having soluble salts and/or ceramic body instabilities were re-examined. In order for an object to be included in the project, it needed to satisfy two criteria: the presence of loose fragments that would be disturbed or lost in transit, and a problem with soluble salts. Objects that had salt efflorescence but no active ceramic body instabilities were not included in the project because they could be safely transported to the CRC without consolidation. Objects with loose areas that did not have an apparent soluble salt problem were not included because they could be stabilized by consolidation with a standard conservation material like Acryloid B72 and then safely transported to the CRC. Ceramics that met the two criteria but could be transported by special packing were also not included in the project.

### **The ceramics in the project**

The final group of ceramics selected for the project included about thirty, out of the thousands in the museum's collection. Of this group, about a third were archaeological vessels, mostly from South America. The treatment approach towards the archeological vessels was relatively straightforward, based on accepted conservation methods of consolidation with Acryloid B72 followed by desalination; hence they could be made stable for transport without further investigation.

The 21 remaining ceramics were low-fired, hand-built vessels made by potters from the Pima, Maricopa, and Tohono O'odham tribes in Arizona; from the Cochiti, Santo Domingo, San Ildefonso, and San Juan pueblos in New Mexico; and from the Kawia tribe in California. While potters from these tribes use some similar clay preparation and manufacture techniques, there are significant variations, determined by local traditions, and local clay and temper resources.

All of the vessels are fragile and suffering from some combination of salt-related conditions including delamination, flaking, powdering, and subsequent loss, and sometimes deformation in the form of "blistering". All of the vessels test positive with micro-chemical tests to one or more soluble salts: chlorides, nitrates, and/or sulfates.

### **Sources of Soluble Salts**

While the presence of soluble salts in the archaeological pots was most likely an artifact of burial and could be acceptably treated, the presence of soluble salts in the ethnographic pots presented different questions. The salts could have been introduced during fabrication or use and thus might constitute important information about the object and its makers. Alternatively, soluble salts could have been introduced during a previous treatment.

For example, soluble salts may be naturally present in the clay, and might not be removed during dry processing. Some potters do process using wet methods, which might help remove salt impurities (Blair and Blair 1986). Soluble salts may also be introduced as part of the temper, which can be volcanic ash, ground-up sherds, stone, pulverized bone, shell, and sand (Peterson 1997; Peterson 1977). Salts may have come from use: some vessels are used for water gathering and storage, and the water in the Southwest can be highly alkaline. Other vessels are used for cooking, and some, used to store grain and liquid, may be partially buried in the ground (Peterson 1997; Fontana 1962). In addition, some ceramic vessels are used ceremonially, which might introduce soluble salts.

Because the source and significance of the soluble salts were in question, we met with Dr. Bruce Bernstein, NMAI Assistant Director for Cultural Resources, who is a scholar of ethnographic ceramics from the North American southwest. He felt that desalination across the board for the vessels would be inappropriate. He suggested in-depth culture-by-culture field research into the



source of the salts, focusing on use and technology of manufacture.

As it turned out, this kind of research was not possible during the course of this project: time constraints of the move prohibited such a comprehensive study. And as a new museum, NMAI is still in the process of creating policy and procedures for consultations with Native Americans regarding conservation and research. We expect that there will be better possibilities of consultations with potters from these various communities of origin in the future. Therefore, we used secondary sources for background research and focused on finding a way to securely transport the objects without desalination. Specifically, we considered the feasibility of cyclododecane as a temporary consolidant to stabilize sensitive areas prior to travel.

### **Cyclododecane in Conservation**

Cyclododecane has been attractive to conservators because of its ability to sublime: due to its high vapor pressure, cyclododecane goes directly from solid to vapor in the typical laboratory environment. In theory, the treatment leaves the substrate unchanged, and thus promises to be a self-reversing consolidant or barrier film that should not affect future treatment or analysis (Hangleiter et al. 1995; Jägers and Jägers 1999). Cyclododecane is a solid wax-like volatile cyclic alkane ( $C_{12}H_{24}$ ) with a melting point between 58-61° C. It is applied in liquid form as a melt or in solution, and hardens upon cooling or upon evaporation of the solvent.

Hangleiter (1995) and Jägers first developed and tested the material, introducing it to the conservation field in 1995. The primary uses in conservation are stabilization during transport (Hangleiter et al. 1995; Hiby 1997; McGowan 2001); and local surface protection during various treatments (Hiby 1997; Hangleiter 1998a; Bruckle et al. 1999; Bandow 1999). It has been used on several substrates, including paper (Bandow 1999; Bruckle et al. 1999; Keynan and Eyb-Green 2000); textiles (Hiby 1997; Jägers 1996); tempera (Hiby 1997) and oil paintings (Hangleiter 1998b); and unbound earth sculptures (McGowan 2001). It has been used on architectural elements, including stone (Bruckle et al. 1999; Stein et al. 2000); terracotta (Bruckle et al. 1999); mortar (Hiby 1999); plaster (Hangleiter 1998b; Riedl and Hilbert 1998); wall paintings (Hangleiter 1998a; Hangleiter 1998b).

Readers are referred to the excellent recent articles (in English) by Bruckle et al. (1999) and Stein et al. (2000) in which the results of comprehensive literature searches are usefully summarized. The authors discuss the properties of cyclododecane, its various uses in conservation, and application methods. Cyclododecane does not work on all media and in all treatments, mandating careful testing before use. These articles present the results of several tests to assess the suitability of cyclododecane as a conservation material for several treatments. Bruckle et al. report test results of cyclododecane for two uses: first, as a temporary protective fixative for water-sensitive media on paper during aqueous treatments; and second, as a barrier film for taking molds from objects easily stained by silicone mold-making materials. Stein et al., in investigating cyclododecane as a temporary consolidant for stone, address aspects of

penetration into various substrates; sublimation rates; and purity.

Regarding application techniques, we agree with the findings of most of these writers. The melt produces a more homogenous and cohesive layer, while the cyclododecane film produced from solution is more crystalline (Bruckle et al. 1999; Hiby 1997; Stein et al. 2000). The substrate to which the melt is applied may be heated to increase the penetration of the cyclododecane, and deep penetration of the cyclododecane results in a longer sublimation time (Riedl and Hilbert 1998). This of course would not be appropriate for our ceramic vessels.

As our goal was to use cyclododecane to protect the fragile surfaces of the ceramics for the relatively short time it would take to pack, transport, unpack, rehouse, and shelve the vessels, there would be no advantage to deep penetration into the ceramic substrate nor to the resulting long sublimation time. We found that applying molten cyclododecane with a glass pipette was a gentle way to apply the consolidant locally to the most fragile areas without disturbing the powdering and flaking surfaces (Fig. 3).

### **Tests on mock-ups**

We conducted several tests on mock-ups to evaluate application and packing methods. For one series of tests we applied cyclododecane onto fragmentary and powdered ceramic material. The tests were successful: there were no losses in transit and there was no apparent change after sublimation. Based on the success of these tests, we determined that cyclododecane would work as a temporary consolidant to allow for the transport of the rest of the ceramics in our project from the RB to the CRC.

When we saw that the mock-up tests succeeded, we consolidated, packed, and trucked one artifact from the RB to the CRC. The vessel was placed in a fume hood for the sublimation process at the CRC. After about one month the cyclododecane appeared to have completely sublimed. Fourteen months later, the vessel is, at least visually, unchanged (Figs. 4-6).

### **Residue**

Product literature and most of the conservation literature indicate that cyclododecane leaves no residue behind after sublimation. For example, Stein et al. (2000) tested a batch for residues and reported that there were none. Hiby (1997), cautions that it is important to use only a very pure cyclododecane in order to avoid residues. Jägers (1999) notes that “a fundamental precondition for the application of these materials [volatile binding media] is their complete and absolutely residue-free evaporation. A complete evaporation is guaranteed only when the materials are free from impurities. For this reason only products of high purity have to be used.”

We received our first shipment of cyclododecane from Kremer Pigmente in May 2000, and

started experimenting with it to learn about its working properties and rate of sublimation. We dripped melted cyclododecane with a pipette onto glass microscope slides to assess determine the sublimation rate. Stein et al. (2000) used a similar procedure. The slides were left unenclosed in ambient conditions in the laboratory. In the meantime, however, our tests on mock-ups appeared successful (Figs. 1-2).

To our surprise and disappointment, approximately five months later we noticed a minute amount of material, visible only in raking light, remaining on the glass slides after what had appeared to be complete sublimation. Furthermore, we had begun to test a second group of mock-ups at about this time. These were salty brick fragments covered with small mounds of powdery dirt from outdoors. These tests were not as successful as the first group. While the dirt and bricks arrived safely with no losses during transit, a white crystalline material was clearly visible after sublimation on some of the samples. Tide lines from the cyclododecane were also evident. This material is removable from the surface of the ceramic (Figs. 7-9).

We then contacted distributors and manufacturers of cyclododecane to ask about possible residues. Georg Kremer (2001), of Kremer Pigments, the primary United States cyclododecane distributor for conservators, responded that residue had never been reported. On further discussion, he said that while cyclododecane itself leaves no residue, there might be by-products from synthesis. Hans Hangleiter (2001), the German conservator who has been working with cyclododecane since before 1995, told us that he is familiar with an impurity and a residue but that he did not think it would have any measurable effect on treated materials. Our attempts to obtain information from manufacturers were unsuccessful.

### **Analysis of the Residue**

We put the transport of the unstable ceramics on hold while we had the residue analyzed. Samples of cyclododecane were analyzed independently with similar results. Samples analyzed included neat cyclododecane taken directly from three different 500 gram cans from Kremer; one sample from a batch of cyclododecane from Chem Service, and samples from the white crystalline loose layer left on the dirt-covered bricks. It is important to note that no impurities could be detected when solid cyclododecane crystals were analyzed. Other compounds could be detected only when the cyclododecane in the samples was heated to force sublimation.

We were able to have analyses done at three different laboratories. Jamie Martin at Orion Analytical in Williamstown, Massachusetts performed Fourier transform infrared micro spectrometry (FTIR); David Erhardt performed Gas Chromatography-Mass Spectrometry (GC/MS) and Walter Hopwood FTIR at the Smithsonian Center for Materials Research and Education; and Richard Newman at the Boston Museum of Fine Arts carried out GC/MS.

Results of GC/MS analyses done by Erhardt indicate the presence of very small amounts of residue consisting of compounds chemically close to cyclododecane but about twice its molecular weight:

dodecacyclododecane and hydroxydodecacyclododecane. In addition, traces of hydrocarbons such as cyclododecene, cyclododecane, cyclododecanone, and perhaps cyclododecanol were found. [1]

Richard Newman's GC/MS findings confirm those of Erhardt, with a few minor differences. Newman detected most of the same major compounds: cyclododecene, residual cyclododecane, cyclodecanone (probably), cyclododecanol, and a family of higher molecular weight compounds, including one that is probably bimolecular derivatives of cyclododecane. This compound was by far the major component in the residue found on the test bricks (Figs. 10-12). [2]

We have not yet quantified the amount of residual material: it is so small that our balances are not adequate. Erhardt, Hopwood, and Newman all thought it unlikely that the tiny amounts of this residue would be harmful to the ceramics. Erhardt and Hopwood (2001) concluded "Except for its persistence, residual material does not present a threat to substrates treated with the consolidant. For the most part, the residue consists of compounds chemically close to cyclododecane, but about twice its molecular weight, that are probably byproducts of the synthesis of cyclododecane. The percentage of residue is quite small."

## **The Industrial Literature**

A search of the industrial and chemical literature indicates the possibility, perhaps the probability, of impurities. When cyclododecane is produced in industry, it is expected that by-products will also be present unless a purification process is used. Production can be fine-tuned to get the highest yield of pure cyclododecane.

For example, several patents and articles report various processes for the synthesis and purification of cyclododecane. The majority of the literature (Lee 1970; Levine 1972; Morikawa et al. 1972; Hanika 1983; Okamoto 1990) reviewed that included detailed information on the production of cyclododecane described a general process of trimerization of 1,3-butadiene to 1,5,9 cyclododecatriene followed by hydrogenation of 1,5,9 cyclododecatriene to produce cyclododecane. Catalysts, reagents, and processes used vary, as does the reported purity of the resulting cyclododecane. The identification of high boiling point impurities and low molecular weight impurities in cyclododecane are reported by others (Manfred 1971; Usova et al. 1975).

For example, Manfred (1971) specifically mentions cyclododecanone, cyclododecanol, their mixtures, 1,12-n dodecandi-acid, and cyclododecene as by-products of cyclododecane production from butadiene. A method of removing these impurities is discussed. Morikawa et al. (1972) describe a process of producing cyclododecane from butadiene. Part of the process involves the removal of low boiling point by-products such as dimers of butadiene and high boiling point by-products. The resulting cyclododecane is expected to have 99.6% purity.

Cyclododecanone and cyclododecanol are compounds known to be produced from cyclododecane through oxidation (Furusaki and Mitamoto 1993; Zeng and Cui 1993). The impurities seen during the production of cyclododecane are unreacted cyclododecadiene and its incomplete hydrogenated

products (cyclododecene and cyclododecadiene isomers) as well as cyclododecanone and cyclododecanol. These ketone and alcohol high-boiling impurities could be formed either from the autooxidation of cyclododecane or from the hydrogenation of cyclododecadiene that contains impurities. (Usova et al. 1975).

The production methods for the cyclododecane we purchased are proprietary and were therefore not divulged to us, but it is reasonable to conclude from the industrial literature that the cyclododecanol, cyclododecanone, and cyclododecene impurities found in the GC/MS analysis could be by-products from synthesis. The other compounds found in the GC/MS analysis are not specifically mentioned in the literature; however, it seems likely that they are also by-products of synthesis.

## **Conclusions**

There is a real possibility of very small quantities of impurities in cyclododecane. However, we believe that for these ceramics, the quantities are too small to interfere with any future analysis or treatments such as desalination or consolidation. Cyclododecane has been an acceptable and useful product for this project, but we emphasize that of course it may not be suitable for other media.

As the chemists we consulted pointed out, how many of the materials that we have in our conservation laboratories are completely pure and residue-free? Other conservators have tested and used cyclododecane without having apparent impurities and subsequent residue problems. It seems likely that there are batch variations.

The white material that remains visible on some of the dirt-covered brick mock-ups needs further investigation. The residue is easily removed manually, or with solvents such as Xylene. This phenomenon has not occurred on any of the other mock-ups or any of the treated objects.

Over a period of approximately six months we treated 21 ceramics with cyclododecane. We packed and trucked the pots to Suitland, and without exception all arrived safely with no losses. The presence of cyclododecane on the fragile surfaces allowed us to handle the vessels much more easily in the process of unpacking, rehousing, and shelving in our compactor storage ranges. We are examining the objects periodically as the cyclododecane sublimes, and there are no signs of darkening or tide-lines. The pots are all rehoused now, so they can be handled in their storage mounts should they need to be moved again.

The vessels have been moved safely, but now remain in their respective original conditions, for example, one vessel exhibits ongoing loss of ceramic powder as the cyclododecane sublimes in storage. We expected this loss, as it had been occurring over the years prior to the temporary consolidation with cyclododecane.

Based on our findings, we would recommend that anyone interested in using cyclododecane should purchase it in advance, apply a thick layer onto a glass slide and wait for it to sublime. Of course, if access and resources allow, GC/MS analysis would be more precise. In addition, while we may not receive answers, efforts should be made to inquire of the suppliers and manufacturers about the production method and the likelihood of any possible impurities. And of course any information about residues and production is important to include in the treatment documentation.

Given the condition of our ceramics, the time constraints of our move, and our questions about the source of the soluble salts, we believe that using cyclododecane as a temporary consolidant was a good solution to our transport dilemma.

### **Acknowledgments**

We are grateful to the Andrew W. Mellon Foundation for making this research possible, and to Richard Newman, David Erhardt, Walter Hopwood, and Jamie Martin for their analytical work and advice. Thanks are due to Monika Harter, Michael García, Isleen Poiss, and Ulla Zenz for translation of the articles, and to Robert Marvin García, Gary McGowan, Louis Isaacson, Michele Marincola, and Renée Stein for their consultations. We thank Joanne Boyer, Scott Carroll, Marian Kaminitz, Leslie Williamson, and the RB and CRC collections move staff for their contributions to the project.

### **Endnotes**

1. From Erhardt and Hopwood (2001):

“A few flakes of one of the residues [from two brick samples and from Kremer can] prepared by E.K. were dissolved in methylene dichloride. Approximately two microliters of the resulting concentrated solution was injected into a gas chromatograph. The instrument used was a Hewlett-Packard 5890 with a 5972 mass selective detector. With injector temperature 250 C, DB-1 30 m X 0.25 mm column. Temperature was ramped from 50 to 340 C at 10 C deg/min. The interface was set at 340 C.

“In the residue, traces of cyclododecene, cyclododecane, cyclododecanone, and, perhaps, cyclododecanol were detected. About 83 percent of the area under the peaks of the total ion chromatogram (TIC) was attributed to dodecacyclododecane. A significant but lesser amount of a slightly higher boiling constituent, perhaps hydroxydodecacyclododecane, was detected. The hydroxy group on the side chain must be near the ring.

“Finally, trace amounts of three dodecacyclododecanols were detected. Our unconfirmed identifications are 1-dodecacyclododecan-1-ol, 1-dodecacyclododecan-2-ol, and hydroxydodecacyclododecan-2-ol (hydroxy near the ring).”

2. From Newman (2001):

“All three Kremer samples gave similar results (see the chromatograms). In the chromatograms, please note that there are various peaks, including a very large one at about 17.3 minutes, that are from contamination in the instrument. These do not interfere with any of the residual compounds. I have not labeled any of these contamination peaks. Major compounds detected: cyclododecene, residual cyclododecane, cyclodecanone (probably), cyclododecanol, and a family of higher molecular compounds (retention times ~ 17.5-18.5 minutes). Most of these higher MW compounds cannot be specifically identified, but one of the major ones (c. 18 minutes) has a mass spectrum that closely matches that of 'cyclododecane, bicyclo compound' in the Wiley MS library. This compound essentially consists of two cyclododecane molecules bonded together. The pattern of peaks in the 17.5-18.5 minute region is quite similar, but not absolutely identical, for all three Kremer samples. All of the Kremer samples were prepared for analysis by placing a fairly large crystal or cluster of crystals in a cleaned vial, heating the vial to just above the melting point of cyclododecane and leaving the vial in the heating block until virtually all of the visible liquid had evaporated. The residual material was then dissolved in methylene chloride for GC/MS analysis. If a lot of cyclododecane remained, the solution was evaporated to dryness again, left on the block for a while, and redissolved.

“The three brick residue samples gave fairly similar results to one another (see the chromatograms). The major compound by far was the compound identified in the Kremer raw material samples as 'cyclododecane, bicyclo compound.' The brick residues lack the family of other higher MW compounds that the Kremer residues contained (compare the detail chromatograms of the 18-20 minute region). The other compounds (lower MW) found by Erhardt and Hopwood in the brick residues from 2 and 3 seem to be present at lower levels (relative to this high MW compound) in the samples I analyzed than they were in the ones they analyzed. We used somewhat different GC/MS procedures, which could account for some of the differences. The compound that made up about 83% of the total peak area in the brick 3 residue analyzed by Erhardt and Hopwood is clearly the same compound that I found to be the major component in all three of brick residues (although the peak area it accounted for in my analyses would have been much higher than 83%). This is the compound that they identified as dodecacyclododecane. This compound would have the exact same composition as 'cyclododecane, bicyclo compound'. I am only relying on the MS library for the identification.

“The conclusion from my analyses is that the Kremer material contains only very small amounts of compounds other than cyclododecane. Some of this associated material is clearly higher MW material, probably essentially 'dimers'. Apparently quite a range of specific compounds is present in this higher MW group. The remainder of the associated material consists of 'monomers' of the types noted by Erhardt and Hopwood. For some reason, the brick residues are enriched in a single 'dimer' component. I don't know whether the evaporation procedure I used, which involved an elevated temperature, could

have somehow affected the composition (the heating temperature, however, was not that high -- between 60-70 C).

“One final note on the Kremer materials: one can also contained some fatty acids and hydrocarbons, in quite small amounts. I don't believe these are due to any contamination in my instrument, solvents, or sample vials.

“Re. the Chem Service cyclododecane. It gave a quite different result. It contained some of the same high MW compound (the 'dimer') and some of the same residual lower MW compounds, but the major compound detected in it fairly closely matches the reference mass spectrum for erucylamide, C<sub>22</sub>H<sub>43</sub>NO (MW 337). This particular compound is not present in any of the Kremer residues.” [Only one sample from Chem Service cyclododecane was analyzed.]

## **Suppliers**

Kremer Pigments, Inc  
228 Elizabeth St.  
New York, NY 10012

Lancaster Synthesis, Inc.  
P.O. Box 1000  
Windham, NH 03087  
603-889-3302

Chem Service, Inc.  
600 Tower Lane  
PO Box 599  
West Chester, PA 19381-0599

## **References**

Bandow, C. 1999. Cyclododecane in der papierrestaurierung. *Restauro* 5:326-29.

Blair, M. and L.R Blair. 1986. *Margaret Tafoya: a Tewa potter's heritage and legacy*. West Chester, Pennsylvania: Schiffer Publishing Ltd.

Bruckle, I., J. Thornton, K. Nichols, and G. Strickler. 1999. Cyclododecane: technical note on some uses in paper and objects conservation. *Journal of the American Institute for Conservation* 38:2-75.



Erhardt, D. and W. Hopwood, Smithsonian Center for Materials Research and Education. 2001. Consolidant residue: infrared spectroscopy, gas chromatography. February 21, 2001.

Fontana B.L., W.J. Robinson, C.W. Cormack, and E.E. Leavitt. 1962. *Papago Indian pottery*. Seattle: University of Washington Press.

Furusaki S., and N. Mitamoto. 1993. Preparation of cyclododecanone from cyclododecane. *Japanese patent # 9309147*. Assigned to UBE Industries, LTD.

Goldberg, Lisa. 2001. Personal communication. 261 Wall St., Corning, NY 14830.

Hangleiter, H.M. 2001. Personal communication. Bismarckstr.13, D-64853 Otzberg, Germany.

Hangleiter, H.M. 1998a. Erfahrungen Mit Fluchtigen Bindemitteln. Part 1. *Restauro* 5:468-73.

Hangleiter, H.M. 1998b. Erfahrungen Mit Fluchtigen Bindemitteln. Part 2. *Restauro* 7: 468-73.

Hangleiter, H. M., E. Jägers and E. Jägers. 1995. Fluchtige bindemittel. *Zeitschrift Fur Kunsttechnologie und Konservierung* 9: 385-95.

Hanika, J., V. Ruzicka, J. Soukup, K. Sporka. Oct 15 1983. Cyclooctane and cyclododecane. *Czech Patent #204068*.

Hiby, G. 1999. Cyclododecan als temporare transportsicherung. *Restauro* 5: 358-63.

Hiby, G. 1997. Das fluchtige bindemittel cyclododekan. *Restauro* 2: 96- 103.

Isaacson, L. 2001. Personal communication. Physical chemist. P.O.B. 187, Brattleboro, VT 05302-0187.

Jägers, E. 1996. Partielle behandlung von textilen objekten- möglichkeiten und grenzen herkommlicher und neuer methoden. *Ehemaligentreffen der Abegg- Stiftung Riggisberg* 1(2): 60-71.

Jägers, E., and E. Jägers. 1999. Volatile binding media – useful tools for conservation. Reversibility – Does it Exist?, *British Museum Occasional Papers* 135: 37-42.

Jägers, E. 1999. Conservation DistList posting. February 14, 1999.

<http://palimpsest.stanford.edu/byform/mailling-lists/cdl/1999/0218.html>

Keynan D., and S. Eyb-Green. September 2000. Cyclododecane and modern paper: a note on ongoing research. *WAAC Newsletter*. 22 (3) 18-19.

Kremer, G. 2001. Personal communication. Kremer Pigmente, Inc., kremer-pigmente@t-online.de

Lee, C.Y. May 19. 1970. Process for producing high purity cyclododecane. *U.S. Patent #3,513,208*. Assigned to Cities Service Company.

Levine, R. Nov. 21. 1972. Process for preparing a pure hydrogenated cycloolefin. *U.S. Patent #3,703,558*. Assigned to Cities Service Company.

Manfred, R. December 23 1971. Removing low-molecular-weight solid impurities from cyclododecane or its crystalline secondary products. *German Patent #2030257*. Assigned to Chemische Werke Huls AG.

McGowan, G. 2001. Personal communication. Cultural Preservation and Restoration Inc, Hackettstown, N.J.

Morikawa H., M. Sagara, and G. Kakemoto. CDT/CD from C4 fractions. *Hydrocarbon Processing*. 51(8). J. 102-4.

Newman, R. 2001. Boston Museum of Fine Arts. Analysis report. March 28, 2001.

Okamoto, K. 1990. Ceramic binder composition. *EU Patent Application 350070*.

Peterson S. 1997. *Pottery by American Indian women: the legacy of generations*. New York: Abbeville Press and The National Museum of Women in the Arts.

Peterson S. 1977. *The living tradition of Maria Martinez*. Tokyo: Kodansha International.

Riedl, N., and G. Hilbert. 1998. Cyclododecan im putzgefuge. *Restauro*. 5: 494-503.

Stein, R., J. Kimmel, J., M. Marincola, and F. Klemm. 2000. Observation on cyclododecane as a temporary consolidant for stone. *Journal of the American Institute for Conservation*. 39 (3): 355-369.

Usova, E.P., L.I. Mitina, G.S. Sizova, and A.P. Znamenskaya. 1975. Gas-chromatographic analysis of cyclododecane and products of 1,5,9 cyclododecatriene hydrogenation. *Zhurnal Analiticheskoi Khimii*. 30(7):1410-13.

Zeng, C. and M. Cui. 1993. Catalytic oxidation of cyclododecane to cyclododecanol and cyclododecanone. *Nanjing Huagong Xueyuan Xuebao*. 15: 54-60.

**Authors' Addresses**

Sara Adina Caspi, Brooklyn Museum of Art, Conservation Dept., 200 Eastern Parkway, Brooklyn, NY 11238, (718) 638-5000 x 562, (scaspi@yahoo.com).

Emily Kaplan, Smithsonian Institution, National Museum of the American Indian/Cultural Resources Center, 4220 Silver Hill Road, Suitland, MD 20746, (301) 238-6624 x 6316, (kaplane@nmaircr.si.edu).



Figure 1. Cyclododecane applied by pipette in the melt on glass microscope slides.

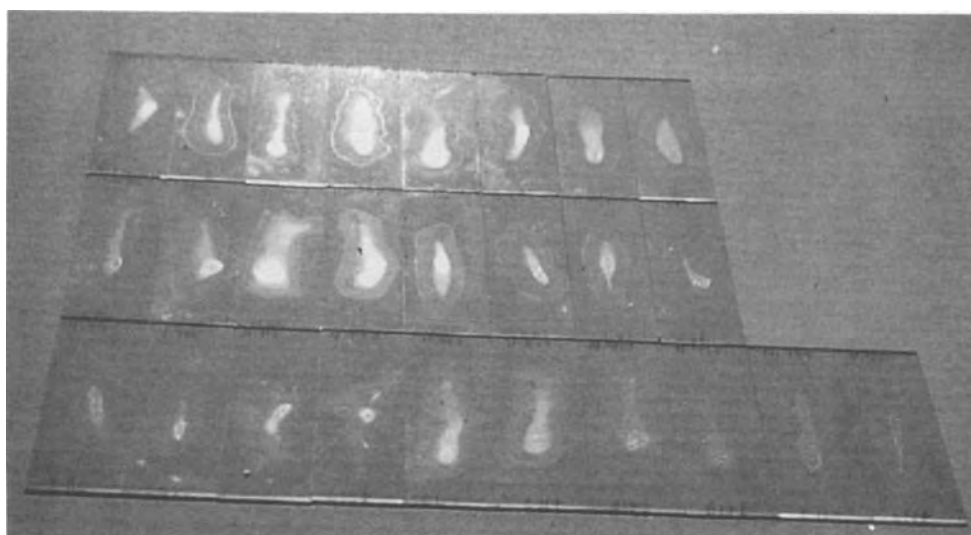


Figure 2. Cyclododecane residue on glass microscope slides, visible in raking light.

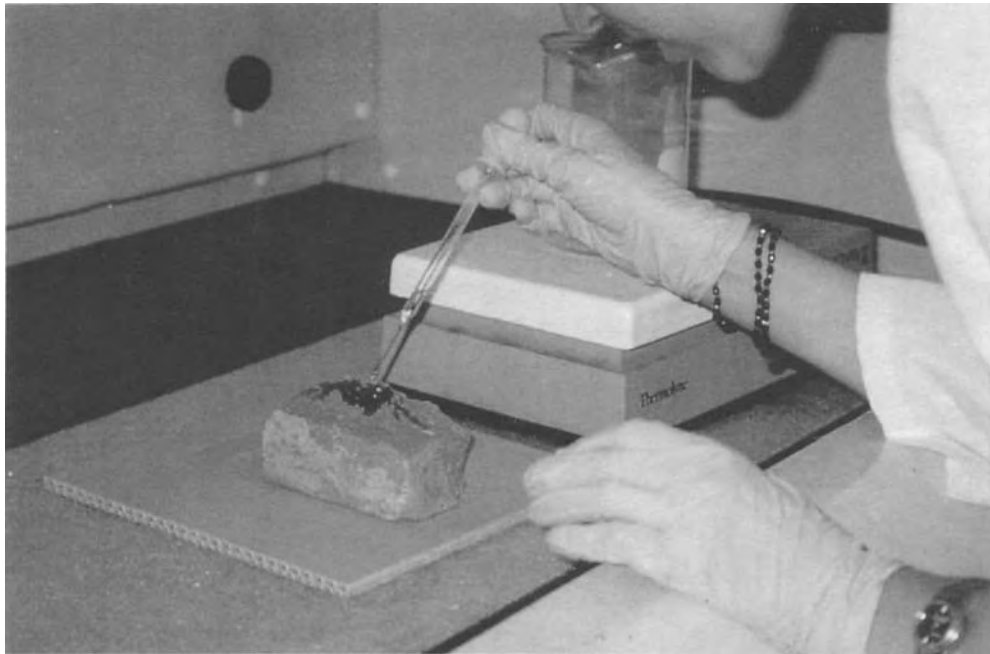


Figure 3. Applying molten cyclododecane by pipette to test brick sample.



Figure 4. Santo Domingo Pueblo pitcher (NMAI 050833.000). Before treatment.



Figure 5. Santo Domingo Pueblo pitcher (NMAI 050833.000). During treatment, cyclododecane partially sublimed.



Figure 6. Santo Domingo Pueblo pitcher (NMAI 050833.000). After treatment. The cyclododecane has sublimed completely.



Figure 7. Test Brick #4, cyclododecane newly applied.



Figure 8. Test Brick #4, after six months, cyclododecane partly sublimed.



Figure 9. Test Brick #4, after nine months, Residue from cyclododecane is visible.

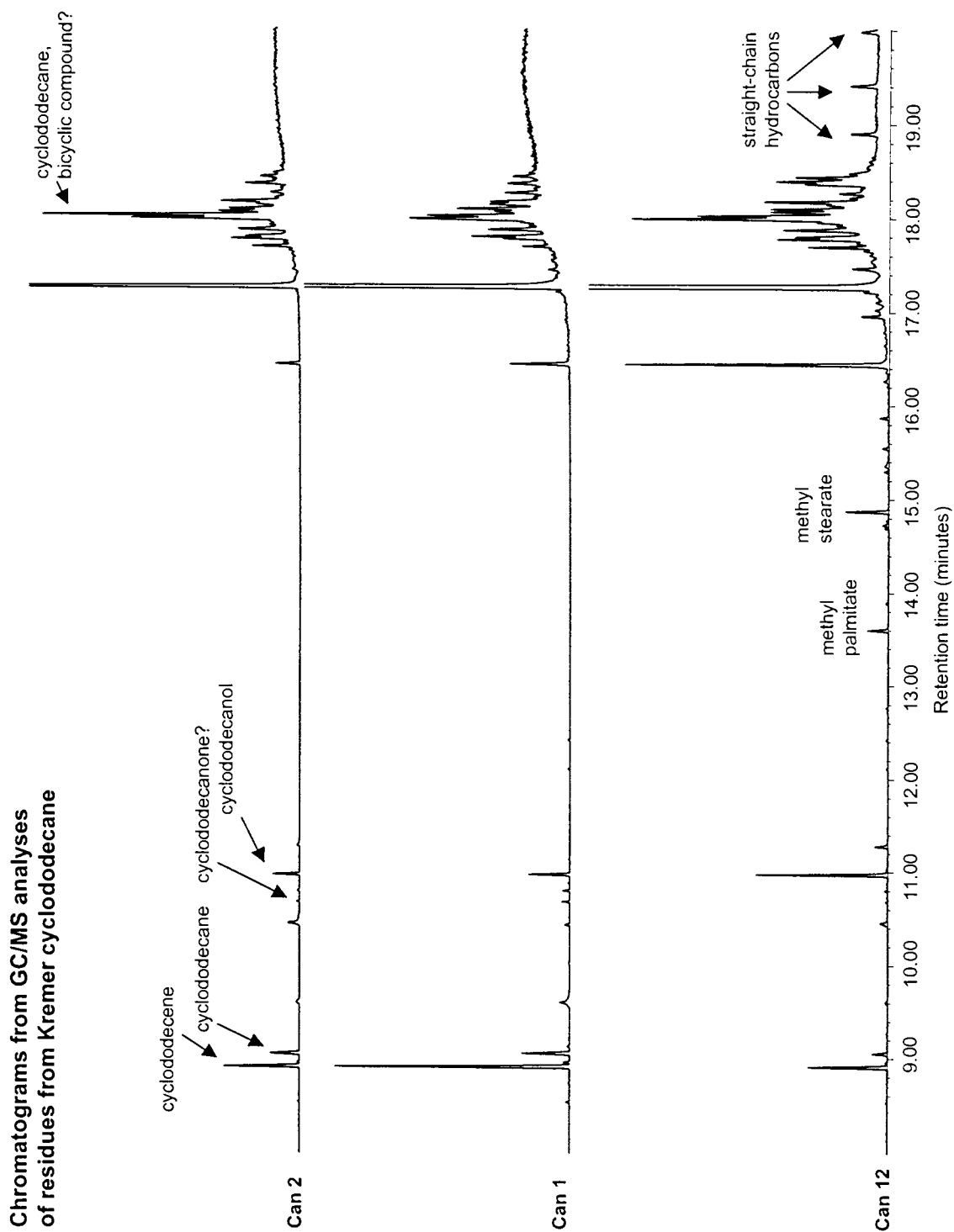


Figure 10. Chromatograms from GC/MS analyses of residues from Kremer cyclododecane (Newman 2001).



Chromatograms from GC/MS analyses  
of residues from bricks treated with cyclododecane

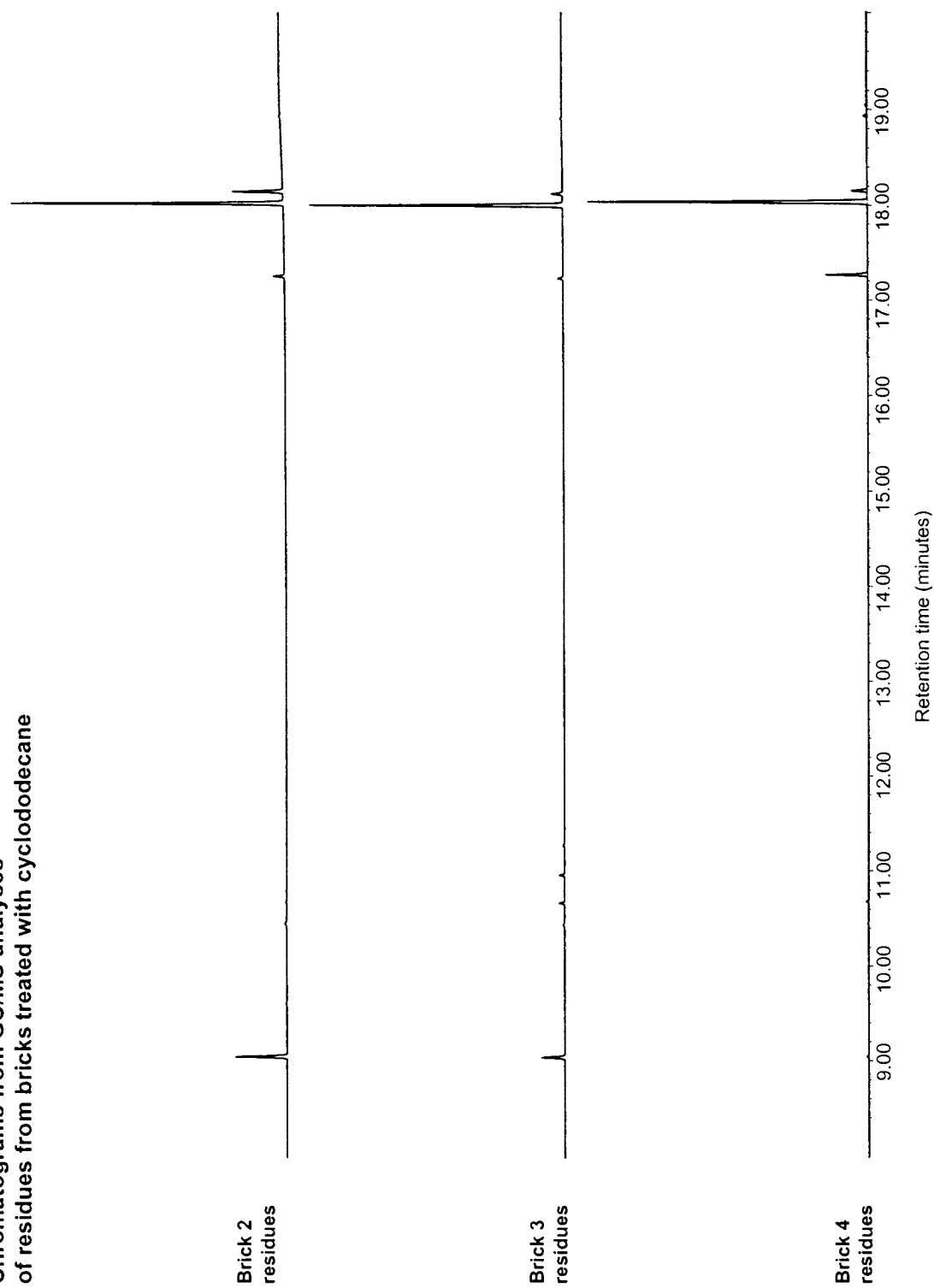


Figure 11. Chromatograms from GC/MS analyses of residues from test bricks #2, 3 and 4 (Newman 2001).

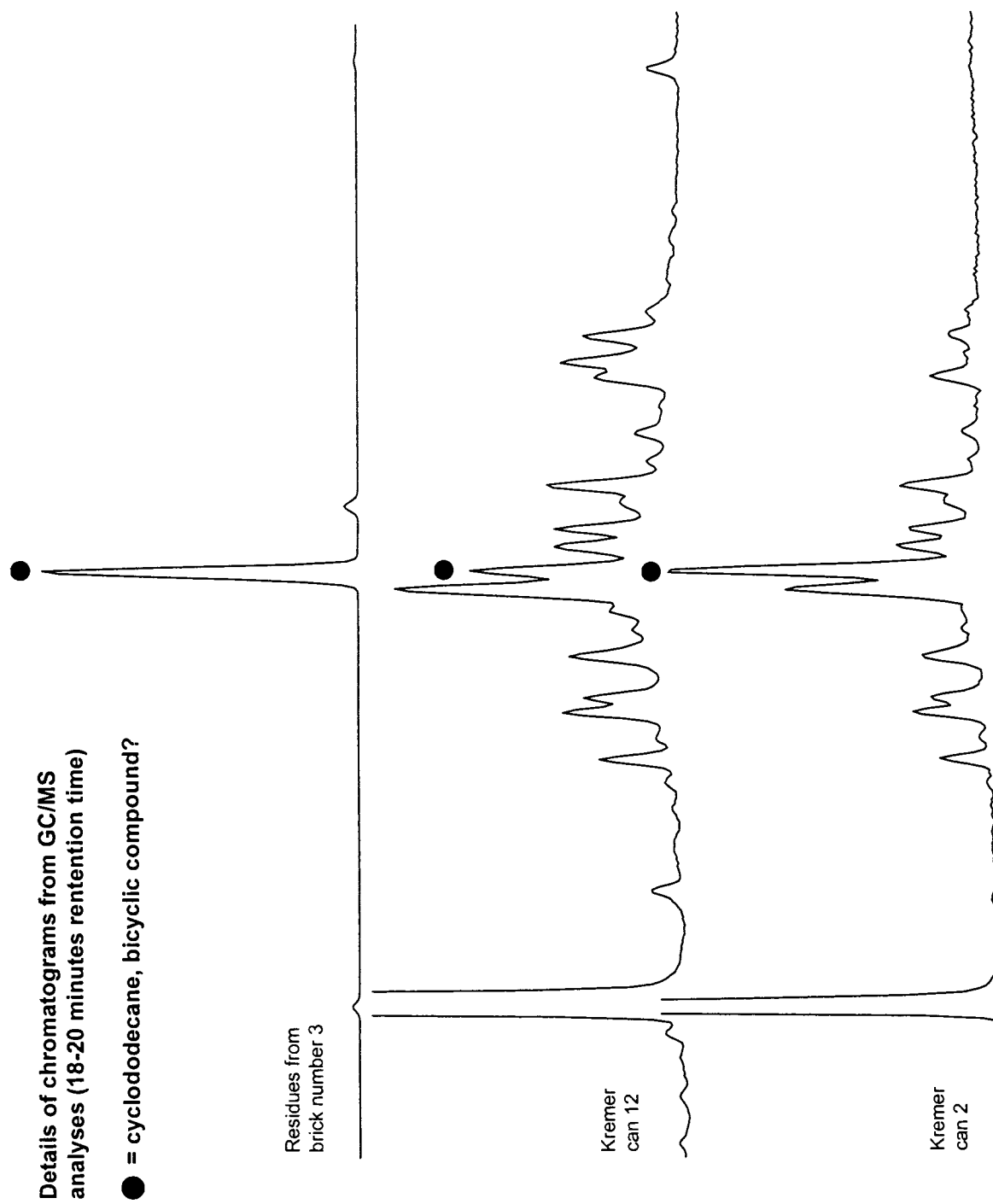


Figure 12. Details of chromatograms from GC/MS analysis (Newman 2001).

## **MOSAIC CONSERVATION AT THE WORCESTER ART MUSEUM**

Paula Artal-Isbrand

### **Introduction**

The Worcester Art Museum, in Worcester, MA, has organized a traveling exhibition of ancient Roman art objects excavated from Antioch with the title *Antioch: The Lost Ancient City*. The show opened in Worcester in the fall of 2000, then it traveled to the Cleveland Art Museum in the spring of 2001, and its third venue was at the Baltimore Museum of Art in the fall of the same year. This exhibition marked the first time since the excavations in the 1930's that many important finds from Antioch, currently housed in 29 European, Middle Eastern and USA museums, were re-united. The highlight of this event consisted in the exquisite Antioch mosaics, made of stone and glass tesserae. They were the floors of private and public buildings.

### **History of Antioch and the Excavations**

Founded in 300 BCE, Antioch-on-the-Orontes became one of the four major cities during the Roman Empire besides Rome, Constantinople and Alexandria. The ancient city of 800.000 inhabitants during its height was repeatedly rebuilt after major and minor earthquakes. The worst one destroyed it in 526 CE. Much of the damage to the excavated objects is attributed to this earthquake. The excavations which began in 1932 and ended in 1939 were a collaborative effort of five institutions including the Louvre Museum, Princeton University, Harvard University, the Baltimore Museum of Art, and the Worcester Art Museum. Antioch or modern Antakya, now in Turkey, was during that period under the jurisdiction of the French Protectorate of Syria. For their time the Antioch archaeologists were unusual because of their effort to properly document the excavations in the form of extensive and detailed field notes and hundreds of photographs. The finds were published by Princeton University Press.

### **The Conservation Campaign at the Worcester Art Museum**

The conservation of objects for this exhibition started over three years before the exhibition opened. A total of four conservators worked on the conservation team at different times: Lawrence Becker, Sarah Nunberg, Diane Fullick and the author. The conservation team in collaboration with the curator, Christine Kondoleon, contributed to the development of ideas expressed in this paper. Also, Sari Uricheck and Sarah McGregor worked on this project during their graduate internships. The help of numerous volunteers was invaluable as well.

Even though ceramic, metal, stone and stucco objects were also treated, this paper will be limited to the conservation of the mosaics. Besides Worcester's own collection, a number of mosaics that came on loan were also treated.

## **Conservation Goals**

Most Antioch mosaics had very similar structural problems due to the same lifting techniques and on-site stabilization procedures in the 1930's. Each institution had treated and stored their mosaics in different ways. Therefore, problems and conditions specific to each museum were also encountered.

One of the challenges was to prepare the concrete-backed mosaics for travel. In addition to being heavy it is their shape, which is large in two dimensions and relatively small in the third dimension that makes them extremely fragile, especially when moved from one place to another. During movement the center of gravity can easily shift and lead to cracking or even breaking. Some mosaics weigh over half a ton.

Another challenge was concerning their presentation. Questions about how to compensate for losses that were treated in numerous ways at different museums had to be addressed. All new fills had to be homogenous and consistent among themselves and made of a material softer than the original stone and glass tesserae, as well as strong and flexible enough to endure travel.

Even though there were also other problem solving situations during this conservation campaign, such as the cleaning of the mosaics, these aspects of the conservation treatment will not be addressed in this paper.

## **Stabilization and Transport of the Mosaics**

When a mosaic first came to the conservation laboratory it was checked for loose tesserae by tapping its entire surface. Any loose ones were secured with Paraloid B-72 adhesive. The mosaics were also checked for cracks. All mosaics had been backed with concrete reinforced with iron bars and chicken wire mesh immediately after excavation (Fig.1). This system over time led in many cases to cracking due to the rusting of the iron in the concrete matrix (Fig.2). For mosaics that had been exhibited or stored outdoors over the years this was especially a problem. If the cracks did not extend to the tessellatum on the front, Flexi-Weld 520 epoxy was used to fill them. Otherwise, cracks were filled with Paraloid B72 adhesive bulked with 3-M glass micro-balloons.

The major intervention to stabilize the mosaics consisted in framing them with custom-made steel or aluminum frames (Fig.3), which were fastened to the mosaics with screws that were anchored into the concrete backing. Crossbars on the back of the frames, padded with high density Ethafoam, provided additional support for cracks.

The crates fabricated for the transport of the mosaics were lined with Ethafoam and Volara. Also, a vibration absorbing neoprene padding (30005 Series) was constructed into the riding edge of a number of the largest crates for additional protection of the mosaics.

All the mosaics were moved and transported vertically only. This is the safest orientation for the concrete-backed mosaics, since concrete is strongest under compression. If transported flat the shear stress across cracks can seriously damage the thin mosaics.

### **Loss Compensation**

Many mosaics exhibited losses of tesserae that had to be compensated for the exhibition. As the freshly excavated pavement fragments were backed with concrete while still in Syria, areas of missing tesserae got filled at the same time with the same concrete leaving an unattractive, irregular, gray fill that was flush with the tessellated surface, often obscuring original tesserae on the edge of the loss.

Each institution dealt with these fills differently upon receiving their share of Antioch mosaics. Some did not do anything to these fills (Fig. 4). Others painted over them, replicating the pattern of the mosaic by often inventing the design (Fig. 5). In other cases the concrete fills were replaced with plaster that was consequently painted, also imitating a mosaic design. At the Worcester Art Museum mosaic artists from Italy restored a number of mosaics in 1936. They removed part of the concrete, and filled the losses with stone tesserae (Figs. 14, 16). Besides using new tesserae, unfortunately ancient tesserae were also used during these restoration efforts. These tesserae came from mosaic fragments thought not worthy of exhibit at the time. The numerous photographs taken during excavation proved to be invaluable to the Worcester conservators during the treatment of the mosaics because they allowed them to clearly distinguish original parts from restorations.

The question was what to do with all these losses treated in different manners over the last 60 years. The new fills had to meet the following requirements: the fill material had to be stable, reversible, and softer than the tesserae surrounding it. Also, it needed to have adhesive and cohesive strength to endure vibration during transport. The fills had to be aesthetically pleasing and recognizable as integrations. The color of the fills, which had to be stable over time, had to not only harmonize with the color of the surrounding original tesserae but preferably with fills on the other mosaics as well. This was especially important to achieve for the six mosaic segments that make up the Atrium House triclinium floor.

It was decided to chisel out the old concrete fills, and create new recessed fills with a lime-based, salt-free restoration mortar called Custom System 45 produced by Edison Coatings (Fig. 13). This fill was to resemble the bedding mortar. The Custom System 45 mortar is made in a large variety of colors with the intention of imitating the appearance of different stones and mortars. They are produced by adding crushed stone and inorganic pigments of different colors to the lime mortar base. This restoration mortar is a two-part system that consists of the mortar powder solid and an acrylic emulsion which are mixed in a proportion of 5:1 to 7:1 by weight. In order to improve the adhesion of the restoration mortar to the substrate, the acrylic emulsion is brushed on first.

The Edison mortar has all the characteristics that are required from the fill material. Due to the acrylic component in the formula, the cured mortar slightly softens when wetted with acetone. This makes it quite easily reversible. In cases where the water-sensitive glass tesserae bordered areas of losses, the fill material consisted of Paraloid B-72 adhesive bulked with 3M glass micro-balloons and glass beads and added inorganic pigments. These fills are very close in appearance to the mortar fills.

This filling approach became the general rule during this mosaic conservation campaign. But, as usual, where there is a rule there are inevitably exceptions.

In some cases where individual tesserae were missing in central parts of a mosaic it was thought necessary to use a different compensation approach. This was the case in the *Funerary Symposium* mosaic for example, specifically in the area of the head of one of the women. The absence of individual tesserae was visually disruptive making it impossible to appreciate the 2-dimensional illusion of a 3-dimensional work of art. Each little hole created by a missing tessera appeared as a dark shadow distorting the design immensely. If these multiple losses were filled with the restoration mortar, their appearance would not be very different to the image in Fig. 6. It was thought that it would be appropriate to fill these losses with newly fabricated restoration tesserae.

Two approaches were used to make new tesserae during the Worcester conservation campaign. One was to cast them in plasticine using Whatman's paper pulp mixed with Sigma methyl-cellulose; the other one was done by casting them in President-Coltene silicone-based impression material using plaster. The plaster was consolidated with Paraloid B-72 after curing. Windsor & Newton watercolors or Golden acrylics were used to paint them. Figs. 7 and 9 show the detail of the head in Fig. 6 after filling with paper pulp restoration tesserae, and after in-painting with water colors. This filling approach was taken only where the shape and color of the tesserae were predictable since no invention of the design was acceptable.

Another exception to the filling rule was the compensation of a large loss in the center of the dining room floor. In a computer model of it in Fig. 9 all the mosaic segments now belonging to six different museums can be seen side by side as they were found and as they were exhibited in the Antioch exhibition. In Fig. 10 is a field photograph before the floor was lifted. The damage in the center of the floor occurred before the mosaic was discovered, when a trench was dug to build a wall. In this particular case the conservators and the curator decided to continue parts of the repetitive geometric border with plaster restoration tesserae cast in entire sections in order to better integrate these two fragments into the floor (Figs. 11, 12). The remainder of the loss was to be filled with Edison mortar.

In Fig. 13 the panels can be seen *after treatment* incorporated into the dining room floor at the exhibition venue in Worcester. The plaster restorations were painted using an airbrush in a slightly lighter color than the original border to make the restorations obvious. To compensate for the missing mosaic pavement between these two fragments an entire separate fill panel was

fabricated, using a wooden board for the substrate.

In the case of the Funerary Symposium mosaic it was decided to cover areas of the 1930's tesserae restorations with tinted tissue paper instead of removing the restoration tesserae (Figs. 14-16). It was felt that these skillful restorations are now part of the history of the mosaic. Besides being incorrect, the modern faces, for example, which were in perfect condition, made the ancient, eroded faces look secondary.

But not all the restorations were covered. It was decided that the restorations of the geometric border sections and the background curtains would be left uncovered because they don't seem to be invented shapes but rather a continuation of existing patterns. Also, the curtains help to establish the physical space in which the banquet is taking place.

### **Conservation and Techniques Gallery**

In addition to the galleries featuring the art, the exhibition also incorporated a gallery dedicated to the conservation and the excavation of the mosaics. It included a case with materials, tools and description of techniques used by Worcester Art Museum conservators during this recent conservation campaign, as well as two text panels explaining what conservators do and how mosaics were made in antiquity.

In the same gallery the visitor could also view archival photographs showing mosaic lifting and cleaning methods during the excavations in Syria, the installation of the mosaics at the Worcester Art Museum in 1936, and the Italian mosaic artists at work.

### **Conclusion**

This project did present the conservation team with tough but interesting challenges. The stabilization and moving of the mosaics required a lot of heavy equipment and close collaboration with contractors such as riggers, welders, crate makers and art transport professionals most of whom had never dealt with mosaics before. Problem solving often involved long discussions and, the decisions made were rarely clear-cut answers to fundamental questions. For example, the conservators had to compromise in their filling decisions by restoring parts of a number of the mosaics "invisibly" with tesserae. This decision was based on the fact that it was believed that it is also the role of the conservator to present the art object in such a way that it helps the viewer in the process of looking and interpreting it.

It was a very rewarding project, which has afforded the Worcester conservation team a unique opportunity to work very closely with a large number of mosaics and learn immensely from this favorite art medium of the Romans.

## **Acknowledgments**

I want to thank the Andrew W. Mellon Foundation for financing my attendance to the conference. My deep appreciation also goes to Lawrence Becker for having given me the opportunity to part-take in this outstanding project, and to Christine Kondoleon for having envisioned and organized this exhibition. Finally, special thanks to my friend and colleague Tony Sigel for his constant support.

## **Suppliers**

### **3M Glass Micro-balloons, and Microbeads**

3M Center Building, 220-8E-04, P.O.Box 33220, St. Paul, MN 55144-1000,  
(800) 367-8903

### **30005 Series Neoprene Pads**

Barry Controls, 40 Guest Street, P.O.Box 9105, Brighton, MA 02135, (617) 787-1555

### **Cabosil, Fumed Silica**

Conservator's Emporium, 100 Standing Rock Circle, Reno, NV 89511, (702)852-0404,  
Fax (702)852-3737, [www.consemp.com](http://www.consemp.com)

### **Custom System-45 mortar**

Edison Coatings, Inc., 3 Northwest Dr., Painville, CT 06062, (800) 697-8055,  
Fax (860) 747-2280, [www.edisoncoatings.com](http://www.edisoncoatings.com)

### **Ethafoam**

Tuscarora Incorporated, P.O.Box 360893, Pittsburgh, PA 15251, (508) 829-7175

### **Flexi-Weld 520 Epoxy**

Edison Coatings, Inc., 3 Northwest Dr., Painville, CT 06062, (800) 697-8055,  
Fax (860) 747-2280, [www.edisoncoatings.com](http://www.edisoncoatings.com)

### **Golden Acrylic Paints**

Johnson Paint, 355 Newbury Street, Boston, MA 02115, (617) 536-4065  
Fax (617) 536-8832, [www.johnsonpaint.com](http://www.johnsonpaint.com)

### **Green's Lens Tissue**

Talas, 568 Broadway, New York, NY 10012, Fax (212) 219-073

### **Harbutt's plasticine**

Conservation Resources International, L.L.C., 8000-H Forbes Place, Springfield, VA  
22151-2203, (800) 634-6932



### *Artal-Isbrand*

#### Methyl cellulose

Sigma, 3050 Spruce Street, St. Louis, MO 63103, Fax (800) 325-5052, [www.sigma.com](http://www.sigma.com)

#### Paraloid B-72

Rohm and Haas Co., Independence Mall West, Philadelphia, Pa. 19126,  
Fax (215) 592-3377

#### Plaster

Samuel H. French Co., 4446 Cresson Street, Philadelphia, PA 19127, (215) 482-6770  
Fax (215) 482-1211

#### President-Coltene Silicone Moldmaking compound

Williams Dental Supply, Inc., 50 Water Street, Worcester, MA 01604, (508) 752-7879,  
[www.williamsdentalsupply.com](http://www.williamsdentalsupply.com)

#### Solvents

Fisher Scientific, 2000 Park Lane Dr., Pittsburgh, PA 15275, Fax (800) 926-1166,  
[www.fishersci.com](http://www.fishersci.com)

#### Volara

Tuscarora Incorporated, P.O.Box 360893, Pittsburgh, PA 15251, (508) 829-7175

#### Whatman Ashless Paper Pulp

Whatman Inc., 9 Bridewell Place, Clifton, NJ 07014, (973) 773-5800

#### Winsor & Newton Watercolors

Johnson Paint, 355 Newbury Street, Boston, MA 02115, (617) 536-4065  
Fax (617) 536-8832, [www.johnsonpaint.com](http://www.johnsonpaint.com)

## **References**

Artal-Isbrand, P., and Nunberg, S. 1999. New Solutions for Loss Compensation on Mosaics at the Worcester Art Museum, *International Committee for the Conservation of Mosaics*, Arles/Saint Romain en Galles (France). In the process of being published.

Brandi, C. 1996. Theory of Restoration, I, II. In *Historical and Philosophical Issues in the Conservation of Cultural Heritage*, eds. N. S. Price, K. Talley, A. Melucco Vaccaro. Los Angeles: The Getty Conservation Institute. 230-235, 339-342.

Çimok, F., ed. 2000. *Antioch Mosaics-A Corpus*. Istanbul: A Turizm Yayinlari

*Artal-Isbrand*

Demir, A. 1996. *Antakya Through the Ages*. Istanbul: Akbank Culture and Art Publications.

Downey, G. 1961. *A History of Antioch in Syria*. Princeton: Princeton University Press.

Elderkin, G. W., ed. 1934. *Antioch on the Orontes I: The Excavations of 1932*. Princeton: Princeton University Press.

Fiori, C. 1991. *Mosaico, Analisi dei Materiali e Problematiche di Restauro (Parte Terza)*. Ravenna: Banca Popolare di Ravenna.

Griswold, J., and Uricheck, S. 1998. Loss Compensation Methods for Stone. *Studies in Conservation* 37:89-110

Kondoleon, C., ed. 2000, *Antioch: The Lost Ancient City*. Princeton: Princeton University Press

Koob, S.P. 1986. The use of Paraloid B-72 as an adhesive: Its application for archaeological ceramics and other materials, *Studies in Conservation*, 31:7-14.

Koob, S.P. 1991. The use of Acryloid B-72 in the treatment of archaeological ceramics: minimal intervention. Paper presented at Spring 1990, Materials Research Society Meeting, 185:591-596.

Levi, D. 1947. *Antioch Mosaic Pavements*. 2 vols. Princeton: Princeton University Press.

Morey, C. R. 1938. *The Mosaics of Antioch*. London: Longmans, Green and Co.

Philippot, P. 1977. The Problem of Lacunae in Mosaics. Paper presented at 1<sup>st</sup> ICCM conference: *Deterioration and Conservation*. Rome: 83-88.

Stillwell, R. ed. 1938. *Antioch on the Orontes II: The Excavations of 1933-1936*. Princeton: Princeton University Press.

Stillwell, R. ed. 1941. *Antioch on the Orontes III: The Excavations of 1937-1939*. Princeton: Princeton University Press.

### **Author's Address**

Paula Artal-Isbrand, Assistant Objects Conservator, Worcester Art Museum, 55 Salisbury Street, Worcester, MA 01609, (508) 799-4406, Fax (508) 798-5646, Paulaartal-isbrand@worchesterart.org



Figure 1. Syrian workmen backing a mosaic with concrete that is reinforced with iron bars and chicken wire, shortly after excavation in the 1930's. Photograph courtesy of the Department of art and Archaeology, Research Photograph Collection, Princeton University.



Figure 2. Mosaic with a cracked concrete backing at the Worcester Art Museum in 2000.



Figure 3. The same mosaic as in Fig. 2., after being framed with a metal frame.

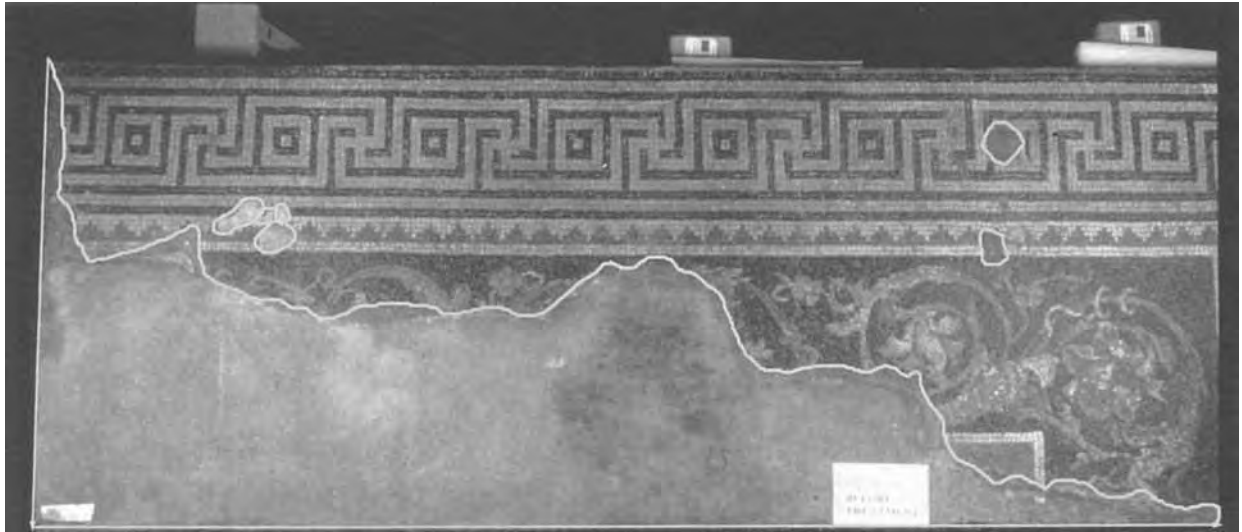


Figure 4. Mosaic fragment from the Atrium House dining room before treatment (collections of the Wellesley College Museum; early 2<sup>nd</sup> century CE). Outlined are the losses that were filled with concrete during the backing process shortly after excavation.



Figure 5. Detail of the *Menander, Glykera and Comedy* mosaic (collection of The Art Museum, Princeton University; c. 250-275 CE). Outlined are painted concrete fills imitating a tesserae pattern with an invented design in the largest fill.



Figure 6. Detail of a head of the mosaic representing a *Funerary Symposium*, after removing concrete fills (collection of the Worcester Art Museum; late 4<sup>th</sup> century CE).



Figure 7. Same detail as Fig. 6, after filling losses with restoration tesserae.



Figure 8. Same detail as in Fig. 6, after inpainting the restoration tesserae.



Figure 9. Atrium House dining room floor. Computer-generated photo composite showing all the panels that were separated after excavation and distributed to several institutions. They were reunited during the Worcester exhibition. The loss in the center of the floor was caused by the low wall-like structure visible in Fig. 10.

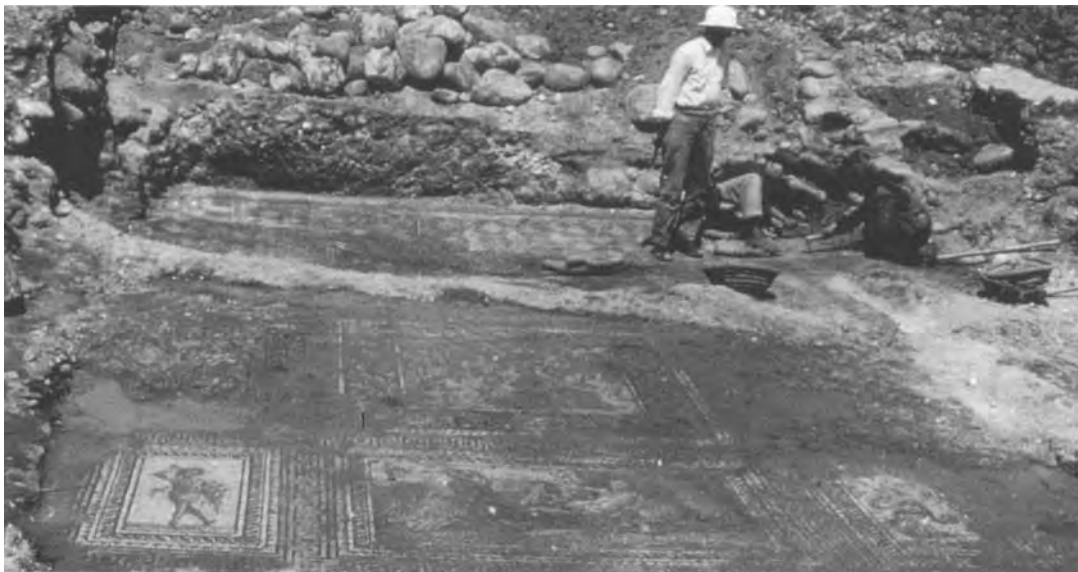


Figure 10. The Atrium House dining room floor during excavation.

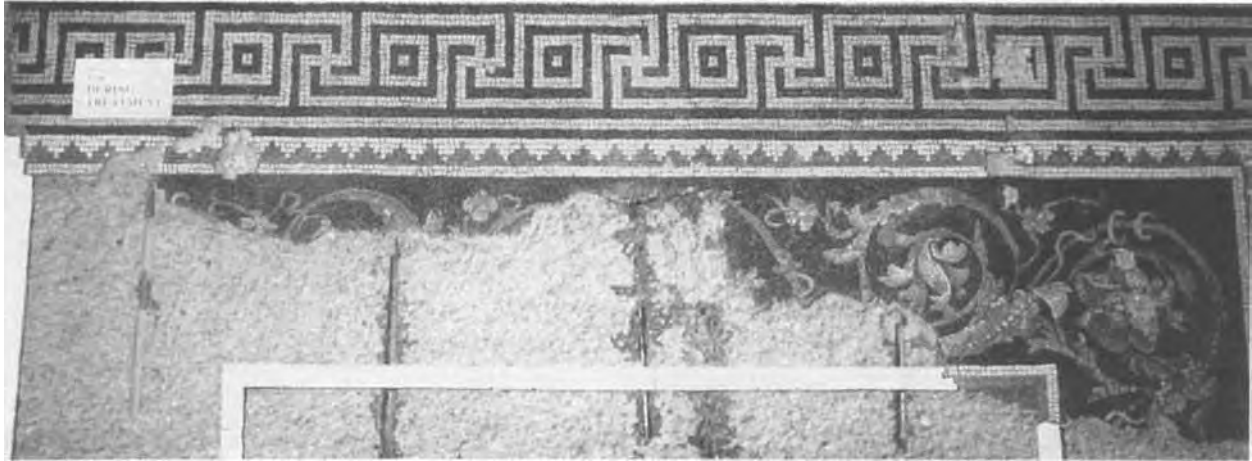


Figure 11. Mosaic fragment from Fig. 4, after recessing the concrete fill and with plaster tesserae restorations in place.

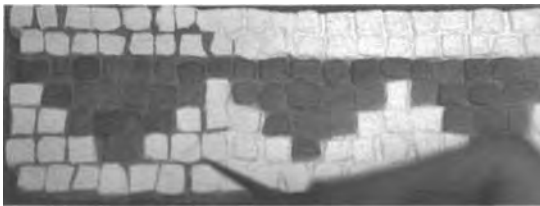


Figure 12. Cast plaster tesserae restoration strip in the process of being painted.



Figure 13. Panel representing Aphrodite and Adonis (collection of The Art Museum, Princeton University), from the Atrium House dining room. After conservation, in the Worcester exhibit. The upper border is the Wellesley fragment in Fig. 11. The border areas, except for the sections along the top and lower left, are a black and white photographic image of fragments which are in the collection of the Antakya Museum.





Figure 14. Detail of *Funerary Symposium* mosaic after the 1930's restoration with stone tesserae (the outlined areas is to be covered with tissue paper).



Figure 15. Detail of Fig. 14 after covering the 1930's restoration of the faces with tinted tissue paper.



Figure 16. *Funerary Symposium* mosaic, after treatment. Outlined are all loss areas, most of which were filled with stone tesserae in the 1930's.



## THE TREATMENT OF A 19<sup>th</sup> CENTURY BUCKSKIN JACKET

Deborah Long

As a regional conservation laboratory, the Ford Center conservators treat objects from nearby museums. A recent project involves a beaded leather jacket owned by the Joslyn Art Museum in Omaha, Nebraska. The treatment of the jacket was requested as part of a permanent gallery reinstallation. The treatment was challenging and interesting on a number of levels.

The jacket was thought to have been originally owned by Logan Fontenelle, a prominent figure in the Omaha tribe. In 1854, he was a member of the Omaha delegation that signed the treaty establishing the Omaha reservation in Nebraska. Fontenelle's father was a prominent French trader and his mother was the daughter of Black Elk, an important Omaha tribal chief and elder. This gave him access to both native American and European cultural traditions. Fontenelle was killed in 1855 at the age of thirty while on a hunting expedition, when his group was attacked by a Sioux raiding party. After his death, the jacket stayed in the Fontenelle family until 1913. Just prior to her death, Fontenelle's widow gave the coat to Howard Schulenberger, a local twenty-year old bank clerk with an interest in Native American objects.

Mr. Schulenberger kept the coat for more than seventy years as a prized part of his collection of Native American materials. He displayed it with other items from various tribal groups in his home in southern California.

In 1985, at the age of ninety-one, Mr. Schulenberger wrote to the senior curator at the Joslyn Art Museum, offering the jacket for acquisition. His letter mentioned a desire for the jacket to be returned to Nebraska.

The curator, in her correspondence with Mr. Schulenberger, learned that at the suggestion of someone in a local museum, he had repaired some holes with deerskin patches. He also mentioned that the museum staff suggested that he "dress the coat inside with neat's-foot oil". Unfortunately, he didn't apply just a little, he saturated the coat with it. He further noted in his letter that "the coat will lighten up in color as in the future years it loses its softness created by the oil".

Once she received the coat, the curator hired a local objects conservator to examine and treat it prior to initial exhibition. In addition to the oil, the conservator found the coat to be covered with surface grime and to have many crude leather patches and stitched repairs. She vacuumed the object, replaced the leather patches, stitched loose seams, and cleaned the beads. Because of a concern with possible red dye transfer of some stains on the coat, as well as concerns over stiffening or damaging the leather, she decided not to remove any of the oil. The jacket was placed on a body mount and kept on nearly permanent display for the next fourteen years. On the few occasions when the jacket was in storage, it was stuffed with acid free tissue and periodically turned over. Over the years, the replacement patches darkened as they absorbed oil from the surrounding leather of the jacket.

## *Long*

When the jacket arrived at the Ford Center, in 2000, the acid free tissue stuffing the arms and chest was immediately replaced, as it was once again soaked with oil. The most immediate impression that one got upon initial examination was of the great weight of the coat. The fringe was especially heavy. The style of the jacket, sometimes known as a scout jacket, was constructed with six body sections stitched together by machine with heavy cotton thread. The two-piece gusseted sleeves, and all of the fringe sections were hand stitched with sinew. The seed bead design elements were also applied with sinew. The jacket closed with six bone buttons fastened through simple slits in the leather.

Overall, the structural condition of the jacket was fair. Although there were loose threads and sinew, the pieces were structurally intact. The replacement patches were readily visible throughout the interior, although some were partially detached because the sheer volume of oil in the leather inhibited the poly vinyl acetate emulsion adhesive from adhering to the surface. The coat was sticky to the touch and smelled somewhat rancid. The surface was soiled overall and exhibited many stains. The fringe was detached from the coat in several places. There were tiny remnants of red silk ribbon that had originally lined the center front edges, and the sleeve ends had shreds of light green silk fabric caught in some hand stitching. A few small discrete areas of the body interior had red stains.

The shoulders had suffered multiple tears and holes, most of which were patched with leather. The leather on the proper left upper chest was much thinner than some of the other leather used to create the jacket. This leather seemed to be separating slowly under the constant weight of the saturated lower section. There were a few spots that were almost torn through. The sleeves were constructed from thicker leather than the body, making them very heavy and causing stress to the shoulder seams while on long term exhibit. The rows of short fringe around the sleeve ends were curled and blackened with soil.

Although the body was decorated with small seed beads, the shoulder seams were enhanced with less commonly found drawn, or cane, beads. These appeared at first to be red glass. However, upon closer inspection, the beads were found to be transparent glass with a deep red resinous coating lining the interior. This coating, which was found to be soluble in non-polar solvents, stained the long fringes over which the beads were threaded.

It appeared that the large volume of neat's-foot oil was the greatest long term threat to the stability of the jacket. If it were scheduled to go into long term storage, loose parts could simply have been tacked down and the staff could have been instructed to replace the tissue stuffing on a regular basis for the rest of the objects life. However, because the curator wanted to exhibit the jacket in the round on a body mount, on a long-term basis, it was important to reduce the overall weight somewhat more quickly and provide enough support to keep the jacket in one piece. Solvent testing showed that the oil levels could be safely reduced with Stoddard Solvent or petroleum benzine without harming the silk remnants or affecting the use/wear stains on the body interior. Some conservation literature mentioned immersion in solvent baths as an oil removal method. Because of the solubility of the resin in the beads along the shoulder fringe,

*Long*

this technique was not a suitable option for the jacket.

Many calls were made to objects conservators specializing in the treatment of ethnographic objects. Advice was sought particularly from conservators with experience in the treatment of oil soaked leather objects. While all of them were extremely sympathetic, most had removed only spots of oil. Between calls, solvent delivery methods were tested in hopes of finding the perfect solution. Tests included rolling solvent-dampened swabs across the surface, wetting the surface with non-polar solvents and applying blotters weighted down to wick them out, as well as the application of poultices. All worked somewhat, but were slow, produced uneven results, and tended to leave faint tide lines.

Tests on the Ford Center's vacuum suction table, however, did yield promising results. The table is a 40 x 60 inch Museum Services unit that can attain a maximum working vacuum of 80 PSI. Several inner pieces of fringe from the back of the coat were used to test differing numbers and types of solvent applications. The goal was to reduce the oil volume, but not to remove so much that the leather was affected. Tests revealed that, following the initial application of solvent, a point of diminishing return was quickly reached. A single application was often enough to produce significant improvement in both weight and appearance. After discussing the test results with the curator, the actual treatment began.

With a method in place, the cleaning process itself was relatively straightforward. The jacket was first vacuumed overall to remove loose soil and dust. The suction table was prepared by masking all but a small segment with Mylar. A piece of lightweight blotter paper was placed over the unmasked area. The portion of the jacket to be treated was placed over the blotter and the vacuum was adjusted to approximately 60 PSI, depending on the thickness of the leather. The section of jacket was wetted with solvent and then immediately pressed against the blotter to draw the solvent out of the leather. This process proceeded section by section until most of the body had been rinsed once. The fringe, seams, and patched areas held more oil due to their greater thickness, and so were treated twice. The beaded areas also needed extra attention. The aim throughout was simply to reduce the volume of oil, not to remove all of it. It was encouraging to see that visible process was being made, even though the work was very tiring! During the process, many trays full of dirty, oil stained blotter and tissue were collected.

Because it was important to see how the exterior surface appearance was changing during treatment, all of the work was done from the front. Although working from the front necessitated drawing surface materials into the leather, it appeared that most of the fine sooty surface dirt was mobilized by the solvent and pulled right through the leather into the blotter.

The treatment of the sleeves was not as successful as that of the body. An extra layer of blotter was placed in the center of the sleeves and the vacuum was turned up to maximum, but the results were uneven. An attempt was made to use a small suction disk, but the tiny pore diameter and the extra thickness of the leather in the sleeves prevented adequate suction. Ultimately, the sleeves were stuffed with absorbent material, wetted with solvents overall, and placed on the

## *Long*

suction table to dry. Cotton gauze was placed over the surface of each sleeve during drying to reduce the formation of tide lines in much the same way that textiles are dried.

After all of the cleaning was finished, structural repairs were completed. Old patches that had loosened over the years were re-adhered. The proper left upper chest area was so thin and weak that small patches would have been inappropriate. Instead, a large piece of very thin chamois was cut to fit between the neckline and armhole seams, the edges were skived down, and it was adhered with a small amount of a 1:1 mixture of Jade 403 poly vinyl acetate emulsion and very dry Aytex P wheat starch paste.

After treatment, the coat weighed approximately one third less than it had before treatment. Even though the appearance remained somewhat uneven, the color was improved and the leather retained plenty of oil. Perspiration and other use/wear staining also remained readily visible. The leather was more flexible and there was an improvement in the loft. While there was some remaining concern over loss of some of the original tanning materials, the treatment seemed to strike the balance between structural stability and retention of original materials. The curator was very pleased with the improvement in appearance and the possibility of long term survival were improved. There was no bleeding of the red colorant from the beads or the red silk remnants. The interior of the coat still retains a certain amount of excess oil in the seams and fringe, but this preferable to excessive removal of oil. To minimize exhibit stress, a mount was designed that would spread the weight as much as possible.

Overall, the treatment was both successful and quite satisfying. It met the curator's goal for prolonged display and the my objective to stabilize the jacket and reduce its weight so that it could withstand long-term exhibit without tearing itself apart. The suction table worked very well and has great potential for increased use in objects conservation. The development of additional shapes of hand held suction devices would most certainly increase the use of this tool by objects conservators.

## **References (partial list, see Editor's note)**

Chapman, V. 1987. The Conservation of a Group of North American Indian Moccasins: a textile conservator's approach. In *Recent Advances in the Conservation and Analysis of Artifacts*. Jubilee Conservation Conference. London: University of London, Institute of Archaeology. Summer Schools Press.

Dubin, L.S. 1987. *The History of Beads, from 30,000 B.C. to the Present*. New York: Harry N. Abrams.

Fenn, J. 1984. Queries about cleaning agents used on skin and leather. In *Recent Advances in Leather Conservation*. Proceedings of Refresher Course V. Washington, D.C.: Foundation of the American Institute of Conservation. 66-70

*Long*

Fogle, S. 1985. Neat's-foot Oil in Commercial Products. *Leather Conservation News*, 2 (1):

Gallagher, M. 2000 Personal communication.

Goodberry, M. 1985. Conservation Treatment Proposal and Report.

Greene, V. 2000. Personal Communication. Senior Conservator, University of Pennsylvania Museum.

Karklins, K. 1985. The Levin Catalogue of Mid-19th Century Beads, a sample book of 19th century Venetian beads, Guide to the Description and Classification of Glass Beads. Ottawa, Ontario: Canadian Government Publication Centre.

Karklins, K. and R. Sprague 1987. A Bibliography of Glass Trade Beads in North America, First Supplement. Ottawa, Ontario: Promontory Press.

O'Donnell, A. 2000. Personal Communication. Objects conservator in private practice.

Orchard, W. C. 1975. *Beads and Beadworks of the American Indians*. New York: Museum of the American Indian Heye Foundation.

Smith, P. 2000. Joslyn Art Museum permanent record files.

Wouters, Jan. 1989. A Comparative Investigation of Adhesives used for the Restoration of Leather Objects. In *International Leather and Parchment Symposium*. Offenbach am Main, Germany: Deutsches Ledermuseum; Deutsches Schuhmuseum.

#### **Author's Address**

Deborah Long, Gerald R. Ford Conservation Center, 1326 South 32nd Street, Omaha, NE 68105.

**Editor's note:** This paper, with illustrations and a full set of references, is being submitted to JAIC.

## JEROME EXPOSED: TREATMENT OF A 19<sup>TH</sup> CENTURY ANATOMICAL MODEL

Beth Richwine

In April of 2000 the National Museum of American History installed a small temporary exhibit called *Artificial Anatomy*. The exhibit focused on the history of anatomical models. The earliest models in the exhibit were made of wax while the modern models were made of plastics. However, the primary material for the models in the exhibit was papier-mâché. Most of the models in this exhibit were manufactured by a company started by Dr. Lois Thomas Jerome Auzouz. Dr. Auzouz started his company in the early 1820's after experiencing difficulties in medical school acquiring and maintaining cadavers for dissection. Eventually his factory was to produce not just human anatomical models but veterinary and botanical models as well. The company still exists today in France but produces models made of plastics.

The most highly visible anatomical model in the exhibit was a full sized male figure made by Dr. Auzouz's company in approximately 1893 and nicknamed "Jerome" by American History staff after one of his maker's given names (Fig. 1). Jerome had been bought by the Smithsonian from Ward's Natural Science Establishment in Rochester, NY, and placed in an exhibit on comparative anatomy by the Smithsonian in 1893 in Chicago at the Columbian Exposition. From there it was also on exhibit in 1895 at the Cotton Exposition in Atlanta, Ga. It may have been on exhibit after this at the Smithsonian's Arts and Industry Building for some years but this is unclear. After coming off exhibit Jerome was put into a crate and stored for years until being used for the *Artificial Anatomy* exhibit. Although the model was generally in good condition and the colors still bright and vibrant, he suffered from imbedded dirt and flaking problems on the unusual surfaces.

For a temporary smaller exhibit such as *Artificial Anatomy*, complex and lengthy conservation treatments are not normally performed. However, in addition to Jerome many of the other papier-mâché models had similar and sometimes more severe problems, and needed treatment just to stabilize them. The Objects Lab had only two full time conservators and one part time term conservator. The part time conservator was tied to special projects and only available to do some treatment on this exhibit. Richard Barden, the other full time objects conservator in the lab, was co-curating the exhibit and most of his time was taken up with curatorial duties.

Given limited staff resources and the exhibit deadline, compromises were reached on the amount of treatment work that would be performed on each model, with stabilization of the flaking layers the primary goal. With Jerome as the featured model of the exhibit (and the largest), much of the 200 treatment hours agreed upon for this exhibit were devoted to him. Despite this number of hours allotted, many difficult treatment choices had to be made on what to treat and what not to treat.

The total height of Jerome is 5'6" tall by himself and 6 feet tall on the stand. The model comes apart to reveal deeper layers. The chest cover, both arms and the proper left leg come off. The organs can be removed singly or in groups from the chest cavity. The deconstruction and

reconstruction is facilitated by an elaborate system of pins and latches. Small paper labels printed with pointing hands alert the student to where latches are located (Fig. 2).

The literature from Auzouz gave the purchaser the option of the figures “after nature” or with “organs of generation”. Since this critical part of his anatomy was missing and no extra hooks in that area were apparent we assumed that he was not purchased “after nature”. He also was missing his brain although it seemed likely that he had it at one point and it was lost.

We assumed there was an internal armature based on x-radiographs taken of some of the smaller models used in the exhibit and the ferrous metal wires protruding out from some of the fingers (Fig. 3). Molded around the armature was true papier-mâché; masticated paper fibers and a binder. This material was very hard and dense. On top of this there appeared to be one or more layers of smooth paper. Individual muscle fibers were then painted in accurate colors over all surfaces.

The smallest veins were simply painted on but larger veins were created three dimensionally by applying bundles of wires. As the veins split and got smaller the wire bundles were simply separated (Fig. 4). The bundles were further wrapped in fibers and paper and tacked onto the surface. The small tacks are visible on one of the smaller models in this x-radiograph. Both copper alloy and ferrous metal wire bundles were found. Reasons for placement of one over the other in various areas is not obvious.

Where the interiors of some organs were visible, internal structures were defined (Fig. 5). Examples of this can be seen in the flocked lining of the stomach, the knobby surface of the small intestines as well as thread-like structures inside the heart. A thin tissue covering the muscles was illustrated on a portion of the proper right leg by a thin translucent material, which we chose to call a film. Some of the other films could be seen as flaps sticking out of the organs or connecting two areas. Most surfaces were also covered with a coating, which gave it some gloss. The film material appeared to be the same as the coating separately laid out, painted and applied to the surface.

The figure was presented in various stages of dissection with the proper right side primarily illustrating the surface muscles and the proper left side being interior muscles and bones. Various organs, bones and muscle groups were labeled with small paper labels in either text or numbers and were attached to the final surfaces. The original model would have come with a key to the numbers. The Smithsonian no longer owned the original key but the curators for the exhibit were able to locate and copy one. The original labels were in French. Cruder and larger labels in English were probably applied by the Smithsonian when it was on exhibit.

Structurally the model appeared to be in good condition. The figure was well supported and attached. The chest cavity cover no longer fit on the figure when the organs were in place and had probably warped. The condition of the surface varied.

Some areas of the model were very dirty. These areas tended to be on the upper surfaces where dirt would naturally fall and on some of the organs, which would have had more handling. There were also differences between interior and exterior surfaces. As one would assume, the interior surfaces were considerably cleaner as a whole than the exterior surfaces.

There were sections in which the painted surface and coating appear quite stable and intact. There were scattered areas in which the painted layer was quite cracked and in some areas was lifting. This was especially apparent on the proper left thigh (Fig. 6). In other areas the painted surface appeared intact but the coating was peeling. The peeling was quite scattered and quite widespread. There was also less severe flaking on the interior surfaces probably due to less light damage.

The Smithsonian Center for Materials Research and Education analyzed samples of the coating using protein analysis and infrared spectroscopy and found that it was nearly pure collagen. The coating was also soluble in water. When wet up, the surface had a very distinctive smell of gelatin. We surmised from this that it was probably gelatin. Conversations with Lynne Gilliland, paper conservator at American History led to cleaning tests with ice water and treatment protocols similar to treating gelatin prints and negatives.

The ice water swelled the surface slightly yet allowed dirt to be removed. Little or no surface coating was removed if the proper procedure was followed. A small area to be cleaned was swiped once with the ice water and a swab. A few seconds were allowed to pass and then the swab was rolled or rubbed over the surface quickly. No more than that was allowed or the surface coating would begin to be removed.

The paint on the applied veins and arteries was extremely water-soluble and generally these areas were not cleaned unless they were especially dirty. Only a single quick swipe with the swab was acceptable, as paint would begin to come off. The veins and arteries did not appear to have the same protective coating that had been applied to the other surfaces.

A combination of rolling and /or rubbing was used over the whole figure depending on the surface conditions in each area. For stable areas with little cracking or peeling, rubbing worked well and was an efficient way to cover large areas at a time. Rolling swabs over the surface was more effective in areas with cracking or peeling.

Rubbing over a cracked surfaced tended to embed the dirt into the cracks and by rolling swabs it was easier to maneuver around peeling and flaking. It was also easier to clean both surfaces of some of the peeling, which had collected dirt on the interior surfaces (Fig. 7). Attempts at setting down these areas first and then cleaning was often unsatisfactory because dirt was trapped under the surface. Rolling also helped to partially relax and straighten some peeling areas, which were quite severe.

In general, dirt removal by these methods on Jerome was quite sufficient. Only one other model,



a miniature male figure we called "Junior", had embedded dirt so severe that water with a small percentage of Orvus detergent was used to assist in the cleaning process. He had been well used as a model and there was very little surface coating left. The dirt appeared to be ingrained into the painted surfaces.

There was a variety in severity and location of the flaking or peeling. Some areas of the surface coating were flaking in small, slightly curled flakes or a split with lifting on either side. These could be seen from an angle but more importantly could be felt as I rubbed my fingers over it. This was the usual way in which I found the flaking areas as I worked on the consolidation.

Other areas were worse where the coating had actually started to curl up. There were some especially large areas like this at the proper right shoulder. The surface coating in this area also had some additional painted designs on the upper surface, which was unusual.

Other more severe flaking, especially on the upper portion of proper left leg included not just the upper surface coating but into the upper layers of paper. These areas were especially stiff although not as curled as some of the flaking that involved just the surface layer.

A variety of consolidants were ultimately used. After cleaning, the surface coating was sufficiently softened so that many of the smallest flaking areas could be set down with finger pressure alone. This had to be done immediately after cleaning. After the surfaces had been allowed to dry naturally for two or three hours it would be evident where this procedure did not work.

Gelatin was used in the areas of small flakes, which would not set down with reactivation of the surface and finger pressure alone. Slightly warm gelatin could be flowed into cracks and under the flakes easily. The gelatin was mixed with a small amount of ethanol to reduce the amount of overall moisture that was applied and thus the amount of swelling to the coating. This worked very well for almost all of the thin surface coating flakes.

The large flakes would distort significantly and it was difficult to get the flakes laid down without wrinkles. Sometimes it was necessary to set down partial sections at a time to reduce the ultimate amount of overall distortion.

The gelatin was not strong enough in the areas of thicker peeling and flaking. Most of these areas responded to a solution of sturgeon glue mixed with ethanol. Sometimes several applications of sturgeon glue were needed in one spot. There were other areas which would still not set down completely.

These tended to be the largest areas of flaking where the upper layers of paper were also lifting. After some trial and error it was decided on Beva 371 film. Tiny strips were cut and placed under the edges of these flakes and then set down with heat.

We discovered that the Beva also worked well for the cracks in the areas that were more film like. I had tried spreading out gelatin on a sheet of silicone-coated Mylar, letting it dry, peeling it up and then cutting it to bridge the splits. I thought at first that if the gelatin had only been recently made it would be easy to use a heated spatula to bind it to the film. This did not work at all. I then tried adding a small amount of fresh gelatin and binding it with heat but this was not good either. Beva turned out to be the best selection.

Since some of these films were suspended in air I could not just press onto them with the heated spatula and to protect my fingers found that I could bend small spatulas to get into almost all areas to press on the either side of the break. I left one side of the carrier on the Beva while using the heated spatula and then just peeled it off when done.

We discovered through trial and error that the Beva was actually more successful with other areas as well. The interior of the stomach appeared to be a thick layer of the coating material with some type of flocking to simulate the lining of the stomach. These areas were not cleaned because it was felt that the flocking might easily be removed.

When the gelatin was applied to the flaking areas it got wicked into the flocking and created unsightly darker areas. At the time we hadn't discovered the full usefulness of the Beva so only minimal setting down was done here. We discovered on a flocked area on another piece that the Beva could successfully secure these areas without darkening the surfaces.

One other type of consolidant was used on Jerome. The proper left shoulder was attached to the figure with two pins and swung away from the body on a hinge. The pins were bent so it was not possible to remove the shoulder from the body to work on it. The swinging action and the weight of the arm had caused the flat plane of muscles to split. There was an old repair of unknown origin at this split already but the area still had a substantial crack and was a bit loose. The old fill material also extended out over into the original surface. Since this area was in the back of the model and the treatment agreement was not to do any compensation this fill was not removed or cleaned up. Hot hide glue was injected into the crack and the crack was aligned with clamps until it set up. This helped to stabilize this area. Attempts were not made to straighten out the bent pins.

Setting down the flaking areas after applying consolidant was usually successful with finger pressure. I found after a while that I could apply consolidant to a number of spots in the same area, apply small pieces of silicone Mylar and using several fingers on each hand to hold down several spots at once. This position was held for about 30 seconds. The slight pressure minimized distortion from swelling and was faster than setting up clamps in so three-dimensional an object. This also allowed me to become very good at pinpointing areas that needed more or less pressure.

Some of the larger areas of peeling and the thicker areas of flaking which required stronger consolidants would not set down with simple finger pressure. A heated spatula with a small tip

worked very well for the most part to do this. A temperature of about 130 degC worked the best. It gave gradual softening of the layers and reactivation of the consolidant and did not melt the gelatin surface coating. One of the most important procedures to remember was to wait at least one to two hours and sometimes overnight after applying the consolidant before applying the heat. If done before there was still sufficient moisture in the consolidated areas to re-solubilize the gelatin and create an uneven surface texture.

There were no structural repairs to Jerome other than the crack in the shoulder but there were other anatomical models in the exhibit that did have some structural problems. The turkey had probably been dropped at some point. It was attached to its base through the feet and legs and when it dropped one of the legs split open. This allowed us to see some of the interior structure and the density of the papier-mâché material. The turkey had been small enough to x-ray so we had a good image of the internal armature. We explored some ways of closing up the split and eventually decided against it. We felt that we would probably have to soften up the papier-mâché in order to realign the leg. We felt that it was too risky with the metal armature, the applied ferrous metal wires and the layers of paper and we might make the situation worse if things began to rust. The bird could still stand on its own with a little assist from the bracket maker and on a whole the split was not readily apparent to most visitors.

In addition to the consolidation of the flaking the attached metal parts such as the pins and the hooks were cleaned with Petroleum benzene and waxed with Renaissance Wax to give them some protection from fingerprints and changes in humidity.

Each one of the models presented the conservators with different challenges and we learned techniques and tips from each other as we progressed with the treatments. We also had to keep special track of the humidity in our lab. We were experiencing problems with the humidity control on a daily basis. There were days when I would spend a couple of hours consolidating one area of the object only to come in several hours later or the next morning to find the curls back up. We attributed all of this to our bad lab conditions and there were days when I did other types of treatments because I knew that I could not work on Jerome.

The choice to leave some areas uncleaned was especially difficult for me since I feel that this might have been the only chance to work on Jerome with our heavy exhibition schedule and our staffing situation as well as just wanting to complete the whole object. The areas of loss on the legs was also visually disturbing and it would have been nice to have filled and inpainted those. These models were also so beautifully made that we all would like to have worked on more of them and made them as presentable as possible for the exhibit.

## Acknowledgments

I want to thank Richard Barden and Judy Chelnick, co-curators of *Artificial Anatomy*, for giving me this opportunity to work on some really cool objects; and Catherine Williams and Elizabeth

Richwine

Walmsley, whose computer knowledge made it possible for me to get through the complexities of doing a presentation using the computer.

## References

Hopwood, W., E. McMillan, J. Mishara and R. M. Organ. 1975. #2063, Report on a papier-mâché lung. Washington, DC: Conservation Analytical Laboratory, Smithsonian Institution.

Davis, A. B. 1977. Louis Thomas Jerome Auzoux and the Papier-Mâché Anatomical Model. *Atti dell I Congresso Internazionale sulla ceroplastica nella scienza e nell'arte*. Biblioteca della Rivista di Storia delle Scienze Mediche e Naturali, ed. L.S. Olschki. Firenze. 20(3-7): 257-279.

Dexter, G. 1844. *Catalog of Anatomical Models made by Dr. Auzoux*. Albany, NY: Stone & Henly.

Mulder, W. J. 1992. L. Th. J. Auzoux's Models used for the Dissemination of Anatomical Knowledge. *Proceedings of the 6<sup>th</sup> Congress, European Association of Museums of the History of Medical Sciences*. Leiden, Netherlands. 129-136.

Henry Rawls & Co. 1841. *Catalogue Preparations of Artificial Anatomy by Dr. Auzoux of Paris*. Albany, NY: C. Van Benthuy.

Singley, Katherine, AIC preprints of Conservation of a painted papier-mâché anatomical Model, American Institute for Conservation 13<sup>th</sup> annual meeting. Washington, DC: AIC. 149

Singley, Katherine, personal communication. Private conservator, Bethesda, MD.

## Author's Address

Beth Richwine, Preservation Services, MRC 642, NMAH, Smithsonian Institution, Washington, DC 20560 (richwineb@nmah.si.edu)

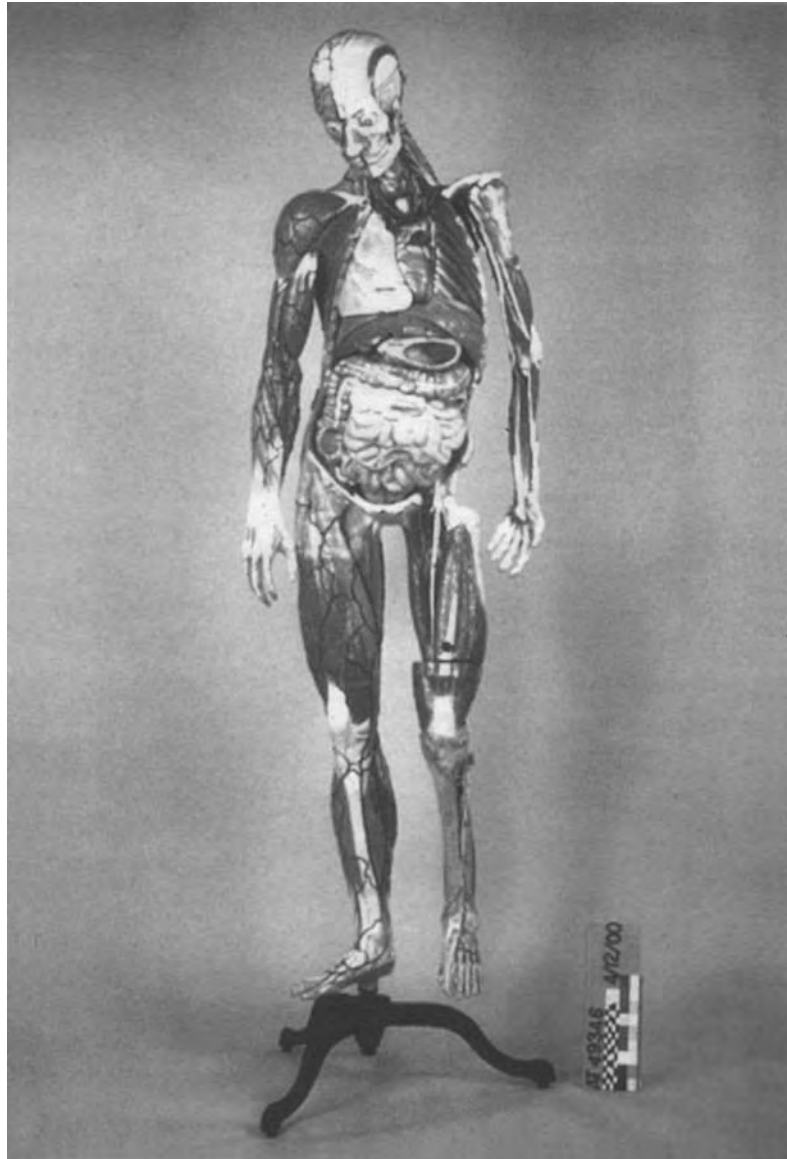


Figure 1. Full frontal view of “Jerome” without chest cover.



Figure 2. Labels and latch.

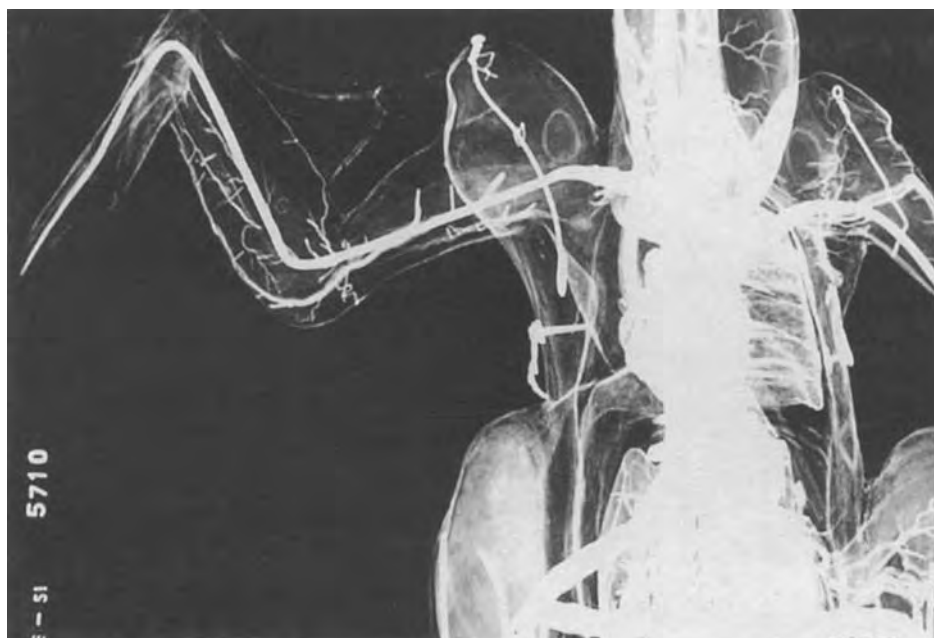


Figure 3. X-radiograph of turkey showing wires, tacks and armature.

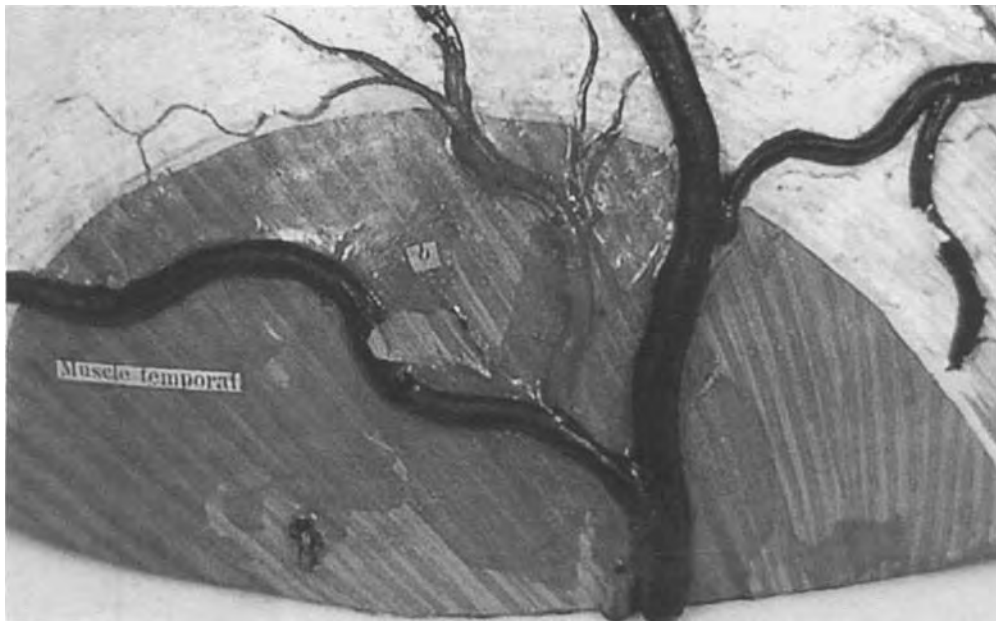


Figure 4. Closeup of veins showing division of wires and tacks.

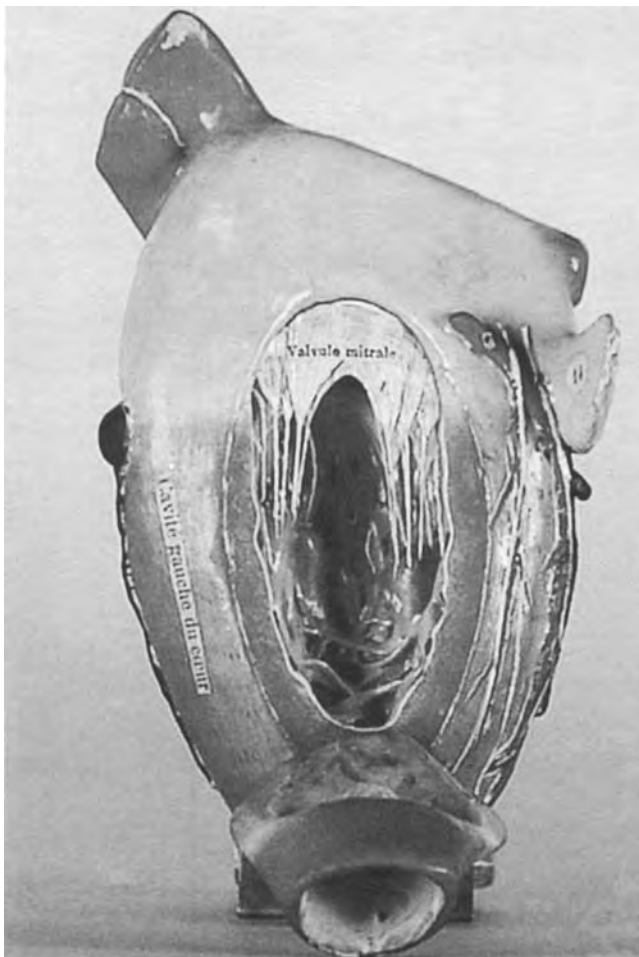


Figure 5: Portion of heart, partially open to reveal internal structure.



Figure 6. Curling of surface layers  
on upper left thigh.



Figure 7. Badly peeling surface layer at  
upper proper right shoulder of figure.



# **AN EVALUATION OF QUILLWORK AND HAIR STABILIZATION METHODS USED AT THE NATIONAL MUSEUM OF THE AMERICAN INDIAN**

Elizabeth Brown

## **Introduction**

During the recent treatment of approximately 45 Plains Indian shirts in the conservation laboratory of the Smithsonian National Museum of the American Indian (NMAI) we evaluated and developed several techniques for the stabilization of quillwork and hair locks. The treated shirts were selected for display in an exhibition *Beauty, Honor and Tradition: The Legacy of Plains Indian Shirts*. The exhibition, curated by NMAI's George Horse Capture and his son Joe Horse Capture, a curator at the Minneapolis Institute of Art (MIA) opened in New York in December 2000 and is scheduled to travel to the Minneapolis Institute of Art in 2002. The intent of the exhibition was to illustrate the beauty of the shirts and to portray the history, cultural context and development of the shirts. Therefore in developing treatment methods we took into consideration the need to stabilize the shirts for travel and for exhibition on mannequins, to maintain the historical integrity of the shirts, and to improve the aesthetic of the pieces as requested by the curators.

The shirts incorporate a large variety of styles and materials, and many contain bands of woven quillwork and quill-wrapped hair locks with varying degrees of damage and deterioration. Many quills are broken or lost due to mechanical and insect damage. Hair loss was caused both from brittle hair breaking and loose hairs slipping out of the wrappings. As a result of the differing demands of the shirts, a shortened exhibit timetable, mannequin requirements, and the diverse group of people working on the project, we investigated a variety of techniques for the stabilization of these damages. The following is a description and critique of the quillwork repair techniques used, some established and some new.

## **Part I - Quillwork Repairs**

### **Adhesive Choice**

After comparing solutions and films of Acryloid F-10, Jade 403 and Acryloid B-72, we selected Acryloid B-72 as it had the best characteristics for quillwork repair. The adhesives, tested by NMAI interns Melinda McPeck and Shannon Parker, were chosen for their stability and their ability to create strong flexible films. Both strength and flexibility were important as the shirts would be manipulated during fitting for the mannequin installation, travel, and de-installation. The testing methodology involved adhering small painted strips of Tyvek to the ends of dyed quills as this was the most common method of repair (see below). While all the adhesives created flexible films, all except the Acryloid B-72 failed when the bond was flexed and/or pulled slightly.

## **Application of Adhesives**

Depending on the method of repair, several different techniques can be used for applying the adhesive. Evaluations of the strength and flexibility of the repairs was done by simple manual manipulation.

### **Cast Acryloid B-72 film**

- A small puddle of 40% w/v Acryloid B-72 in xylene or toluene is placed on Teflon sheeting between two strips of paper tape. A glass slide is then drawn down over the two tape strips producing an even film approximately 1mil thick after solvent evaporation. When dry another layer can be applied. In most cases two to three layers provides the best working characteristics. Both xylene and toluene films were used in this project and no obvious difference in flexibility was determined. Six months after this project unused sections of these films remained flexible with only slight stiffening. (For more extensive research on the subject see Hansen1995)
- A miniature square is then cut from the cast Acryloid B-72 film and placed with tweezers between the broken quill and Tyvek bridge (or an adjacent quill).
- The quill is pressed down and a tiny drop of 3:7 xylene:acetone\* is fed into the adhesive with either a syringe or brush to re-activate the film.

### **Acryloid B-72 solution applied with a syringe or brush.**

- A drop of a 30% w/v solution of Acryloid B-72 in 3:7 xylene:acetone\* is applied between the quill and Tyvek bridge with a syringe or brush.
- By sticking the syringe needle through the plastic lid of a small empty container when it is not in use, drying of the adhesive bead on the end can be prevented.
- The quill is then pressed down and held (or clamped) until the adhesive sets.

\*Initially pure acetone was used in these applications. However, as some of the repairs failed during initial mount fittings, xylene was added to the mixture in an attempt to gain a stronger more flexible bond. (See comparison of solvents below.)

## **Comparison of Adhesives and Application Techniques**

- The strength of the repair appears to be the same for both the film and solution

## *Brown*

application of the adhesive.

- The Acryloid B-72 film is a neater application and allows a faster tack time than direct application of Acryloid B-72 with a syringe or brush.
- In re-activating films, personal preferences outweighed any particular merit of solvent application with either a brush or syringe. Many found the syringe difficult to control but others felt that with practice it was more efficient and controllable than the brush.
- The solution takes longer to set than the reactivated film and usually requires light clamping. (Films will usually grab if held for a few seconds and thus do not usually require clamping.)
- Light weights or clamping increases the bond strength with both films and solutions.
- Direct application of the solution is usually faster repair method. If many quills need to be set down, the syringe works better than the brush as the latter tends to get a large buildup of adhesive.
- The reactivated film method can be difficult as the little squares tend to slip out of place, pop out of the tweezers and generally get misplaced.

## **Comparison of solvents**

- Acryloid B-72 films cast with xylene, toluene, or xylene and acetone mixtures appear to remain more flexible than those cast with pure acetone.
- When the Acryloid B-72 is applied directly in solution, the repair appears to remain stronger with xylene/acetone solutions than simple acetone solutions. Xylene, however, increases the set time and thus often requires clamping.
- Films re-activated with 3:1 xylene:acetone appear stronger than those re-activated with acetone alone.

## **Tyvek Bridges**

### *Overview of Technique*

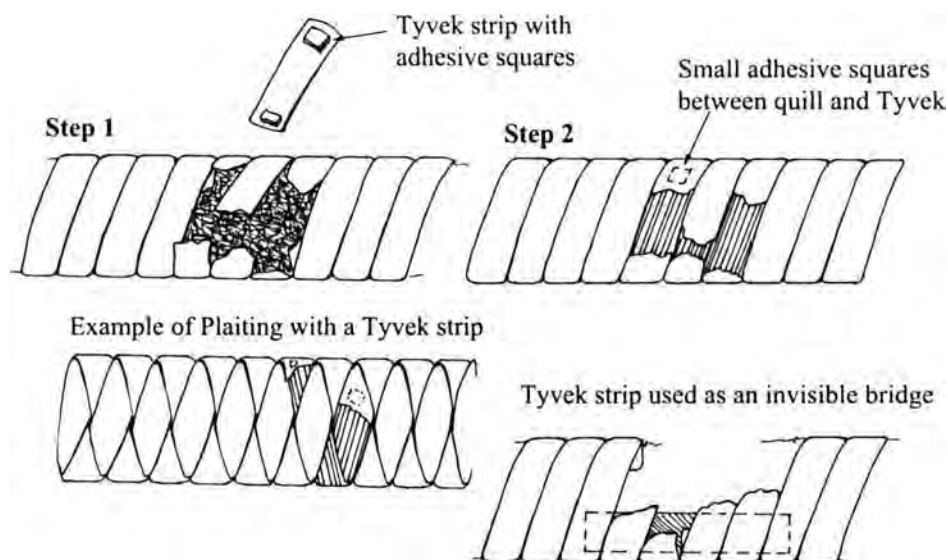
Narrow strips of toned Tyvek are used in this well established technique to replace missing quills and to stabilize broken ends. In some instances a simple bridge is made between the two extant ends and no attempt is made to fill the adjacent losses. In other cases large areas can be re-woven

## *Brown*

to fill and visually re-integrate the entire area of loss. Adhesive methods using both Acryloid B-72 films and solutions applied directly with a syringe or brush were tested.

### *Method of application*

Sections of heavy weight Tyvek (#1025D) are toned with acrylic paints to imitate the missing quills. If desired the gloss can be increased using either a thinned solution of Acryloid B-72 or an acrylic gloss medium. The toned Tyvek® is then cut into strips the width of the original quills and adhered to the end of the broken quill with either Acryloid B-72 film, Acryloid B-72 in a syringe or Acryloid B-72 applied with a brush as described above.



### *Findings*

- This method works best for areas where only a few quills are broken and missing. Very large areas where complete re-plaiting was attempted often became bulky in appearance and was extremely time consuming.
- With frequent handling, the bridges tend to fail at the adhesive join. Many of the bridges needed repair during the frequent fittings on the mannequins and during installation. However this may have been in part due to incomplete setting of the adhesive as very little failure occurred during de-installation.
- Light pressure or clamping after the initial grab increases the strength of the join.

### *Brown*

- The technique is visually satisfying as the toned Tyvek successfully imitates the missing quills.
- The fills are identifiable with close examination and are easily reversible.

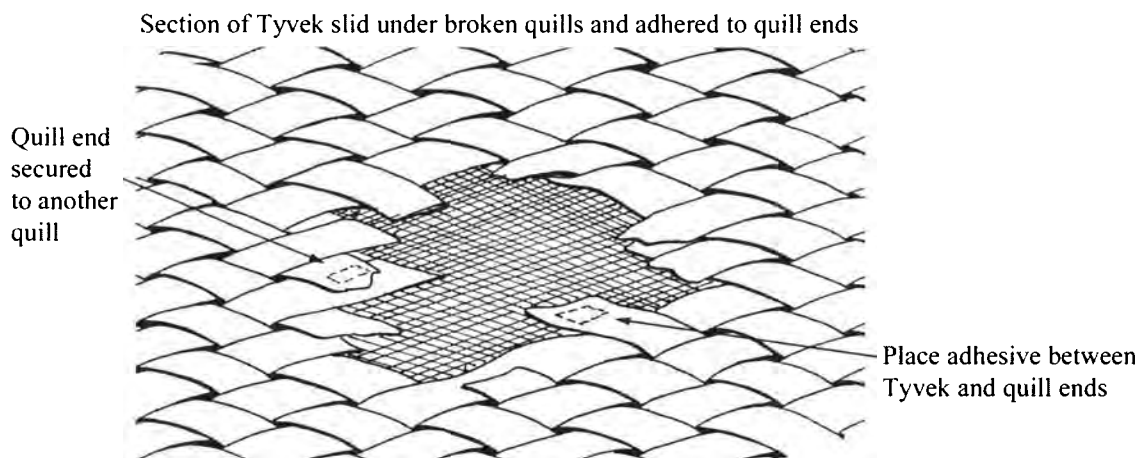
## **Color Field**

### *Overview of Technique*

For this technique solid pieces of toned Tyvek are used to stabilize and visually re-integrate relatively large areas of quill loss. As no attempt is made to replicate and re-weave the individual missing quills the technique is very useful for re-integrating large areas of loss.

### *Method of application*

Heavy weight Tyvek is toned with acrylic paints to blend with the adjacent quillwork. It helps to drag a comb or stiff brush across the wet paint to impart the impression of the woven quills because flat color fields do not integrate well (technique fine-tuned by Melinda McPeck). The toned Tyvek is then placed under the extant broken quill ends and held in place using either tiny cut squares of Acryloid B-72 film or Acryloid B-72 in solvent applied directly as described above.



*Brown*

### ***Findings***

This method effectively stabilizes the extant quills and avoids the problem of Tyvek bridges “popping” apart.

- In large closely woven areas this method can be effective as it avoids some of the bulky appearance problems which can occur with the Tyvek bridge method.
- Although the technique was developed to avoid the time intensive process of re-weaving, we found that in actuality it is not extremely time efficient because it is difficult to produce a large fill that appears visually satisfying.
- These fills are easily identifiable and removable in the event the repair needs to be reversed in the future.

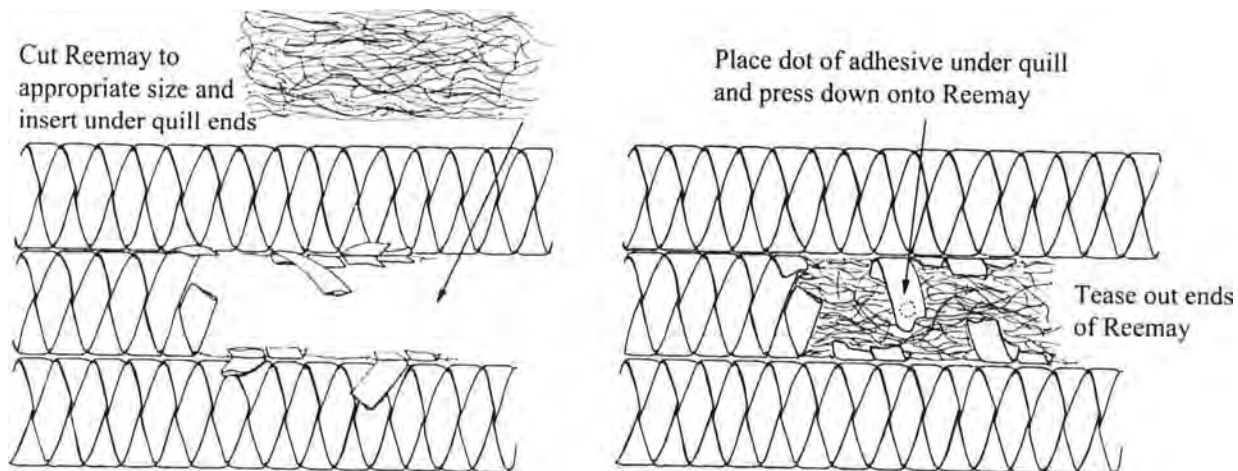
### **Reemay Fills**

#### ***Overview of Technique***

Reemay, toned to blend with the hide substrate behind the quillwork band, is used to stabilize large areas of quill loss where only small fragile ends of the quills remain. The damaged quills are adhered to a Reemay insert instead of the hide in order to make the repairs more reversible and avoid staining of the hide with adhesive. Both heavy and lightweight Reemay were tested. This is a stabilization method that makes no attempt to visually re-integrate the losses.

#### ***Method of Application***

Sections of Reemay are toned to the color of the hide with thinned acrylic paint. The best results are achieved when a porous material such as blotter paper or paper towels is placed under the Reemay during painting to absorb the excess paint and avoid filling the interstices of the fabric. The Reemay is then cut to the shape of the loss and exposed edges are teased out. The toned Reemay is placed under the broken quill ends and adhered to them using a viscous (~40% w/v) solution of Acryloid B-72 in acetone. This solution allows the adhesive to set before it seeps through the porous fabric and adheres to the hide below.



### ***Findings***

- Like the color field technique, this method effectively stabilizes the extant quills and avoids much of the problem of small bridges “popping” apart.
- Visually it blends convincingly with the hide. However it does not visually re-integrate the areas of quill loss.
- This method is the most time efficient of all those tested.
- The repairs are identifiable with close examination and they removable in the event the repair needs to be reversed in the future.
- The lightweight Reemay was preferred in most cases as it blends more effectively with the hide.
- Exposed edges of the lightweight Reemay can be effectively disguised by teasing out the fibers and intermingling them with the hide fibers beneath the fill.

*Brown*

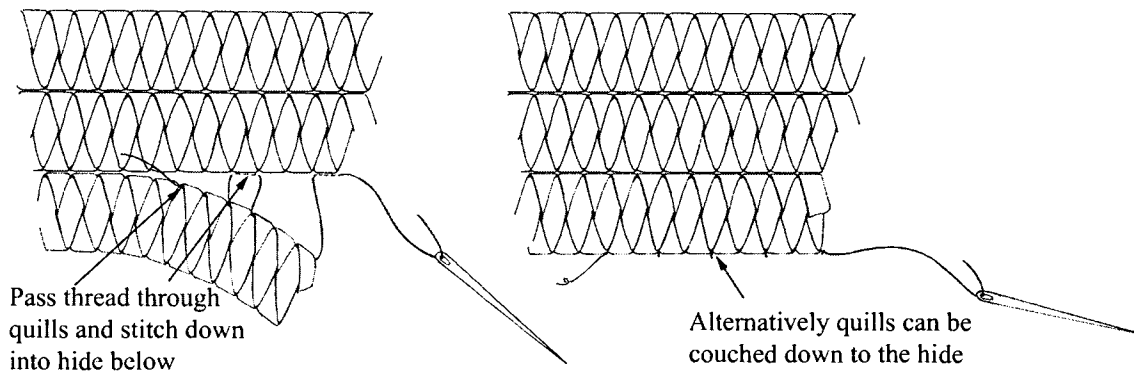
## **Restitching**

### ***Overview of Technique***

Fine polyester thread is used to secure areas where quillwork bands are still intact but the stitches holding them in place have broken or pulled out of weakened hide. The thread is passed through the folded edge of the quill band and then down into the hide to stitch the lifting and in some cases precariously hanging bands of quillwork back down to the hide substrate.

### ***Method of Application***

A strand of a fine tan polyester thread (Skala) is threaded through the quill bands and stitched down into the hide below every 4-5 quills or when necessary. Where the hide is in good condition a couching technique similar to that originally used to hold the quills in place can be used. However, in instances where the hide is very deteriorated and friable, large running stitches are necessary to prevent the stitches from simply pulling out. Hair silk can also be used, but it tends to catch and break frequently and cause unnecessary damage to the hide and quills.



### ***Findings***

- This system holds the quill strips securely in place.
- The tan colored fine thread is invisible at a distance of a few inches.
- This method can be time intensive and difficult to execute in areas where the hide is extremely degraded.



### *Brown*

- Although the repair is reversible in that the stitches can be cut and removed, new holes (from the beading needles and monofilament) were made in the hide as the original holes were torn and could not be re-used.
- The technique avoids the possibility of staining the hide with an adhesive.
- Hair silk was also tested but it tended to break easily and catch inside the quill bands.

## **Part II - Hair Lock Repairs**

### **Adhesive Choice**

Acryloid B-72 in xylene and acetone mixtures was used for the repairs below with the exception of the first example where adhesive is not used at all. This mixture was chosen as many of the repairs will be difficult to reverse in the future and this adhesive has been shown to be one of the most stable (Down 1996). All of the following applications were performed under magnification.

### **Hair Silk**

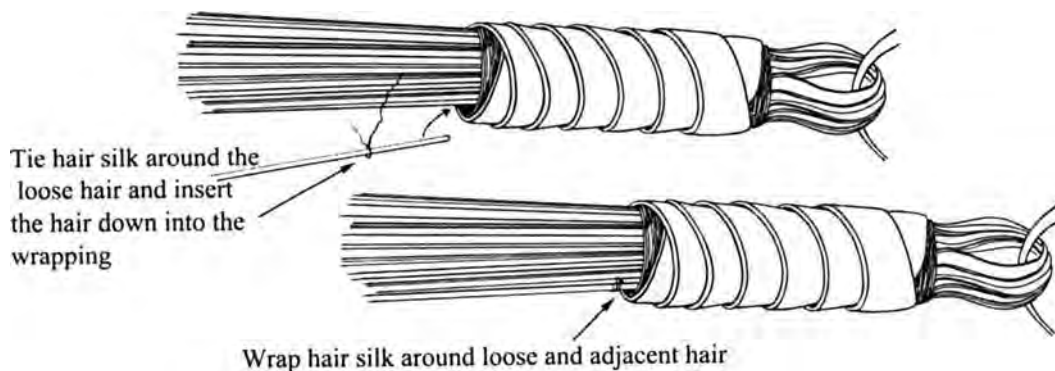
#### ***Overview of Technique***

This technique secures the detached hair back into the hair lock with hair silk. As it avoids using an adhesive, this is the most easily reversible of the techniques used.

#### ***Method of Application***

A strand of hair silk is tied around the end of a hair detached from the hair lock. The hair is then slipped down into the sinew wrapping at the base of the hair lock as far as possible and secured in place by wrapping the ends of the hair silk around the detached hair and an adjacent hair. In some instances it is possible to simply slip the hair down into the sinew wrapping and then wrap the hair silk around this and an adjacent secure hair at the same time. However this second method tends not to hold the detached hair as securely.

## *Brown*



## *Findings*

- When only one hair is broken and the extant hairs are not brittle, this method can be effective.
- It is difficult to get the silk tied tight enough to prevent slippage without breaking the tied hair.
- The repair is invisible at a distance of a few inches.
- Of the three techniques tried, this is the most time intensive.
- This is the most reversible stabilization technique.

## **Adhesive Coated Hair Silk**

### *Overview of Technique*

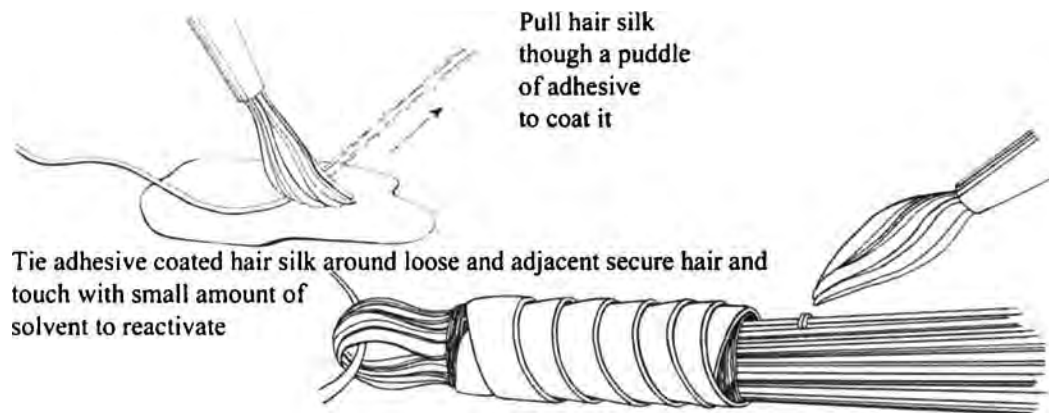
Hair silk, with an adhesive coating applied to increase the hold, is tied around broken and secure hairs in order to secure the loose ones in a hair lock. The adhesive is reactivated after the hair is secured to provide a light and easily reversible bond between the silk tie and the original hairs.

### *Method of Application*

A strand of hair silk is pulled several times through a small puddle of an approximately 30% w/v solution of Acryloid B-72 in 3:7 xylene:acetone. When the thread is covered with a light, barely visible coat of adhesive it is taped to the edge of the table and allowed to dry evenly. The

## *Brown*

detached hair is then slid down into the base of the hair lock, the adhesive coated thread wrapped around the loose hair and an adjacent secure hair several times and then knotted. A small drop of acetone is applied to the area to reactive the adhesive and secure the silk wrapping to the hairs.



## *Findings*

- This method is extremely effective in re-attaching broken hairs without damaging the extant ones, as the threads do not need to be pulled very tight.
- In some cases many hairs can be attached at once by weaving the thread over and under broken hairs.
- As only a very thin layer of adhesive is used, the repair is discreet and invisible at a distance of a few inches.
- Like the previous methods, it is extremely time intensive.
- Reversibility tests indicated that only a light nap bond was achieved between the adhesive and the hair. Thus when solvent was reapplied and the adhesive thread removed, very little (no visible) adhesive remained behind on the hair.

## **Dipping**

### *Overview of Technique*

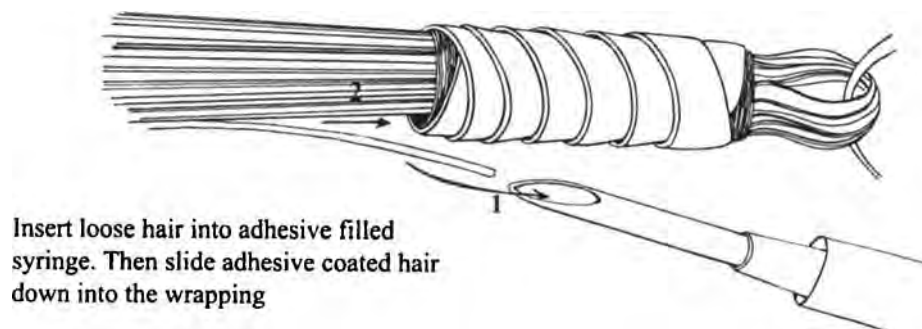
This method rapidly secures many broken hairs by coating the ends of the hair with adhesive and pushing them down inside the sinew wrapping of the hair lock. As the hairs are often entangled

### *Brown*

in the locks and removing them can be difficult and can possibly cause unnecessary damage, the system of dipping the hairs into a syringe was developed.

### ***Method of Application***

A syringe fitted with a fairly large sized needle (16G) is filled with a %15 w/v solution of Acryloid B-72 in 3:7 xylene:acetone. It is then held near the broken hair and the broken hair is slid a short distance into the needle to coat it with adhesive. The adhesive coated hair is then removed and quickly slid down into the sinew wrapped base of the hair lock.



### ***Findings***

- The system does not require manipulation of the adjacent hairs and thus avoids breakage of brittle but still intact hairs.
- The repairs are invisible.
- This method is by far the most time efficient.
- It is not as reversible as the other techniques as it is virtually impossible to determine which hair was broken and it would be difficult to remove the adhesive from down inside the wrapping.

*Brown*

## **Conclusion**

In treating these shirts we found that a variety of techniques were necessary in order to accommodate the varying stability of the quills and hair, the nature of the loss, the aesthetic needs of the shirt, and exhibit schedule. The large number of conservators working on this project enabled many innovative ideas to be brought to the project and successful solutions developed while revisiting established techniques and developing new ones.

## **Acknowledgments**

Project Manager: Monika Harter

Staff Contributors: Jessica Johnson, Marian Kaminitz, Susan Heald, Kelly McHugh

Fellow Contributors : Dominique Cocuzza, Ellen Roblee

Intern Contributors: Mary Coughlin, Sarah Kitch, Travis Lane, Nancy Love, Melinda McPeck, Shannon Parker, Heather Richardson

## **Materials**

3M Scotch Long-mask Masking Tape (Treated blue crepe paper with synthetic adhesive.)

3M Industrial Tape and Specialties Division, 3M center, Building 220-7W-03, St. Paul, MN  
1-800-722-5463. [www.3M.com](http://www.3M.com)

Acryloid (Paraloid) B-72 (An acrylic co-polymer of 70% ethyl methacrylate and 30% methyl acrylate, T<sub>g</sub> 40° C.)

Available from Talas, 568 Broadway, New York, NY 10012. 1-212-219-0770 and  
Conservator's Emporium, 100 Standing Rock Circle, Reno NV 89511. (702) 852-0404.  
(formerly Conservation Materials Ltd. Of Sparks NV).

Disposable Syringe and Precision Glide Needles (Becton and Dickinson, green #21G 25mm, purple 16G 38mm, stainless steel and polypropylene.)

Fisher Scientific. P.O. Box 1768. Pittsburgh, PA 15230 or 3970 John Creek Court Suite #500 Suwanee, GA 30024 ([www.fishersci.com](http://www.fishersci.com))

Golden Polymer Medium, Gloss (100% acrylic polymer emulsion.)

Conservation Support Systems, P.O. Box 01746, Santa Barbara, CA 93190-1746.  
1-800-482-6299.

Hair Silk (100% silk thread, imported from France, used in textile repair. The same thread is used to weave silk crepe line. Natural color, two strand.)

Talas, 568 Broadway, New York, NY 10012. 1-212-219-0770.

*Brown*

Plain Microscope Slides (Pre-cleaned 25mm x 75 mm x 1mm glass slides.)

Fisher Scientific. P.O. Box 1768. Pittsburgh, PA 15230 or 3970 John Creek Court Suite #500 Suwanee, GA 30024 [www.fishersci.com](http://www.fishersci.com)

Reemay<sup>TM</sup> (Porous, spun bonded non-woven polyester fabric made from long continuous fibers of 100% Dacron.)

Talas, 568 Broadway, New York, N.Y. 10012. 1-212-219-0770.

Skala thread (Fine semi-translucent polyester sewing thread produced by Gütermann in Germany.) U.S. distributor: Testfabrics, P.O. Box 26, 415 Delaware Ave., West Pittston, PA 18643. 570-603-0432. [www.testfabrics.com](http://www.testfabrics.com) and [www.guetermann.com](http://www.guetermann.com)

Teflon Coated Fiberglass Sheeting (Premium 6mil sheeting.)

Chemfab Corporation, Water St., P.O. Box 476, North Bennington, VT 05257, USA  
Tel. 802/447-1131, 1-800-243-6322

Tyvek<sup>TM</sup> (Synthetic paper made from olefin, manufactured by DuPont. 100% high density fine white polyethylene fibers as continuous filaments bonded by heat and pressure with no binders or fillers.)

Avery Dennison, 250 Chester St. Painesville, OH 44077

## References

Collins, Catherine. 1986. Conservation techniques for ethnographic leather artifacts: application to the Paul Kane collection. *Leather conservation news* 3 (1):14-16.

Collins, Catherine. 1988. Conservation techniques for ethnographic leather artifacts: application to the Paul Kane collection. In *Symposium 86. The care and preservation of ethnographic materials: proceedings*, ed. R. Barclay et al. Ottawa: Canadian Conservation Institute. 62-67

Down, J.L., M.A. MacDonald, J. Tetreault, and R.S. Williams. 1996. Adhesive testing at the Canadian Conservation Institute- an evaluation of selected poly(vinyl acetate) and acrylic adhesives. *Studies in Conservation* 41:19-44

Hansen, Eric. 1995. The effects of solvent quality on some properties of thermoplastic amorphous polymers used in conservation. *Material Research Society Proceeding* 352:807-812

Howatt-Krahn, Ann. 1987. Conservation: skin and native-tanned leather. *American Indian Art Magazine* 12 (Spring)(2):44-51.

Jenssen, V. 1987. Conservation of wet organic artefacts excluding wood. In *Conservation of marine archeological objects*, ed. Colin Pearson. London: Butterworths & Co Ltd. 122-163.

Munro, Katherine. 1989. The treatment of a feather headdress. In *Proceedings of the 14<sup>th</sup> annual IIC-CG conference*, ed. Johanna G. Wellheiser. Ottawa: IIC Canadian Group. 172-179.

National Museums of Canada. Canadian Conservation Institute. 1983. Care of Quillwork. CCI Note 6/5. Ottawa: National Museums of Canada. Canadian Conservation Institute.

Stone, Thomas G. 1989. The conservation of skin and semi-tanned leather at the Canadian Conservation Institute: three case histories. In *International leather and parchment symposium*, Wolfgang Gerhardt et al. Offenbach am Main: Deutsches Ledermuseum; Deutsches Schuhmuseum. 228-242.

#### **Author's Address**

K. Elizabeth Brown, Smithsonian National Museum of the American Indian, Cultural Resource Center, 4220 Silver Hill Rd., Suitland, MD. 20746-2863, (301) 238-6624 ext 6299 (brownce@nmaircr.si.edu)

## STORAGE SYSTEM FOR ARCHEOLOGICAL TEXTILE FRAGMENTS

Lisa Anderson, Dominique Cocuzza, Susan Heald and Melinda McPeck

### Introduction

The holdings of the National Museum of the American Indian consist of approximately 805,000 archaeological and ethnographic objects from Native peoples of the Western hemisphere. NMAI is currently in the process of relocating and re-housing the collection from its Bronx, New York Facility to the new “state-of-the-art” Cultural Resources Center (CRC) located in Suitland, MD. As part of the relocation effort, the collections management and conservation departments have collaborated to devise a re-housing system for over 2,000 archaeological textile fragments in the collection. These textiles are currently stored in polyethylene bags in wooden drawers in the museum’s Bronx storage facility (Fig. 1). This project focuses on concerns for re-housing smaller archeological textiles and fragments, within the constraints of the entire re-housing effort.



Figure 1. Storage at the Research Branch, Bronx, NY.



## **Evaluation of Previous Techniques**

Published and unpublished literature on the storage of archaeological textiles was reviewed. Commonly used mounting systems included variations of padded and unpadded sink mat folders, crepline covered window mats that enclose the textile, Mylar encapsulation, and direct stitching of the textile to a fabric substrate such as linen. Mounting systems that did not allow the textile to be viewed from both sides or that prevented the textile from being removed from the mount were excluded as possible design candidates. A prototype of the crepline covered window mat enclosure was constructed, but proved too time consuming to produce on a large scale and visually obscured the textile. The sink mat folder seemed to be the best suited for our needs.

## **Criteria**

Prior to the construction of prototypes, the following list of criteria was developed addressing rehousing requirements and availability of resources within the Collections and Conservation departments:

- both sides of the textile should be accessible
- the textile should be easily removed from the mount with minimal handling
- the system should be user friendly
- materials should be stable, non-abrasive, durable (& relatively static-free)
- the mount should provide a buffer from the environment
- sizes should be standardized
- mounts should be straight forward and easy to produce on a mass scale
- materials should preferably be already employed in collection rehousing, minimizing costs and standardizing the vocabulary of materials used collection wide.

## **Evaluation of Prototypes**

Various prototypes of sink mat folders were constructed using a variety of methods and materials. Each prototype was evaluated using a select group of textiles that were recently moved to the CRC.

Sink mats were made using archival mat board and corrugated blue board window mats, strips of blue board, and strips of Volara (cross-linked polyethylene foam sheet). Using strips of blue board to build up the sink proved to be more efficient, as it was quicker and would utilize scrap corrugated blue board.

We tested both padded and unpadded folders, and found that a padded surface helped to prevent the textile from shifting in the mount when flipped.

Muslin, Tyvek, and a Testfabrics polyester knit were used to line both interior surfaces of the folder and mock archaeological textiles were tested on each of the surfaces. The muslin seemed to cause less fiber loss than the polyester knit, while still holding the textile in place. Besides being difficult to work with, the openness of the polyester knit structure allowed fibers to become imbedded. Soft Tyvek worked well on the front cover of the folder as it provided a slick surface that would allow the textile to be easily removed from its mount, but was too slick to be used on both sides of the folder interior.

In order to minimize the amount of adhesive used, we decided against a linen tape hinge for the folder itself and instead scored the corrugated board to create the folder. Different types of adhesive systems were used to attach the fabrics, the sink mat, and ties to the folder. Polyester heat set webbing, ethylene vinyl acetate hot melt glue, and Tyvek™ tape with an acrylic adhesive were chosen to use in the mounts. The heat set webbing worked well to attach fabric, Tyvek, and twill tape ties securely to the blue board. The inner edges of the blue board strips forming the sink mat were covered in Tyvek tape to create a smooth surface, should the textile come into contact with the mat edge. Low temperature hot melt glue had a strong bond and worked well to attach the sink mat strips to the folder.

## **The Design**

A design evolved which consists of a portfolio that can be flipped to view both sides of the textile (Fig. 2). The basic format includes a padded muslin-covered resting surface surrounded by a stationary sink mat, a Tyvek-covered opposing side, and cotton tie closures. These materials were chosen for their ability to minimize fiber loss and abrasion, while preventing movement of the textile by maintaining adequate grip. Innovations in the design include:

- a scored spine on the portfolio, that eliminates the need for a hinge
- a single stationary sink mat made of scrap corrugated archival board, which can be easily precut
- the use of two different surface linings that are integral to the operation of the portfolio
- a smooth Tyvek-lined viewing surface that enables the textile to be easily removed from

*Anderson, et. al..*

the mount

- a repositioning guide on the Tyvek-lined viewing side that ensures proper placement of the textile before closure
- inert heat-activated polyester webbing to adhere surface linings and cotton tie closures to the corrugated board

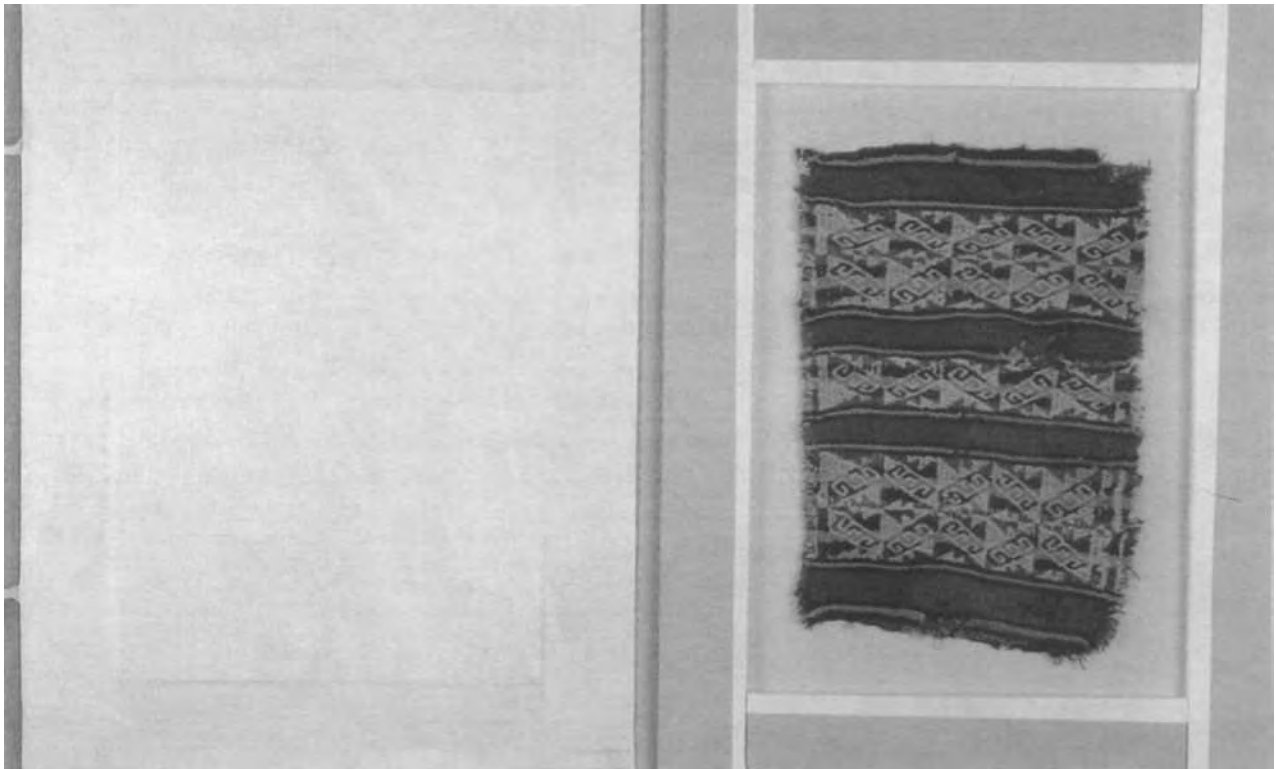


Figure 2. Archaeological textile in its portfolio.

### **Testing of Adhesive Webbing**

The conservation lab had a roll of thermoplastic adhesive web from Archivart that worked well to adhere the Tyvek to the board. However, Archivart no longer carries the product because the company that had manufactured it, Sharnet, had been sold to Bostik. Bostik was contacted for information about other available adhesive web products and a technical representative sent several samples that he thought would suit our purposes. Each sample looked and felt different

from the Sharnet adhesive web, and concern was raised regarding the chemical stability of all the products.

Three samples were submitted for testing at the Smithsonian Center for Materials and Education Research (SCMRE): Sharnet polyester adhesive web SH-4200 .8 oz. (formerly sold by Archivart), Bostik polyester web PE75, and Bostik polyolefin web PO90. Walter Hopwood, Organic Chemist, analyzed the samples using Fourier-transform infrared spectroscopy. The two polyester webs showed polyester absorption bands based on phthalic acids for the Sharnet sample and adipic acids for the Bostik PE75 sample. The Bostik olefin sample showed bands for olefin as well as polyvinyl acetate, suggesting that the material was actually a co-polymer. Based on the results, Hopwood suggested that the Sharnet SH-4200 was the most stable, the Bostik PO90 the least stable, and the Bostik PE75 of intermediate stability. The authors decided to use the available Sharnet adhesive web as economically as possible and hope that the amount stocked would be sufficient for the project.

## **Conclusion**

Providing a protective storage system for the museum's collection of archaeological textiles was considered a priority. Because of the prior poor storage conditions, the textiles had not been accessible to researchers. A user-friendly mount was important because of anticipated research interest in the collection. This pilot project enabled the authors to develop an efficient storage system and construction method utilizing relatively quick standardized production with materials that were already employed in the collection rehousing project. The staff foresees students and volunteers to assisting with portfolio production with the expectation that the fabrication process will be refined and adjusted as needed. There are limitations to this mounting system however: They are suitable only for smaller fragments where portfolios can be easily turned over; the mounts are not suitable for brittle, three-dimensional textiles or large textiles. The portfolios are space efficient and can be stored in closed cabinetry or layered in boxes on open shelving. In order to ensure proper handling, detailed instructions with digital images accompany each portfolio.

## **Construction Method (Fig. 3)**

Cut the single wall blue board to the appropriate size for the portfolio – twice the width + 1" X the height (the extra inch forms the spine of the portfolio.) For example the board for an 11x 14 portfolio would be cut 23 x 14. The corrugations in the blue board should run parallel to the width to maximize the strength.

Measure the width for the storage (right) side of the portfolio and score with an awl.

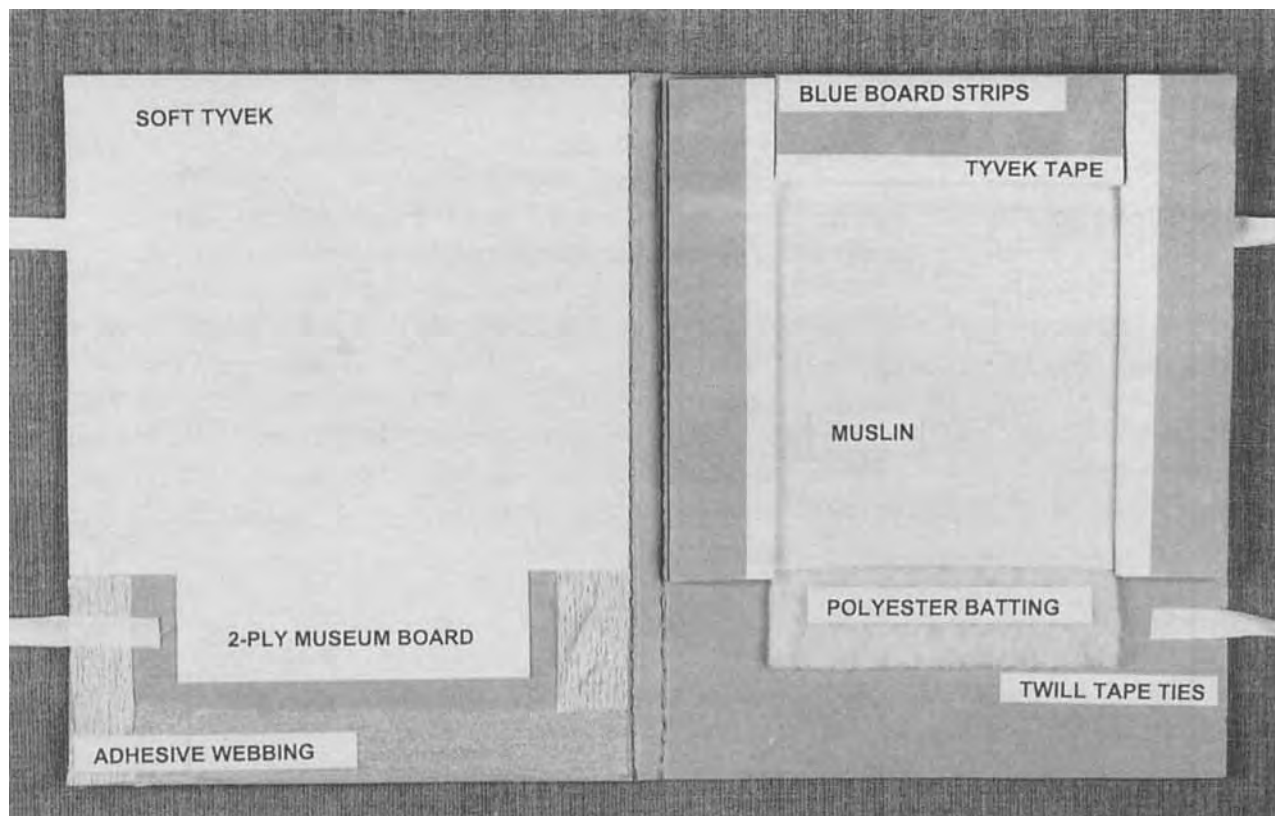


Figure 3. Construction of portfolio.

Cut the sink mat strips from double walled or single walled blue board (according to the height of the textile.) These will form the mat to enclose the textile on the storage side.

Cover the exposed inside edges of the blue board strips with Tyvek tape.

Position two twill tape ties approximately 1/3 of the height at top and bottom of the storage side (right hand side) of the portfolio. With a tacking iron or regular iron at low setting adhere the tapes to the board using small strips of polyester webbing. It is recommended that a piece of silicone release Mylar be used between the iron and twill tape.

Cut a piece of polyester batting to the exact size of the opening on the storage side. Measure and draw the opening with pencil and tack the batting down in the outline with a small piece of double-sided tape.

Cut a piece of muslin larger than the batting so that there is ample fabric to adhere to the board. Adhere the muslin to the board using either polyester webbing or hot melt adhesive. If hot melt

*Anderson, et. al..*

is used be sure to spread the glue thinly and evenly to avoid raised areas of glue under the fabric.

Attach spacers to the edges of the storage side of the portfolio with hot melt adhesive, again making sure the glue is spread flat and evenly to ensure the spacers lay flat.

Fold the front cover of the portfolio up at a 90 degree angle and mark off the height of the sink mat to obtain a spine measurement. With a straight edge placed just outside of the mark score the board with an awl and fold. It is useful to flatten the spine and score lines with a bone folder to obtain a flat cover for the portfolio. Next, cut the excess blue board from the front cover.

Adhere the twill tape ties to the front cover, making sure they match up with the ties on the storage side.

Cut a piece of 4-ply Museum board to the same size as the space within the sink mat on the storage side of the portfolio. This will serve as the positioning guide on the interior front cover of the portfolio. Matching the window opening, attach the board to the cover using a few pieces of ½" double-sided tape.

Cut a piece of soft Tyvek to the size of the front cover. Adhere the Tyvek over the positioning guide (with the smooth side up) using 1" strips of polyester webbing. The strips of webbing should be placed at the very outer edges of the Tyvek to keep the edges of the Tyvek™ flat and smooth.

## **Materials**

EVA Low temperature hot melt glue, Polygun LT Glue applicator

Tape Systems, 460 East Sanford Boulevard, Mount Vernon, New York 10550,  
(914) 668-3700

100% rag 4-ply museum board, Corrugated acid-free paper board, 2 1/4" pressure sensitive Tyvek™ tape with acrylic adhesive, 3M™ double-sided tape, ½"

University Products, 517 Main Street, P.O. Box 101, Holyoke, MA 01041-0101  
(413) 532-3372

Silicon release Mylar™

Talas, 568 Broadway, New York, NY 10012, (212) 219-0770

"muslin" - unbleached cotton print cloth, style 400U, polyester 1/8" Polyfelt, no resin

Testfabrics, 415 Delaware Avenue, West Pittston, PA 18643, (570) 603-0432

Polyester based polymer adhesive web (SPE 107)

Bostik, 211 Boston Street, Middleton, MA 01949-2128, (978) 777-0100

Anderson, et. al..

Soft structure Tyvek™ with Corona anti-static treatment  
Fall River Paper, 701 State Road, Suite A, Philadelphia, PA 19136- 1460  
(215) 708-1460

## References

Burnham-Staehli, E. 1974. Mounting archeological textiles. In *Archeological textiles: Proceedings, Irene Emery roundtable on museum textiles*. Washington DC: The Textile Museum. 52-53.

Collins, S, M. Mecklenberg and M. Ballard. 1989. Fabric selection and its relationship to dimensional changes in support systems for constrained fabric mounting devices. In *International perspectives on textile conservation: Papers from the ICOM-Committee for Conservation Textiles Working Group Meetings*, ed. A. Timar-Balazsy and D. Eastop. London: Archetype Books. 162-169.

Commoner, L. 1992. Storage Containerization for Textile Collections. In *Conservation concerns: A guide for collectors and conservators*, ed. K. Bachman. Washington: Smithsonian Institution Press. 91-96.

Greene, V. 1992. Adaptation of Standard Matting Folders. In *Storage of natural history collections: Ideas and practical solutions*, ed. C.L. Rose and A.R. de Torres. Pittsburgh: Society for the Preservation of Natural History Collections. 149-152.

Love, N. 1999. Unpublished guidelines for constructing archaeological textile mounts. 1999.

McClintock, C. 1990. A method for mounting and storing archeological textiles. In *Archeological textiles occasional papers*. London: United Kingdom Institute for Conservation. No.10. 59-61.

Morrison, L. 1987. The treatment, mounting and storage of a large group of archeological textile fragments. ICOM Committee for Conservation preprints vol. 1, 8<sup>th</sup> triennial meeting, Sydney, Australia. Los Angeles: Getty Conservation Institute. 391-396.

Newton, C., M. Segal and J. Vuori. 1989. Development of archeological textile mounts at the Canadian Conservation Institute. *Journal of the International Institute for Conservation-Canadian Group*. 14:3-11.

Peacock, E. 1987. Anthropological textiles: A mounting solution. ICOM Committee for Conservation preprints vol. 1, 8<sup>th</sup> triennial meeting, Sydney, Australia. Los Angeles: Getty Conservation Institute. 407-411.

*Anderson, et. al..*

Piechota, Dennis. 1978. Storage containerization: Archeological textile collections. *Journal of the American Institute of Conservation*. 18:10-18.

Segal, M. and J. Vuori. 1984. The treatment of archaeological textiles. International Institute for Conservation Canadian Group abstracts, 10th annual conference, Peterborough, Ontario. 20.

Smithsonian Center for Materials Research and Education. Report # 5751. W. Hopwood. Three Adhesive Webs. April 16, 2001.

Vuori, Jan. 1984. A method for putting crepeline onto mats. *Textile Conservation Newsletter*. 11-14.

Wolf, S. J. 1985. Housing for Archeological Textile Fragments. *Conservation Notes* 12 (April):1-4.

#### **Authors' Addresses**

Lisa Anderson, Collections Department, Smithsonian National Museum of the American Indian, Cultural Resources Center, 4220 Silver Hill Road, Suitland, MD 20746-2863, (301) 238-6624 x6306 (andersonl@nmaircr.si.edu)

Dominique Cocuzza, Assistant Conservator, American Museum of Natural History, Anthropology Department, 79th Street and Central Park West, New York, NY 10024 (212) 769-5434

Susan Heald, Head Textile Conservator, Smithsonian National Museum of the American Indian, Cultural Resources Center, 4220 Silver Hill Road, Suitland, MD 20746-2863 (301) 238-6624 x6317 (healds@nmaircr.si.edu)

Melinda McPeck, Collections Department, Smithsonian National Museum of the American Indian, Cultural Resources Center, 4220 Silver Hill Road, Suitland, MD 20746-2863 (301) 238-6624 x6306 (mcpeekm@nmaircr.si.edu)



