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## **DON'T ROCK THE BOAT: RECONSTRUCTION AND MOUNTING OF A WATERLOGGED DUGOUT CANOE**

Howard Wellman

### **Abstract**

A 19<sup>th</sup> century dugout canoe was excavated from the banks of LaTrappe Creek on Maryland's Eastern Shore in 1993. In the following years it was treated by the standard process of impregnation with polyethylene glycol, and dried in a vacuum freeze-drier at the Maryland Archaeological Conservation Laboratory (MAC). The canoe was recovered in several pieces, continued to break during treatment, and the treated yellow pine now has the approximate strength of hard cheese. Knowing that the canoe would go out on loan to a local museum, the MAC Lab conservator had to devise a reconstruction method and supporting mount that would serve for both transport and display, and could be done with limited resources. The canoe was reassembled by pinning the pieces together with fiberglass rods, with additional adhesion provided by Butvar B-98. The conservator relied heavily on the expertise of a volunteer boat restorer during the pinning and reconstruction. Of equal value was the help of a volunteer blacksmith who built the base frame on which the boat was reconstructed, and then custom fit curved ribs that supported the fragments. The reconstruction and support were intended to work as a permanent unit – once the canoe is in place, its own weight will hold it together and hold it in place on the mount. The museum borrowing the canoe has incorporated the frame into a custom display case, and is providing the case with environmental controls to minimize the natural dimensional movements of the wood. The process used proven techniques adapted from much larger shipwreck conservation projects, but could not have been carried out without the expertise of the MAC Lab's volunteer corps.

### **1. Introduction**

In 1993, a hiker discovered an almost intact 19<sup>th</sup> century dugout canoe eroding out of the bank of LaTrappe Creek, a tributary of Chesapeake Bay on Maryland's Eastern Shore (Site No.18TA303). The subsequent history of this canoe's treatment and re-treatment contains valuable lessons for conservators: the benefits and problems of volunteer involvement in conservation, and how to complete a project with extremely limited resources.

It was decided to conserve this particular canoe since local watercraft from this period are rarely preserved. Interesting technological details were immediately apparent, such as the technique for gauging hull thickness during construction: Dowels of a fixed length were inserted into the hull from the exterior, so that when they were exposed during the carving of the interior, a uniform hull thickness was ensured. Other features are comparable to canoes of similar age and contexts in the Chesapeake and surrounding Mid-Atlantic area (Thompson 2006; Lavish and Surgent n.d.).

A hastily assembled crew of more than 30 volunteers excavated the canoe during a winter storm

under the direction of Bruce Thompson, Assistant State Underwater Archaeologist from the Maryland Historical Trust (MHT), who volunteered his own time (Fig. 1). The canoe was recovered in approximately fourteen pieces ranging in size from 1.5m long to palm-sized fragments. The pieces of the canoe were transported to the Chesapeake Bay Maritime Museum (CBMM) in St. Michaels, Maryland, which had expressed an interest in preserving and displaying the boat. The staff and curator of the CBMM undertook the conservation of the canoe with volunteer labor, following a treatment plan drafted by Betty Seifert, the Chief Conservator of the MHT. Ms Seifert could not directly assess the condition of the boat, or treat it herself, since this was a private project and State resources could not be used. Treatment recommendations were based on deterioration assessments and species ID from the archaeologists, photographs and video of the excavation, and guided by Ms Seifert's personal experience of treating similar waterlogged wood. The treatment followed a standard outline: mechanical cleaning with water and brushes to remove mud, sand, and plant roots, continued washing to remove salt water, followed by polyethylene glycol (PEG) immersion, and de-watering by slow air-drying. The molecular weights of PEG used (400, 1430, and 3350) were based on donated materials, since there was no funding available for materials. Where vacuum freeze-drying is not available, or not possible due to the size of the object, controlled slow drying is an acceptable alternative, but often requires a higher concentration of PEG.



Figure 1. The canoe being excavated. Photo by B. Thompson.

All work, including the slow-drying, was to be done at CBMM by the volunteers under the control of Museum staff without the direct supervision of an experienced conservator. No records were kept of desalination time, cleaning procedures, or the PEG impregnation schedule. Ms Seifert was contacted again in 1995 for the loan of a circulating pump to filter the PEG solution, but was not asked to inspect the progress of the treatment. She was assured that everything was proceeding “according to the plan” (Seifert 2000).

The canoe had to be moved in 1999 because of renovations in the non-climate controlled barn at CBMM where treatment was underway. The MAC Lab had opened in 1998, so CBMM turned the project over to State control, the canoe was formally donated to the MHT, and delivered to the MAC Lab with little warning in the middle of a hot summer. The volunteers at CBMM had allowed the solution to evaporate to a greasy sludge to reduce the volume of PEG waste for disposal and to make transport easier. They also thought the more concentrated the PEG, the better the treatment would be (Seifert 2000). The PEG concentration was in excess of 80%, and the blend of molecular weights was uncertain. Parts of the canoe were exposed to the air. The failure to follow the treatment recommendations may be attributed to a misunderstanding of conservation methods, opposing ideas of proper treatment, and false economies on the part of the Museum. The number of pieces now totaled approximately 30, as many of the pieces (particularly long side pieces) had fractured badly during treatment and handling.

When the canoe fragments were delivered, the MAC Lab was newly opened with limited staff. The PEG had active bacterial slime, and the wood was very weak. There was no conservation staff to finish treatment and no funding for the work, though State officials were now willing to claim the project. The Chief Conservator decided that freezing the canoe in the newly installed vacuum freeze drier was the best option to save it from further deterioration. MAC Lab archaeologists, technicians, and volunteers helped remove excess PEG from the surface, together with a large amount of mud and sand that had not been removed before PEG impregnation.

Freeze-drying was done in two batches between July and December 1999, using the Virtis 48”x144” vacuum freeze-drier. The hull fragments were pre-frozen at -40°C for 24 hours in the specimen chamber of the freeze-drier. During freeze-drying, chamber pressure was at approximately 20 millitorr, condenser temperature was at -57°C, and the specimen chamber was brought up from -20°C to 0°C in stages as the wood lost weight. Progress was monitored by measuring weight changes of six pieces and with temperature probes in the wood.

After freeze-drying, the surface of the wood was still covered by a thick waxy layer of PEG, there was a lot of sand and mud still adhering to the surface and cemented into the many cracks, wormholes, and root holes. Lab volunteer efforts to remove sand and roots with picks and vacuums proved frustrating because of the excess PEG. While sitting in the lab, it was noted that pre-existing cracks and checks were still unstable, changing with the ambient relative humidity.

## **2. Re-treatment (2000-2001)**

In order to stabilize the canoe and prepare for exhibition at CBMM (who were now being very

vague about when and if they wanted to exhibit it), it was necessary to find an efficient and economical procedure to remove the excess PEG and mud. Perhaps because PEG remains water soluble after impregnation, the conservation literature has few references to reversing a PEG treatment, particularly for large objects (Cooke et al. 1993; Smith 1998). There was no funding available for extensive post-treatment work, so tests were limited to materials on hand at the MAC Lab. The wood was identified by microscopic examination of thin-sections as one of the species of southern pine (e.g. *Pinus taeda* or *Pinus palustris*), which cannot generally be distinguished on the basis of wood structure (Panshin and de Zeeuw 1980; 446). It was assumed that removal of excess PEG would be relatively easy due to the regular and open microstructure of pine. The wood itself was soft and liable to break under its own weight along existing cracks. There was minimal resistance to probing with a pin.

PEG removal by poultice and immersion washing was tested. Considerable success was achieved by immersion washing and gentle brushing. The surface color lightened considerably, and weight losses up to 50% were noted. Dimensional changes were measured across the tangential dimension between stainless steel pins. The weight loss could be attributed to the removal of large volumes of sand, especially with the most worm-eaten wood. At extreme washing times (up to 72 hours for small fragments), significant shrinkage and distortion of the wood on drying was noted, but brief washing times (ca. 1 hour for small fragments) provided good results with minor shrinkage. Because no additional PEG was introduced, the pieces were not to freeze-dried again, but allowed to dry slowly in closed polyethylene containers. Weight and pin dimensions were recorded after drying for 72 hours. The washing and cleaning was reported in greater detail at the Stockholm meeting of the ICOM-CC WOAM working group (Wellman 2001).

Ultimately, it was decided to immerse the canoe pieces in a solution of 70% v/v ethanol/water. Ethanol improved the wetting of fine pore structures, and also speeded the drying while minimizing wood/water interactions. During immersion, surfaces were brushed to remove excess PEG and loose deposits of sand and mud. Where possible, washing was done under a fume extraction hood for safety (Fig. 2). For the largest pieces, the wash tank was placed in the MAC Lab's Solvent Workroom, which is equipped with spark-proof fixtures and separate air-extraction. Lab staff wore respirators and other personal protection as required by health and safety regulations. Washing time for the individual pieces was variable, but based on the tests the time was kept to a minimum. Larger and denser pieces were allowed a longer immersion time to get maximum penetration into deep crevices. Some pieces were re-washed and brushed more frequently if excess PEG was not removed from the surface. The bow and stern sections of the canoe (about 2m and 1m long respectively and up to 10cm thick) were immersed for three days over the weekend, and this still did not remove deep deposits, or all the surface coating. Slow-drying was done in the Solvent Workroom, with the objects initially tightly bagged and wrapped in polyethylene sheet. Drying was monitored by measuring weight changes. The bags were opened slowly over the course of two weeks, and the final weights stabilized in two to six weeks depending on the size of the piece. The used wash solution was recycled in the MAC Lab's solvent still to reclaim the ethanol.



Figure 2. Immersion washing of hull fragments in a fume hood. Photo by H. Wellman.

The wood was then cleaned with brushes and a vacuum cleaner (Nilfisk with HEPA filter and rheostatic control), using a modified nozzle to remove sand from deep crevices. The final weight loss in the large pieces ranged from 8.6% to 54%, with an average of about 20%. The most dense and solid pieces had the least loss, and the most worm-eaten had the highest. This is probably due mostly to removal of sand and mud. All the pieces had a considerable improvement in color and surface feel, and the adherent sand was easily removed. Details such as wood grain and dowel holes that had been obscured became visible. However, some sand remains in the crevices and trickles out when the pieces are shifted. The variability in surface color probably reflects the incomplete removal of the excess PEG in some areas, probably due to the difference in degradation of the wood in different parts of the hull. The upper sections which were more exposed during excavation and impregnation have more fine root penetration and tend to be darker after re-treatment. Micro-cracks have formed, suggesting very small scale collapse of the wood structures. Dimensional changes were visible in the small scale but pre-existing checks and cracks were stabilized. This discrepancy is considered to be the result of localized ethanol drying causing micro-fissures while the removal of excess PEG caused the larger cracks to react less rapidly to environmental changes. The overall fit of the broken pieces is good.

Since re-treatment, there has been no evidence of PEG migration to the surface, so the canoe appears to be stable under the relative humidity and temperature that can be expected from ambient laboratory environments.

### 3. Reconstruction

In order to reconstruct the fragile hull, a combination display/transport mount consisting of a steel frame with form-fitted ribs was designed with the assistance of Pat Fulcher, a blacksmith and MAC Lab volunteer. The design of the frame is intended to make the entire canoe moveable in one piece by forklift, pallet jack, or human-power with appropriate holds for any of these modes. It is cushioned against shock during transportation, and the undercarriage can be dressed in the museum for an appropriate display. The base frame incorporates a slight curvature that is compressed by the weight of the canoe, creating a stiffer foundation.

The canoe was pre-fitted in sections, and Mr. Fulcher shaped support ribs to individual sections with a home-made contour gauge and his portable forge (Fig. 3a-d). Ethafoam padding protected the wood while fitting continued.



Figure 3. Blacksmith Pat Fulcher shaping support ribs. Upper Left: Measuring hull curve. Upper Right: Shaping the rib. Lower Left: Checking the curve. Lower Right: Installing the rib on the armature. Photos by H. Wellman.

With the ribs clamped temporarily in place, the canoe could be reassembled. A new team including the author, the original excavator Bruce Thompson, and volunteers Chris Martin and Steve Pratt (a professional boat restorer) gathered to examine and fit the pieces together (Fig. 4).



Figure 4. Assembling the hull fragments. Photo by B. Seifert.

The canoe fragments were laid out on the padded frame, and fitted to the ribs with plastic clamps while the sequence of joints was mapped out. The assembly technique was adapted by the author from a procedure used at Texas A&M University by Peter Fix on the hull of *LaBelle*, a French colonial ship recovered in Matagorda Bay by the Texas Historical Commission (Fix 2000). Hull fragments are prefitted, dowel holes are drilled, and the sections are pinned together with fiberglass rods. In this case, 1/8" or 1/4" rods were used. The experience of Steve Pratt was invaluable, bringing together interpretive needs, the requirements of the fragile wood, and best possible boat restoration techniques. Where possible, the drill holes and rods were concealed inside the joints, but a few had to be inserted through the exterior surface (Fig. 5). Where possible, these pins were located inside existing root or worm holes. Butvar B-98 (polyvinyl butyral, 50% in ethanol) was used as an adhesive in the joints and inside the dowel holes to provide additional support. The rods were also used to bridge gaps and provide support where wood was missing.



Figure 5. Pinning the hull fragments together. Left: Pre-drilling the pin hole. Right: Inserting a fiberglass pin. Photos by H. Wellman.

Reconstructions of similar sized vessels (e.g., Moore 2001) have usually avoided the problems of pinning fragments together. An internal bolted armature is used, or it may be possible to take advantage of plank and rib structures and existing fastener holes. The vessel's strength comes from the interlocking elements, whereas a dugout's essential structural strength cannot be recovered once fractured.

Once the entire hull was pinned and held rigidly, the ribs were removed one by one and given a final trimming and shaping, then painted with commercial epoxy sealant and enamel paint (Rustoleum flat black). The ribs were then bolted to the frame, and padded with black Volara (closed-cell polyethylene foam). While the frame was painted black to minimize the visual effect, the borrowing institution requested that the visible pins and bridges be left white for educational purposes (Fig. 6).



Figure 6. Canoe, completed. Photo by H. Wellman.

#### 4. Transport and installation

The CBMM finally determined they did not want to display the canoe, but by good fortune a new marine museum in Baltimore, the Frederick Douglas – Isaac Myers Maritime Park (FDIMMP), saw it, fell in love, and decided to craft their new central display of African-American maritime history around it. A professional art moving company was contracted to crate the canoe on its mount, truck it to Baltimore, and load it into the second floor gallery through an external cargo door via a crane (Figs 7-9). The support frame worked extremely well during the whole packing, transport and installation phases, and saved the moving company significant time and effort.



Figure 7. Moving the canoe on its frame. Photo by R. Morehouse.



Figure 8. The canoe in its shipping case. Photo by H. Wellman.

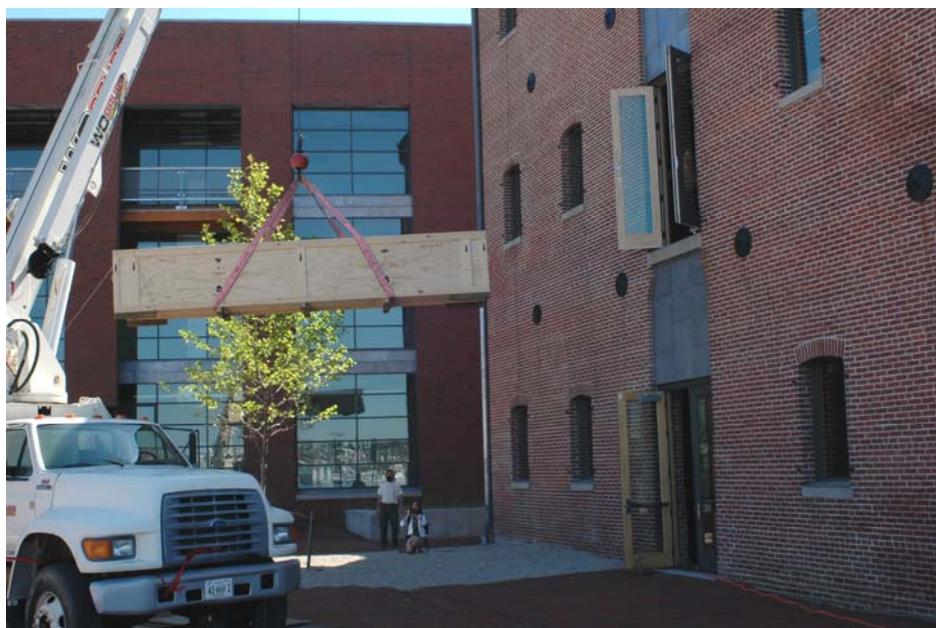


Figure 9. Lifting the canoe to the museum gallery. Photo by H. Wellman.

FDIMMP also contracted for the construction of a custom display case incorporating a micro-climate generator (AirSafe from NoUVIR) to provide constant environmental conditions (Fig. 10). The canoe has not been installed in the case at this time.



Figure 10. Design sketch of the climate-controlled display case for the canoe.

## 5. Conclusion

The MAC Lab conservators learned a number of valuable lessons from this experience. First and foremost were the different experiences gained working with volunteers. Every stage of recovery and conservation involved volunteer labor, some good and some bad. The unwillingness of project managers (or their misunderstanding of the complexities of conservation) at CBMM to provide qualified conservator oversight led to the poor initial treatment of the canoe, and led to a much greater investment in time and labor to ameliorate the damage. By contrast, skilled craftsmen, working in concert with trained conservators, were able to prepare the canoe for display with a minimum of resources. The care put into the canoe paid off in the long run, as it became an object of desire for interpretive uses.

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- Historic St. Mary's City

- Living Classrooms Foundation and the Frederick Douglas – Isaac Myers Maritime Park

## Suppliers

Butvar B-98, Volara:

Conservation Support Systems, (800) 482-6299, (CSS@SILCOM.COM)

Epoxy coating (INSL-X Checkrust, INSLI-Tile II, EP-53BG):

INSL-X Products Corp., Stony Point, NY, 10980.

Rustoleum flat black enamel paint:

Ace Hardware.

Fiberglass rods:

GE Polymer shapes-Jessup, 8255 Patuxent Range Road, Jessup, MD 20794-9600, (301) 604-3623.

AirSafe air control system:

NoUVIR Research, 20915 Sussex Highway 13, Seaford, Delaware 19973, (302) 628-9933.

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