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From wet to dry

THE ASSESSMENT AND CONSERVATION OF THE GRIBSHUND FIGUREHEAD

INTRODUCTION

The *Gribshund* was the Danish King Hans' flagship and one of a fleet of ships on the way to Kalmar to discuss the restoration of the Kalmar Union between Denmark, Norway and Sweden. After anchoring up in the archipelago off the coast of Ronneby in Blekinge, fire swept through the ship and she sank in 10 metres of water. In the 1970s, almost 500 years later, the wreck was found. The chimeric figurehead, resembling a griffin with what appears to be a person in its sharp-toothed mouth, was raised in 2015 and was an international sensation. The wreck is undoubtedly one of the best preserved examples of a carrack; the type of ship used by Columbus and in the golden age of discovery. Closer to home it may be argued that the *Gribshun*d and the ships sailing with her formed part of the nascent Danish navy. Due to this archaeological and historical importance, it was decided that the figure head should be conserved for exhibition and posterity.

LOOKS CAN BE DECEPTIVE: DETERIORATION OF WOOD IN THE MARINE ENVIRONMENT

From the intricately carved details such as the eyes/ears, mouth, teeth and numerous tool marks, the figurehead appears to be in perfect condition; yet below the surface all is not as it appears. Waterlogged archaeological wood from shipwrecks differs from recent wood as it has been affected by a range of deteriorative agents working in underwater environments. Parts of any wreck can be exposed to two very differing environments – the open seawater and the sediments of the seabed. In the open seawater sediment erosion, or scour, in conjunction with wood eating organisms (shipworms and gribble), can lead to the rapid deterioration of those upper parts of a wreck which are not covered

by sediment. However, if the wreck is totally buried in the seabed, the wood will not be degraded by these organisms due to limited dissolved oxygen in the water, which prevents their respiration. Instead, deterioration in the seabed is primarily caused by bacteria. Fortunately, these bacteria only degrade the celluloses and lignin within the individual microscopic wood cells that make up wood. However, they cannot totally degrade the compound middle lamella, which holds the individual wood cells together, and those parts that survive become filled with water, retaining the original form of the artefact. This is the case with the figurehead and wreck of the *Gribshund*. For the first, the waters in which she lies are brackish and the wood eating organisms like shipworm and gribble do not survive. Furthermore, it appears that the figurehead has lain inverted and buried in the seabed for most of the time since the ship sank and has only undergone very slow bacterial deterioration that is invisible to the naked eye. Thus, even though on the surface the figurehead looks well preserved, if it were left simply to dry, it would shrink and crack beyond recognition; hence the need for conservation (Gregory et al. 2012).

Prototype of the wood density profiler. Photo: Robert Pedersen, AKUT

FROM WET AND UNSTABLE TO DRY AND STABLE: ASSESSMENT AND CONSERVATION OF THE FIGUREHEAD

The aforementioned microbial attack usually means that the surface of the wood is soft, despite it appearing intact in dimension, shape and color. The surface feels very spongy, and a metal needle or nail can often simply be pressed by hand into the wood. This is because the bacteria have degraded the wood cell walls where, as mentioned, the substances lost are replaced by water as the wood breaks down. This phenomenon is reflected by the density of the wood; the more degraded the wood, the lower the density. To quantitatively

The Griffin head and the beam in the drained storage tank. The wooden pins and flags are placed in the holes where the density profiles were taken. Photo: David Gregory, Nationalmuseet

assess the density of the figurehead and facilitate its conservation, a non-destructive wood profiler newly developed by the Danish company AKUT and the National Museum of Denmark was used (Jensen, et al. 2017, see photograph on previous page).

The concept of the wood profiler is based on hammering a steel needle into the wood. Based on the correlation between the depth of penetration and the energy used to achieve this, a computer mathematical model determines the density profile. It has several advantages over existing technologies as it is only influenced by the wood density, not its anisotropy or species, and does not require samples to be taken. The prototype is suitable for both fresh (undegraded) and archaeological wood and can be used on land and underwater and in this case measurements were taken on the figurehead after it had been raised and whilst it was being held in a storage tank at Blekinge Museum. Seven 90 mm deep density profiles were made on the beam (see photograph above). The profiles (Figure 1) showed that the wood was degraded to a density of 200 kg/m³ at the surface, increasing to densities of 450 to 500 kg/m³ at a depth of 30 mm. At a depth of 35 to 40 mm the wood had the density of fresh undegraded oak wood, 550 kg/m³, indicating an undegraded central core. Based on data from Mikolaychuk (1996) and The National Museum it was

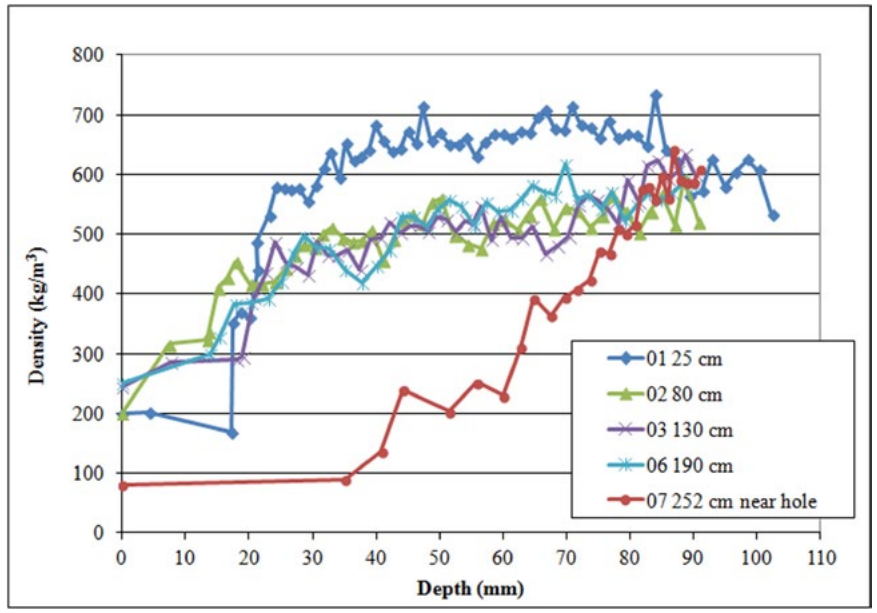

Figure 1. Example of density gradients measured on the figure head. The deeper in the wood (Depth [mm]) the better preserved the wood is as reflected by the increasing density (kg/m³)

judged that the outer degraded zones of the wood would shrink and collapse if the figure head was air-dried. Therefore, it needed a stabilising conservation, and it was decided to impregnate the figurehead with Polyethylene Glycol (PEG) 2000, a type of water soluble wax, followed by freeze-drying, as discussed below.

Prior to conservation at the workshops of the National Museum, the figurehead was examined for any traces of colour by the museum's colour analysis experts. It is rare to find traces of colour on wood that have been in the seabed. But the figurehead was found with the upper side buried in the seabed, and there were still lots of areas that had not been cleaned of sediment residues and there were areas showing smaller stains, that could be paint residue. Special analyses to detect any pigments and traces of binders were performed on the figure head. Around the figure's eye portion and ears a high content of lead was evident, possibly derived from pigment residues. High iron levels were also found in areas of the figure head, although iron may be a trace of ochre, it may also be contamination from the sea or corrosion from iron elements in the ship. Resin or wood tar which may have been used as a binder for pigments was also found. This indicates that the figure head has been painted but cannot definitively confirm how much was painted or how it was painted.

The figurehead is made of a single oak trunk, with the central part of the tree running through most of the figure. Objects of this type are the most difficult to conserve due

to the aforementioned risk of collapse, shrinkage and cracking. Impregnation with Polyethylene Glycol (PEG) 2000, followed by vacuum freeze drying reduces the risk of collapse of the degraded surface. Computerised 2-D simulations (Jensen et al. 1993) of PEG 2000 impregnation of waterlogged wood were made based on the correlation between the measured density and diffusion coefficients (Jensen 1996). Figure 2 shows the concentration of PEG 2000 as a function of time at depth of 28 and 40 mm. A 0.30 g/g concentration of PEG is necessary for satisfactory freeze-drying - which could be obtained after an impregnation time of at least 450 to 700 days.

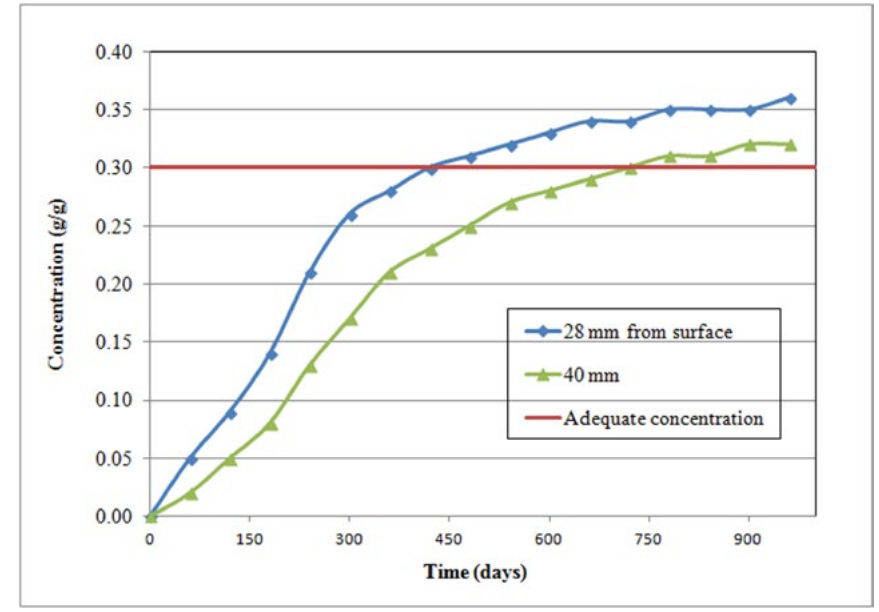

Figure 2. PEG 2000 concentration as a function of time at 28 and 40 mm from wood surface

By means of diffusion, the PEG molecules move into the cells of the wood and replaces some of the degraded wood material. Subsequent vacuum freeze drying ensures that all water is removed from the wood cells without deformation of the wood. On one of the hottest summer days in July 2018, after more than two years in the impregnation bath, the 250 kg heavy figure was lifted out of the conservation tank and moved to the freeze drying tank. Here, summer went abruptly to winter with a temperature of minus 28° C, where all water froze to ice and the PEG solidified. When a full vacuum is established in the freeze drying chamber, the ice evaporates. It is a safe and long-lasting method for drying waterlogged archaeological wood. For the *Gribshund* figurehead, the freeze drying phase lasted half a year. Following the vacuum freeze drying, excess of the white and waxy PEG 2000 was cleaned off the surface, cracks and loose fragments were glued and the figurehead packed in a purpose made crate for the safe return to Blekinge (see photograph on next page).

The figure head following conservation and ready to make the journey back to Blekinge.
Photo: Kristiane Strætkvern, Nationalmuseet

DISCUSSION

Although the figure head is an iconic artefact from the wreck of the *Gribshund* it is only a very small fraction of what potentially still lies on and buried in the seabed – the ship itself is estimated to be over 30 metres in length. In August 2019, small scale excavations were carried out in order to determine more information about the ship's construction. Numerous artefacts, including possibly the earliest arquebus (a form of long gun supported on a tripod or forked rest) recovered from a shipwreck, and indicate that there is a lot of the ship and paraphernalia belonging to the crew still preserved. The authors and staff at the National Museum hope to be able to continue the hitherto fruitful collaboration with Blekinge Museum, Lunds University, and Södertorns Högskola, who are responsible for the investigations, preservation and exhibition of this unique find. Afterall, it is our shared history.

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ILLUSTRATIONS

The photograph on page 49 is a detail of the photograph on page 54, photo: Kristiane Strætkvern, Nationalmuseet