Visualising complex dimensional changes of a wooden panel painting in Freising Cathedral

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A fundamental part of the conservation and restoration of cultural property is the creation of constant environmental conditions. In particular, the supply and removal of moisture can cause swelling and shrinkage of materials. Cultural objects are often complex and consist of many different layers, which have different hygroscopic characteristics. This means that layers will change their volume differently after a change in climate. Frequent climatic fluctuations place great stress and fatigue on cultural objects and can lead to (irreversible) damage (Bratasz 2013, Kilian, et al 2018). These fatigue phenomena can lead to damage such as cracks, deformation, or loosening, which can result in loss of substance or even complete destruction (Reichwald 2005).

Such damage phenomena could be observed on the wooden panel painting of the sacristy in Freising Cathedral. The large-scale work of art[1] by Hans Mair from Landshut, dating from 1495, has a deformed support made of wooden planks. Due to desiccation, particularly because of climatic changes in recent years, the wooden support has shrunk. The painting itself is an object made of organic composites, with layers of a variety of materials. These shrink and grow at different rates when moisture is added and removed. In this case, that led to large, roof-shaped paint layer peeling, as well as spalling. In addition, the panel slipped out of the surrounding decorative frame and deformed longitudinally and transversely.

In 2020 and 2021 individual areas were recorded in detail using structured light scanning to visualise any changes in direct comparison. Two characteristic areas[2] were selected to be monitored at approximately monthly intervals. These 3D-Scans were performed with a COMET L3D 5M Structured Light Scanner (SLS) with a 3D-point distance of 100 µm and mean object error up to 20 µm. To compare two scans, they were aligned and superimposed on each other and then the geometric deviations were compared. The concave and convex deviations of the scans from each other were then visualised in false colour images. These results were further contextualized with continuous

[1] Ca. 382 x 275 cm.
[2] Ca. 140 x 76 cm and 52 x 49 cm.

climate records. By the combination of these two information, the effects of short-term climatic fluctuations should become readable (Holl, et al 2021). It became apparent that the complex structure of the panel painting led to various difficulties in the interpretation of the results. Due to the varying fluidity of the individual wood panels, general statements regarding dimensional changes were made much more difficult. Strong deviations between the adjacent wooden panels show here that each individual wooden panel moved to a different extent and in a different direction (Fig. 1). Thus, movements of ± 1.0 mm can be seen here, in which the panels shifted both forward and backward. Especially in the joint in the middle, a movement of up to 0.8 mm can be detected. In this excerpt, the two panels seem to push each other forward.

Fig. 1. The wooden panel painting of Freising with the overlay of the superimposed false colour image shows the deviation between the two SLS-Scans from March 2021 and July 2021. Movements of approximately ± 1.0 mm can be seen. Red meaning a convex warping and blue meaning a concave warping (© Leander Pallas).

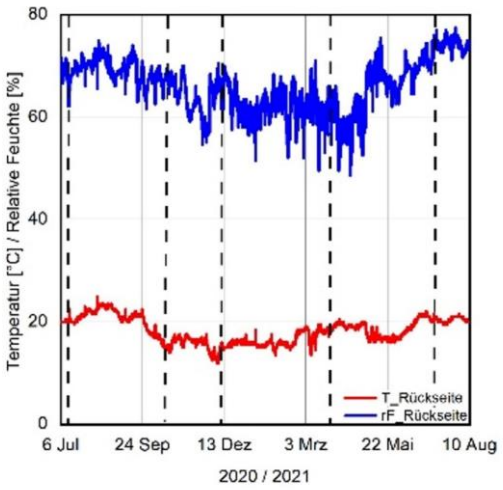

Fig. 2. The climate chart of the sacristy in Freising shows strong fluctuations in relative humidity in blue. The dotted lines show the times of the 3D-Scans. (© Kristina Holl).

Regarding the climate measurements of the recording period from March 2021 to July 2021, a strong increase in the relative humidity can be noticed (Fig. 2). Therefore, it seems to be a moistening process. This makes it apparent that only relative surface changes from one point in time to the next can be detected. Because the individual components of the panel painting all move differently, each of the wooden boards must be considered individually. This means that movement from one measurement to another can only be shown without interpretation in the case of directly adjacent timbers.

In a follow-up project, funded by the Deutsche Bundesstiftung Umwelt, starting in January 2022, the panel painting should now be moistened piece by piece in situ to relieve the painting layers. For this purpose, the University of Bamberg is carrying out an accompanying monitoring by means of high-resolution 3D scanning. This monitoring consists of monthly cycles of 3D scans using SLS. Additionally, two terrestrial Laser Scans (TLS) of the whole wooden panel painting were carried out in January and March 2022 to detect movements on the entire surface. The TLS recordings were performed with a FARO Focus S 350[3]. Then the two point clouds were aligned and superimposed on each other just like the SLS recordings. Just like before, the scans were contextualised using climate data. The climate between the two TLS recordings was characterized by severe dryness and it became apparent that there were serious movements in the panel painting. The superimposed comparison from January 2022 and March 2022 showed that on the right side, the panel painting moved backwards from the frame by up to 1.0 cm (Fig. 3), which could be observed using both SLS and TLS.

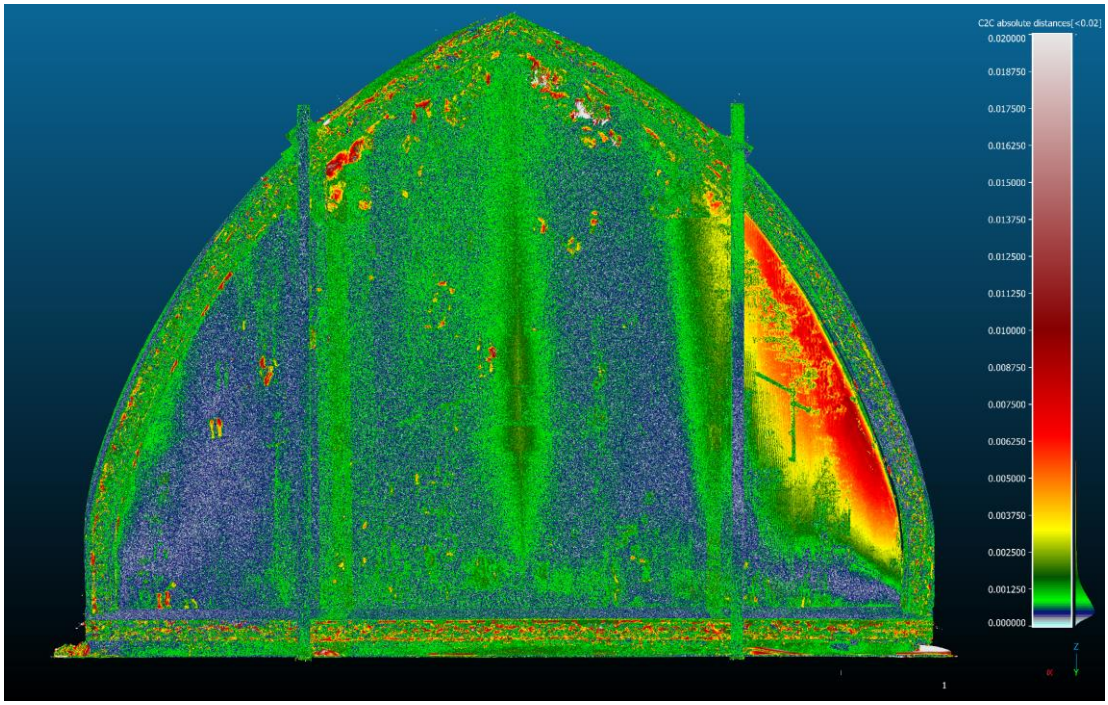

Fig. 3. The comparison of the two TLS-Scans from January and March 2022 shows a 1.0 cm movement on the right side (© Leander Pallas).

Using those comparisons, it was also possible to locate the right side as the location of the greatest movement. As a result, the timbers on the far right have moved backwards by about 1.0 cm. These scans are now contributing to a better understanding of the complex movements of this wooden panel painting and the monitoring will be continued to help the rehumidification process.

[3] 3D Accuracy 2.0 mm at 10.0 m, Ranging Error ±1.0 mm, Angular Accuracy 19 arcseconds.

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Conflict of Interests Disclosure

The authors assure, that there is no conflict of interest in this paper.

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Project Administration: Kristina Holl and Leander Pallas
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