Introduction

In 1962, the best preserved medieval cargo vessel dating from the 14th century was discovered in the river Weser, north of Bremen, Germany. After eight years of reconstruction and almost 20 years of conservation at the German Maritime Museum, the Bremen Cog was still a sensation when presented to the public in May 2000. With a length of 24 metres and a weight of 40 tonnes, the ship belongs to the class of large scale waterlogged archaeological wooden objects. The consolidant polyethylene glycol (PEG) was first used in objects of this size for pioneer projects (the warship *Vasa* in Stockholm, the Saudelsve ships in Roskilde and the *Bremen Cog* and subsequently further developed. Unfortunately for the Bremen Cog, one year after the opening the first deformation occurred. Corrections of the support system were planned, but not completed, as the scientist in charge Per Hoffmann retired in 2008 (Hoffmann 2011). It was only in 2014 that the author initiated the Bremen Cog’s deformation monitoring project.

Aim

Though the *Bremen Cog* was conserved over many years, deformation monitoring had not been considered previously. Any support system will have an impact on the ship’s integrity, therefore it is crucial to design the support with respect to conservation needs, while also taking into account ethical principles. Our deformation monitoring aims to acquire reliable geometrical data twice a year, in order to better understand the ship. Over time, the natural movements of the wood will be identified and distinguished from deformation that could lead to further damages.

Method

Considering the size of the object, 3D-technologies appear to be the most time-efficient and accurate solution to planning a long-term deformation monitoring system. Within the framework of the EU-COST Action “Colour and Space in Cultural Heritage”, data was acquired several times between 2014-2016 as part of a case study. During this initial phase three methods were tested: SFM photogrammetry (Fig. 3), 3D-laser scanning and total station-tachymeter (Colson et al. 2017).

In 2016, the author’s continuing work on the project was financed by the German Maritime Museum, through a three-year PhD-Fellowship. First of all, a critical evaluation of the data collected during the case study (Fig. 4) was conducted by the Institute of Applied Photogrammetry and Geoinformatics (IAPG), in Oldenburg, Germany. Based on that assessment, the decision was made to use photogrammetry. The collaboration went on to define various aspects of the monitoring such as resources (personnel and financial), accuracy and data management (archiving and software use). At the same time, Juri Schmik, a masters student of the IAPG, worked on the ground control system. Here, computer simulations, and control points placed outside the object of interest, are mandatory for the alignment and comparison of datasets over time (Schmik et al. 2018).

<table>
<thead>
<tr>
<th>Year</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photogrammetry (SFM)</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3D Laser Scanning</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total Station</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Laser Tracker</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Fig. 4. Overview of 3D acquisitions according to technology. A. Colson

Results

*Bremen Cog*

- Photogrammetry was validated as a method for deformation monitoring
- Procedure is reproducible (Fig. 6)
- Acquisition time: 2-3.5 hours
- Accuracy to better than 1 mm ensured by the ground control system (Fig. 5)
- Flexibility in data capturing stations, in case of a change in exhibition layout

Furthermore

- Collaboration between conservator and engineers was fruitful, leading to a partnership with the IAPG
- Creation of a European working group: “Monitoring of Preserved Ships” (MoPS)

Conclusion

The *Bremen Cog* project provided the opportunity to contact other museums dealing with the deformation monitoring of wooden archaeological ships on display. This led in 2017 to the creation of a European working group “Monitoring of Preserved Ships” (MoPS), initiated and coordinated by the author. Although the use of photogrammetry for deformation monitoring was controversial, we proved that it is a viable alternative. For now, the network of fixed points on the ship must be optimized and the ground control system checked to ensure its stability. In the future, data collected will be analysed and used to plan a new support system with the help of experts in applied mechanics from MoPS. Our 3D-monitoring protocol can be adapted to other large scale cultural heritage objects, and possibly become a standard methodology for preventive conservation.

References


Contact: Amundine Colson, PhD Candidate
German Maritime Museum, Bremerhaven
colson@bhm.museum
Research associate at University of Bamberg, Chair for Digital Technologies in Heritage Conservation

IIC’s 26th BIENNIAL CONGRESS 2018
PREVENTIVE CONSERVATION: THE STATE OF THE ART
Turin, Italy