THE WOODEN TRACKWAY PR6, ASCHENER BOG, LOWER-SAXONY, GERMANY

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ABSTRACT:

In northern Europe, wetlands hold valuable cultural heritage and enable the conservation of organic material. The region of Lower-Saxony (Germany) boarders the Netherlands in the West and the North Sea in the North. Until the era of cultivation and drainage large parts of northern Lower-Saxony were covered by bogs. Human populations have been living in this environment and developed strategies for crossings since the Neolithic period. There are about 500 wooden trackways listed in Lower-Saxony and several of them have been excavated.
The wooden trackway PR6 located in the Aschener Bog, district of Diepholz has been excavated from 2019 to 2021 in cooperation with the natural park Dümmer and the Lower-Saxony State Service for Cultural Heritage (NLD). The project aimed to study a segment of about 550m, which was endangered by peat mining.
The company DENKMAL3D (D3D) was contracted for the project and conducted the excavation on site supervised by Dr. M. Heumüller (NLD). Additionally, several staff members from D3D were involved in different capacity: 3D documentation, surveying, and conservation-restoration. This contribution shows the importance of interdisciplinarity in an archaeological research project involving organic material, which is very challenging to excavated and to conserve long-term. Which ethical decision had to be made and how did 3D documentation played a central role in supporting this process? The technical details will be presented as well as future perspective will be discussed and the following research project shortly mentioned.

1. INTRODUCTION

For thousands of years, raised bogs and mires were a formative natural area in north-western Europe. The region of Lower-Saxony (Germany) boarders the Netherlands in the West and the North Sea in the North. Before the cultivation of raised bogs began in the 17th century, around a third of the northern part of this region, around 6,300 km², was covered by bogs (Overbeck, 1975). Early on, the local population developed strategies to live in this region and built the necessary infrastructure. The construction of wooden trackways was the only way to safely enter the moors and to maintain communication between different settlement areas. More than 500 trackways are known to have been built from the Neolithic period to modern times in various construction methods, all made of wood. Different types of tracks were found in archaeological contexts based on how the wood is processed and cut for purpose (Fansa and Both, 2011).

In Lower-Saxony, the study of wooden trackways raised interest already in the beginning of 19th century. The oldest trackway is dating from 4,600 BC located in Campe Bog about 20km SSW from the Aschener Bog. The plank trackway PR6 is located in the raised bog of the Dümmer-Geest lowland north of lake Dümmer. The approximately 4 km long PR 6 trackway is one of the first trackways ever mentioned (Nieberding 1817). In this area, the different stages of peat exploration and the increasing destruction of the trackways can be exemplified.

After decades of peat mining the elevation levels around the trackway and the ground water levels could not be maintained, which was provided the best wood conservation conditions over almost two millennia. The decision was taken to excavate the segment which was the most threatened (Figure 1).

In this contribution the authors present how the wooden trackway was excavated and how 3D documentation was playing a central role during the three campaigns and beyond.

Figure 1. Overview Aschener Bog and PR6 (H. Furs, 2019)

2. EXCAVATIONS

2.1 Background

Due to peat mining and climate change, new excavations were once again needed. Between 2019 and 2021, probably the last archaeological investigations of the PR6 took place in the

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Aschener Moor near its northern end. In total, a 550 m long stretch was investigated. Thanks to European Regional Development Fund (ERDF) and further sponsors, the excavation of the threatened segment was funded. The association of the natural park Dümmer was coordinating the project. A total of € 698,300 was available for the whole project.
Dissemination was essential to make the results of the excavation tangible. Towards the end of the excavation, a 1 km long walkway was built explaining the archaeological site's significance and the ecological value of the moor landscape to the public. The visitor's walkway was to end with a viewpoint built as a platform on the so called "healing skin area", which contains the last preserved 400 m long section of the PR 6. Laying at a safe depth, this last section is intended to be preserve for the future and hopefully under satisfactory humidity conditions. At the same time, it should serve as a nucleus for the repopulation of the peat areas on which a new moor is to develop from 2025 onwards. The excavations were carried out by the excavation company DENKMAL3D (D3D) in cooperation with the Wetland Archaeology Department of the Lower-Saxony State Service for Cultural Heritage (NLD). Only the costs for excavation were covered by the project and any further analyses or conservation treatments were not part of the funding.

Conducting archaeological excavation in wetlands is challenging, since the access and the mobility on site is limited in the wet season. For that reason, the work could only take place from approximately April to October each year.

Figure 2. Zone 6 lower construction and zone 7 upper construction (H. Furs, 2019)

2.2 PR6 History

Few archaeological sites in Germany can look back on a research history of more than 200 years like the trackway PR6 does. It was first mentioned in 1817 in a report by C. H. Nieberding, which is also the first report on trackways in Lower-Saxony. In the late 19th and early 20th centuries, various, mostly smaller, excavations took place. From these investigations, the documentation done by the building inspector H. Prejawa deserves special mention. Between 1894 and 1896, he was commissioned by the Prussian government to comprehensively investigate and measure the trackway remains in the raised bog in the district of Diepholz. Thanks to him, the first precise cartography was conducted, providing an unprecedented overview of the trackways' route (Prejawa 1896). In his honour, the trackways of the region are named with the abbreviation "PR" for Prejawa. As a matter of facts, the PR6 was the 6th trackway he examined. Another quantum leap in excavation and documentation techniques followed with the investigations of H. Hayen, who between 1959 and 1987 excavated and documented large sections of the PR6 before their destruction by industrially operated peat mining. For the first time, the peat that had grown up directly above the planks was not removed with peat mining tools, spades or shovels, but by hand so that the sensitive timbers would not be damaged as well as any connected finds. Afterwards, the exposed section of the track was completely recorded in drawings and photographs (Hayen 1977, Fansa, Schneider 1997).

The exact course of the PR6 trackway is largely known. Uncertainties remain only about the exact southwestern starting point, which today has been destroyed by peat and sand extraction. It will therefore remain unclear whether the wooden track bridged 3.8 km or even 4.3 km.

Figure 3. Zone 2 lower construction and zone 3 upper construction (C. Melisch, 2019)

2.3 Methodology and staff

Although the wood looked well preserved the excavation had to be conducted step-by-step to prevent the wood to dry and therefore to decay. Zones of about 20-30m of length were opened at a time with a small excavator. Subsequently the wood was carefully freed by hand from peat. Each wooden element was numbered and the whole area was digitized (see 3D Documentation). Every plank was sampled for dendrochronological analyses, measured manually and eventually removed to the side. The samples were sawn with an electrical sawing machine and placed in individual plastic bags filled with water and vacuumed in a water bucket, for a better preservation of each sample. After the excavation and the removal of the upper construction, the documentation of the lower part could continue following the same procedure: 1) digital documentation and 2) manual documentation and sampling. After each working day, the wood was watered by hand using watering cans and the area was covered by tarp. When not protected the wood could have dried out in a few days, so that the shape and all relevant archaeological information would have vanished.

The team was composed of lead archaeologist (M. Heumüller), an excavation technician (E. Abbentheren) and up to 5 excavation workers. The lead archaeologist was coordinating the excavation and was present on a regular basis on site. Additionally, two surveyors (V. Platen, H. Furs, and later A. Schubert) conducted the digital documentation every one or two weeks. A conservator of archaeological object was supporting the excavation logistic and taking care of the finds (A. Colson). Except of M. Heumüller (NLD) the staff was provided by the company D3D.

2.4 Campaigns 2019, 2020 and 2021

The campaigns 2019, 2020 and 2021 provided numerous insights into the varied construction methods. The average track width varied from 2.6-2.8m, so that vehicles could drive on it. The remains of wooden carts, presumably pulled by cattle, were found several times along the trackway or between the lanes. The track structure is composed of two elements: the upper and the lower construction. The lower construction is made of at least two or more lines of wooden planks parallel to each other laying on the ground in the direction of the track. Their number varies depending on the load-bearing capacity of the bog surface. The upper construction comes on top with planks laying side-by-side perpendicularly to the lower ones. This upper construction had numerous variations: in particular in the central parts of the bog. There, broadly cut and neatly finished split logs were used, with square holes chiselled out at both ends and thus secured to the bog surface with pegs. Towards the edge of the bog, mostly simpler constructions were used. Here, the builders often used only simply split half logs, quarter logs or round logs without further finishing, or planks notched only on one long side. In certain areas, the planks were overlaid with wickerwork. Visually, some stretches gave the impression of a patchwork of wooden pieces put together from different types of constructions (Heumüller and Abbentheren 2022).

The wood determination is still ongoing and conducted by H.H. Leuschner and L. Shumilovskikh (University of Göttingen). But the first results showed that a wide range of oak, alder, birch, poplar/willow and maple were used as building material. Apparently, the builders cleared trees from different locations for the approximately 4 km long wooden construction. Mixed oak forests on the Geest[1], as well as alder and birch forests are widespread in the lowland of Diepholz. The distribution of the timbers depended on the strength of the trees and their species, presumably also on the technical features and preferences of different group of people involved in the construction (Heumüller and Abbentheren 2022).

The dendrochronological investigations (H. H. Leuschner) are still in progress. Nevertheless, previous results, carried out on a selected section of samples, have shown that the majority of these timbers were felled around 46 BC. Therefore, the trackway was probably built around this date or the following year. In at least one section, it was possible to prove that timbers dating from several decades earlier were reused. The logistical difficulties faced by the builders of the kilometre-long trackway were probably so great that they also removed and recycled timbers from an older plank trackway.

3. 3D DOCUMENTATION

Considering that the wood was originally to be entirely discarded, the documentation had to be as precise as possible. In order to ensure reliable geometry in an outdoor surveying context, 3D scanning was the preferred method. On top of that, the digital documentation was to be a support during the excavation to keep on overview on the on-going work. Additionally, the idea of a coloured model was very attractive for the visualisation and future analyses of tools marks or other construction traces. Since the effort was considered scientifically worth it, both 3D scanning and photogrammetry were selected to document the trackway digitally in three dimensions (Stylianidis et al 2016) (Grussenmeyer et al 2016) (Bentkowska-Kafel, and MacDonald 2017).

3.1 Data acquisition

The laser scanning acquisition was performed with a FARO Fokus S and a Leica RTC360 using target spheres as reference points. The instrument was moved to 8-10 different positions to cover each zone (20-30 m of length), and thus two times: one for the upper and a second time for the lower construction. The acquisition time was 0.5 person-day per zone (Figure 4). The scanning resolution was 6mm within 10m, considering the number of scans and the distance to the object a resolution of 2-3mm was reached. The registration combined the cloud-to-cloud and targets, made of spheres and checkerboards. Which leads all and all to an accuracy of ca. 7mm.

Figure 4. Zone 3 - 3D Documentation (C. Melisch, 2019)

For the photogrammetry acquisition, the images were acquired with a drone, either the DJI Phantom 4 or Yuneec H520. A total of 100-200 photographs for each zone were taken, one for the upper and a second time for the lower construction. The acquisition time was 0.5 person-day per zone, following the state of the art (Luhmann et al 2020).

3.2 Coordinate system

The coordinate system made of ground control points was measured in the excavation, which were then densified using the total station. The ground control points were established starting from a position and height reference system, measured by robotic total station GeoMax Zoom90. On top of this, the transverse Mercator reference system was used according to the requirements of the Lower-Saxony state authorities, to enable the link with old excavation documentations. All on site measurements were conducted with national coordinates. No local system was used.

3.3 Data processing and archiving

One person-day were needed for each zone and for each method, including acquisition and data processing. Which makes in total two person-days for 3D scanning and SfM together. The data was processed using Leica Cyclon for the laser scans and with Agisoft Metashape, for SfM, accuracy

[1] Landform raising above the wetlands made of sand and gravels, typical for the plains of Northern Germany, Northern Netherlands, and Denmark.

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dense model was ca. 7mm. The two different datasets were not merged and were saved separately. Nevertheless, the acquisitions were conducted simultaneously, using the same coordinate system, which would enable a data integration. The 3D models only cover 2D+ and not three dimensions. The data was archived on the company server with a volume of about 350 GB, including images and 3D data. Based on the acquires images, orthophotos were produced for each zone, which was printed on A3 providing an overview on the excavation. Thanks to the digital acquisition, the manual documentation: numbering and sampling was more effective.

Since the timbers were still laying in the sediment, it is without saying that only certain area of each wooden pieces could be documented and not the entire elements. Each zone was visualized together in a 3D model (see Figure 5).

Figure 5. Zone 9 upper construction (H. Furs, 2020)[2]

4. DISCUSSION

4.1 Ethical issues

In the field of archaeology, all professionals are conscious of the impact of excavation. The common adage being "excavation is destruction". Since archaeological cultural heritage is not renewable, it should be protected, surveyed, and documented as extensively as possible (ICOMOS 1990) (McGill et al 2012). Organic remains are rare and very precious, but when tonnes of wood are excavated, the question is what to keep? As much as it is ethically discussable to discard archaeological remains, the feasibility to conserve and store such delicate artefacts should be discussed before any excavation.

In the case of the wooden trackway PR6 a total of 50,000 planks has been estimated to cover the whole 4km of crossing (Fansa and Both 2011). It means that 6,250 planks would have been needed to cover 500m. Raising, conserving, and storing such an amount of wood or even exhibit it in any museum, would be hardly practicable. On the other the hand, the excavation was a unique opportunity to document the track with modern technologies and keep the data available for future generations.

Although the decision to discard the wood was not taken lightly, the guarantee of a precise documentation, made it more bearable and in line with current guidelines (Silver 2016). The dendrochronologist and conservation community were informed through different channels, but we received no further enquiry. Samples were taken from all substantially preserved wood for further analysis. The almost 6,000 wooden slices sampled are currently stored in a refrigerated container and are gradually being processed. For this purpose, samples of various parts differently constructed have been selected in order to draw a representative overview.

4.2 Conservation

Although wooden trackways are one of the most relevant archaeological and historical features of Lower-Saxony, only single planks coming from various sites are available in museum collections in the region. As far as we are informed, no complete section of wooden elements belonging to the same site are on display or in storage. Wood conservation is well established, but the costs remain high (Broda and Hill 2021). The wood was aesthetically in very good condition (see Figure 6), but the decay very advanced, so that certain planks were already soft as a sponge. In the case, a natural drying will cause irreversible deformation and destroy the planks. Only a conservation treatment can stop further decay and stabilise the original shape.

Figure 6. Zone 3 upper construction (C. Melisch, 2019)

Certain parts of the trackway were laying lower in elevation and could benefit from more ground water, as well as being better protected from a thicker layer of peat. Under these circumstances, less air got in contact with the wood and the biological decay was reduced. For that reason, the wood in these areas was extraordinary well preserved.

Considering the situation in the museum collections and the wood preservation grade, it was decided to raise some parts and to store them in water for further projects. In total of about 30 planks from two sections were raised in summer 2020 and in spring 2021.

Digital documentation is not part of standard procedures in the deformation monitoring of archaeological waterlogged wood, but certain initiatives on archaeological ships and boats showed promising results (Colson 2023).

4.3 Lessons learned

Interdisciplinary work in the documentation of cultural heritage is challenging and all actors must part of the process (Bentkowska-Kafel 2017). More cooperation is needed between the field of archaeology and conservation-restoration to enable smooth data and knowledge transfer from one project phase to

[2] Online 3D model collection – Bohlenweg Pr VI
https://skfb.ly/oGXox

the next. Thanks to the expertise of the different actors in geodesy, archaeology, and conservation-restoration, this interface was built and make further it possible for new ideas to emerge.

Nevertheless, more interactions between professionals in the documentation of cultural heritage should be supported to avoid unnecessary waste of time and resources (Hess et al 2018).

5. CONCLUSIONS

The excavation was successfully completed in September 2021. Guided tours were organized on a regular basis all along the three campaigns, even though the Covid-19 pandemic sadly affected certain activities. The visitor's walkway was opened in autumn 2021 to invite the local community and enhance tourism. The goal was to raise awareness on the relevance of wetlands in the regional landscape, as well as the history of the area. A series of dissemination activities was organized by the natural park Dümmer and the interest from the public was very high.

The excavation has yielded numerous insights into the varied construction methods and the wood analyses confirmed the date around 46 BC. The track itself is a unique testimony to a major construction project older than 2000 years. Further dendrochronological and scientific analyses are required. The wood used for the construction of the trackway holds a large amount of information on the natural environmental conditions as well as on anthropogenic influences. In connection with pollen analytical investigations, insights into forest dynamics, i.e. age structure, stock density, species composition and their spatio-temporal changes as well as agriculture and (forest) grazing management but also as forms of prehistoric forest management can be gained.

In addition, there are some exceptional organic finds such as broken pieces of axles and wagons, leather straps, footwear or measuring rods. Especially, the wooden measuring rods are unique finds that are only known from trackway PR6. It is not unusual that artifacts unknown from other contexts are occasionally found in bogs. The three-dimensional documentation of these objects as well as other analyzes are part of the ongoing evaluations.

Following the completion of the excavation, a research project was formulated to acquire funding for the wood conservation. The German Federal Environmental Foundation (DBU) accepted in autumn 2022 to fund a project focusing on the development of a three-dimensional monitoring protocol for waterlogged archaeological wood during conservation. The surveying expertise is provided by the University of Applied Science in Oldenburg (Professor T. Luhmann) and the conservation by D3D (A. Colson). As a matter of facts, the digital documentation continues into conservation, based on the data gathered during the excavation.

On top of this, we can say that thanks to 3D technologies, not only the documentation was very precise, but dissemination was more effective. The 3D models were sent to the different partners in real time during the project for follow-ups and the media was very keen on such images.

Thanks to the two datasets acquired with 3D scanning and SfM it will be possible in the future to merge the data and create a virtual walk on the 46 BC wooden trackway as a museum attraction.

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