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PAINTINGS

Strain measurements during structural conservation treatment and the long-term monitoring of a 17th-century Dutch panel painting

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In the past, conservation efforts to stabilize the movement of panel paintings often resulted in cradling. Such restraints may introduce stress-induced damage to the panels, such as permanent deformation, or even cracks and paint loss. To assess the condition of restrained seasoned wood and to help conservators make scientifically supported decisions while performing structural work, a deeper knowledge of the complex behaviour of wood is needed. A transdisciplinary international collaboration between conservators and photomechanical and wood scientists was initiated to perform a pilot study to monitor the mechanical responses of a panel painting during structural treatment. A painting from the collection of the Rijksmuseum, *Jacob Wrestling with the Angel* (1639), painted on an oak panel by the Dutch artist Bartholomeus Breenbergh, showed signs of damage induced by a cradle put on in the past. The cradle consisted of six cross-grain battens that were intended to be sliding but were completely immovable, and six fixed members running parallel to the wood grain. Concerns over cracks in the panel which appear to have been caused by restraint associated with the stiffness and dysfunctional state of the cradle supported the conclusion that the panel needed structural intervention. The method used for the monitoring of the panel was digital image correlation (DIC). DIC is based on digital image analysis in stereo vision, which uses a mark tracking method to measure out-of-plane displacements and strains of the panel. Reversible dots on the back of the panel served as reference marks. The relative dimensional responses in the wooden support are calculated by comparing a pattern from before-treatment images of the panel with images taken during and after structural treatment. All images were taken while the panel was in thermo-hygro equilibrium and a mechanically stable state at 53% RH and 21°C to eliminate dimensional responses caused by climate fluctuations. The monitoring procedure required a fixed set-up using two calibrated digital cameras suspended over the panel painting to capture the 3D displacement incurred during treatment. This mark tracking method also allows for long-term monitoring of the panel to measure the behaviour of the wooden support and its structural integrity over time. The results of the monitoring gave consistent information about the behaviour of the wooden support during every step of the structural treatment. This allowed for all individual steps of intervention to be assessed by conservators and wood scientists. The maximum deflection of the panel during treatment was 1.5 mm over 49.7 cm. The results of the monitoring showed that the panel had warped asymmetrically as a response to the removal of all – made sliding again – cross-grain battens. This could be explained by the partially delaminated state of the cradle on one side. After it had reached its maximum deflection, the panel went back to a less warped state. When removing the rest of the cradle, meaning the remaining – fixed – battens, the warping of the panel decreased even more. This proves that the panel was still restrained with just the – fixed – battens still in place.