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The mock-up: A complementary element to understand the mechanical behavior of cradled panel paintings

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Introduction

Using a mock-up, we aim to recreate the mechanical stresses applied to the panel during the thinning process and throughout the installation of the cradle.

The original panel

Pietà, Flemish painted oak panel, Church of Saint-Denis, Liege, Belgium, 1070 x 683 x 3 mm. 4 boards: quarter and half quarter cutting. 19th century cradle: 10 vertical uprights and 12 horizontal crosspieces, common spruce.



Fig.1. (a) Front and (b) back faces of the panel studied.

Materials and Methods

Historical Sources – 18th and 19th centuries:

MERIMEE, J.-F.-L., *De la peinture à l'huile*, Paris, ed.Mme Huzard-Vallat, 1830, p.260.

HORSIN-DEON, S., *De la conservation et de la restauration des tableaux*, Paris, 1851, p.36.

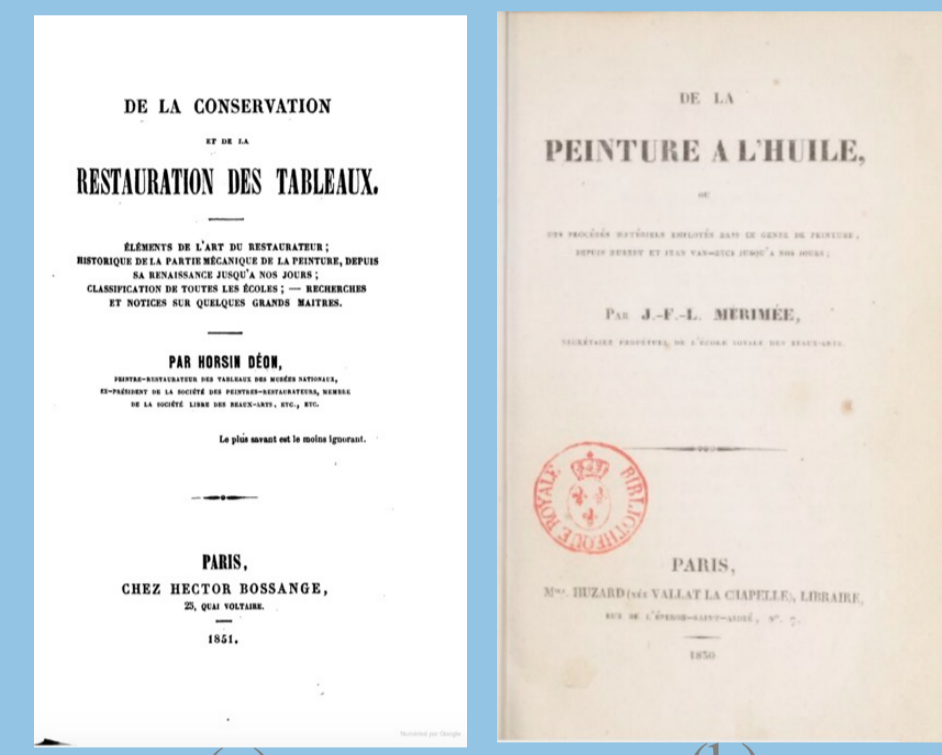


Fig.2a.2b. Two sources.

Three phases:

1 Manufacturing process.

- Selection of oak boards;
- Gluing: 10% fish glue / 100 ml of water;
- Preparation CaCO₃ and oil glazes.



Fig.3a. Thinning process.

2 Thinning process (Only panel 4b)

- Before: 2 months 43% RH / 19°C;
→ Deflection of 3mm.
- Thinning atmosphere: 80% RH / 24 hours;
→ Thickness 8 mm to 3 mm.



Fig.3b. Cradle process.

3 Installing the cradles.

- 7 fixed uprights and 9 sliding crosspieces;
- Gluing: 50% bone glue / 100ml water and press for 24 hours.



Fig.3c. Cradle process.

Difficulties

Homogeneity, precision, controlled glue application.



Fig.4a. Front and back, unthinned panel, 818 x 525 x 7 mm.

Fig.4b. Front and back, thinned panel, 1030 x 507 x 3 mm.

Methodology: 15% humidity variations, monitoring: 10 days / 9 months.

Results and discussion

The unthinned panel – 7 mm thick

➤ After 24 hours:
13 mm deflection.

➤ Over 9 months:
Deflection of 8mm
36% RH.

Blocked, no cracks.

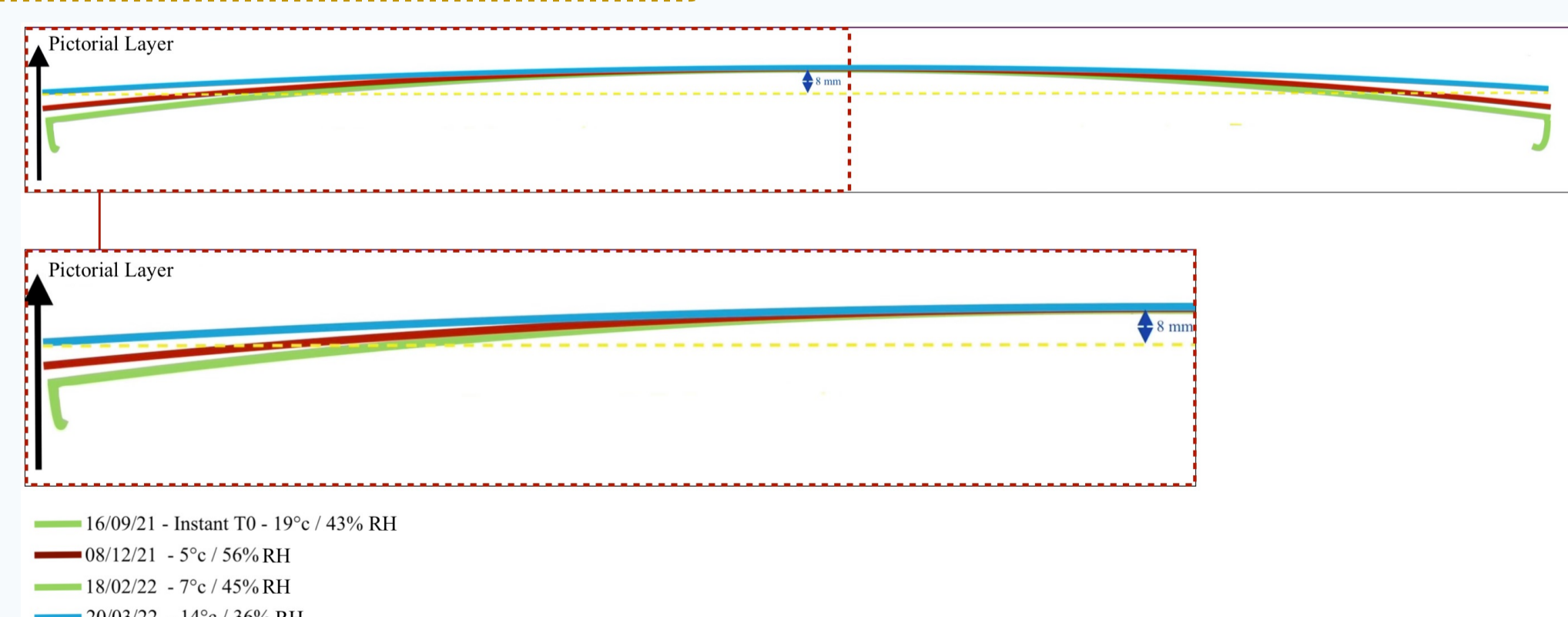


Fig.5a. Monitoring, unthinned panel Fig.4a.

The thinned panel – 3 mm thick

➤ After 24 hours:
Deflection 6 mm, sliding crosspieces.

➤ Over 9 months:
Constant curvature,
sliding crosspieces.

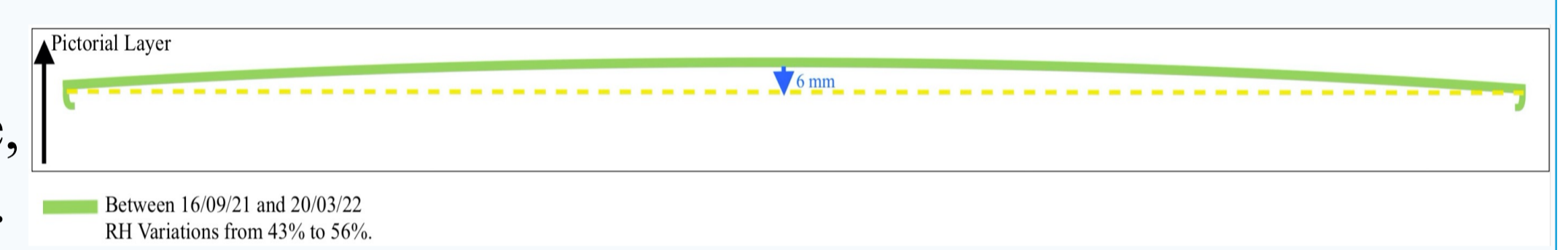


Fig.5a. Monitoring, thinned panel Fig.4b.

After 60 days:

First cracks of 70 mm and 90 mm: upper part of the panel.
Identical crack to the original panel (220 mm).

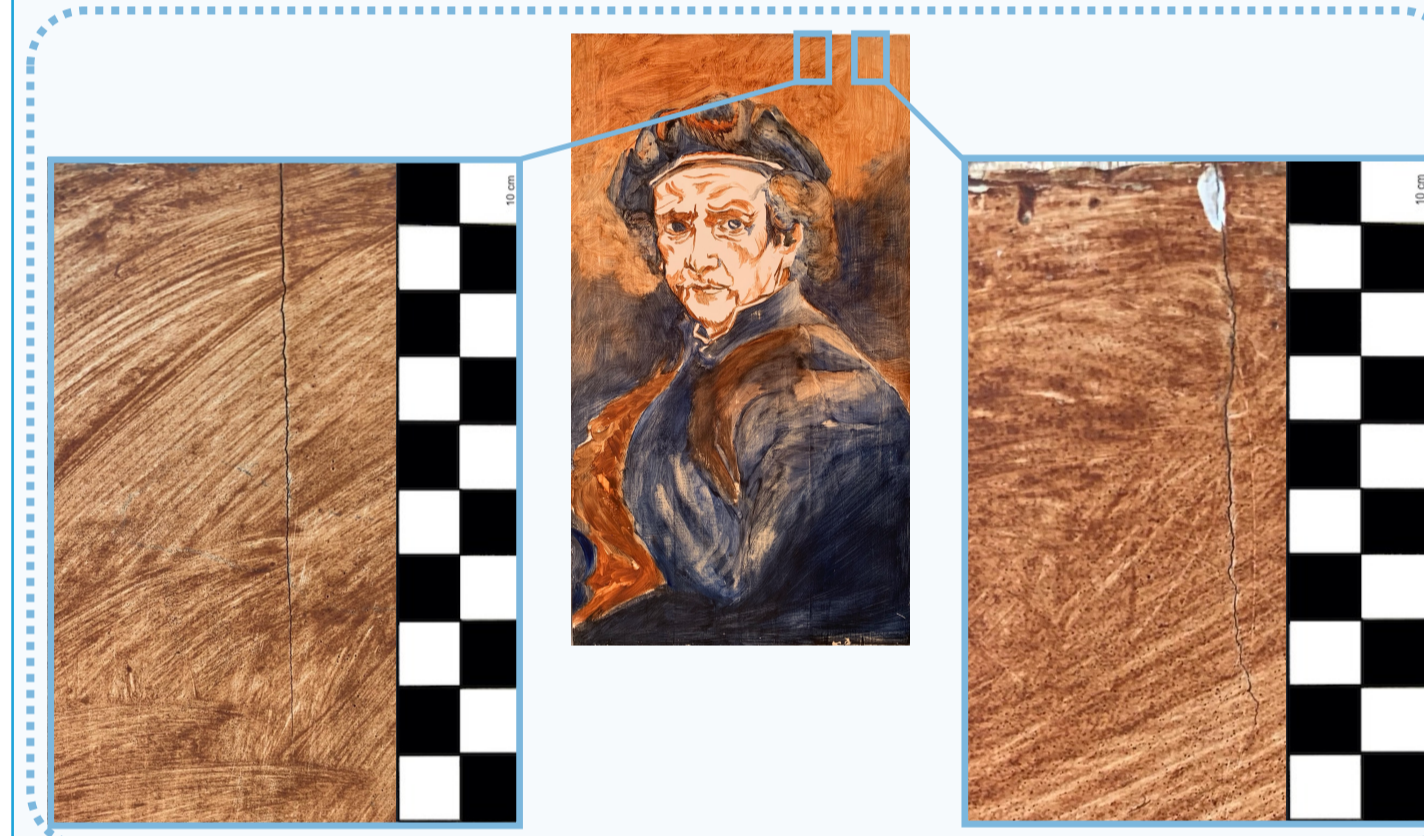


Fig.6a. Detail of two cracks - thinned panel mock-up.

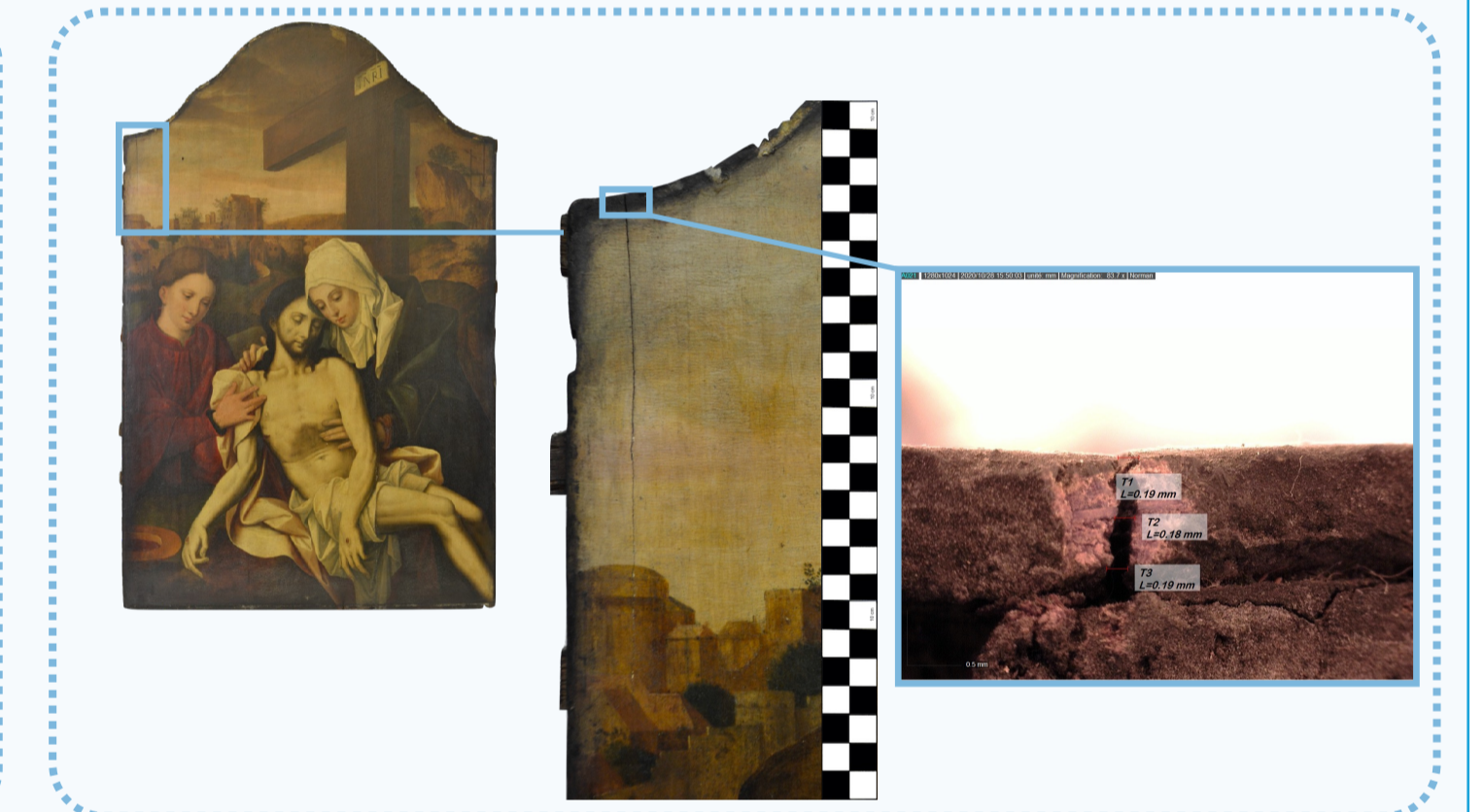


Fig.6b. Detail - crack on the original panel.

Understanding alterations

- Thinning process → Release of compressive, tensile and shear stresses.
- Installing the cradles → New supply of moisture, high compressive stress and crushing of the fibres.

The conservation conditions of cradled panels

Humidity variations ⇔ Compression Set
Heterogeneous swelling: areas under the uprights and free areas + Shear and compressive stresses

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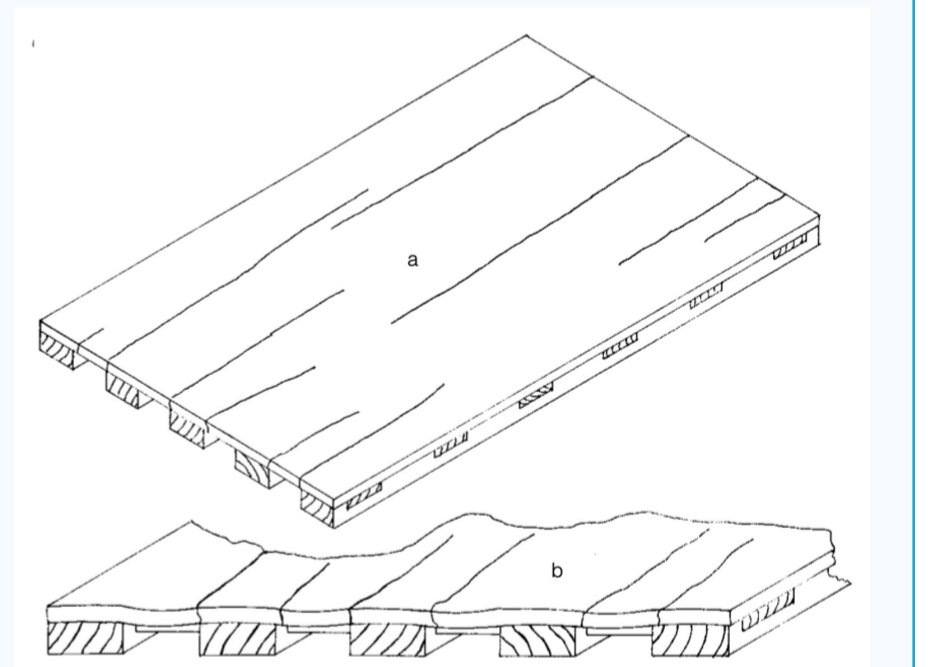


Fig.7. Fractures at the edges with the uprights. ©BOBAK, S. 1995

Conclusion

- Mock-up useful to mimic the effects of thinning process and cradle:
 - Mechanical behaviour of the panel depends on its **thickness**, cradle **density** and conservation **environment**;
 - Validation of a numerical approach by a mock-up instead of a historical panel.
- **Interdisciplinary work**, based on proven historical sources and new experimental data:
 - Difficulties of interpreting historical sources (vocabulary, glue).

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