Multi-Physics Modelling of Degradation in Historical Art Objects

Prof. Dr. Akke S.J. Suiker

Eindhoven University of Technology, The Netherlands

Date	**7 May 2026**
Time	**10.30–11.30**
Room	**2R, DICAM, Mesiano**

This seminar presents advanced modelling approaches for predicting degradation and damage in historical oil paintings, oak wooden cabinets, and paper artefacts, with particular emphasis on the combined influence of environmental conditions, such as relative humidity and temperature, and underlying chemical processes.

For oil paintings, a coupled chemo-mechanical framework is introduced to describe metal soap formation, capturing diffusion–reaction processes and their interaction with mechanical damage, including cracking and delamination. In addition, fracture mechanics analyses of layered systems are used to investigate crack channelling induced by environmental variations, highlighting the role of material properties and structural constraints. Failure mechanism maps are discussed as practical tools for defining safe museum climate conditions.

For oak wooden cabinets, a thermo-hygro-mechanical finite element model is presented that incorporates moisture sorption hysteresis, aging effects, and discrete cracking. The simulations demonstrate that relative humidity variations dominate the damage response, while aging reduces strength and promotes crack initiation, particularly in regions of restrained shrinkage.

For paper artefacts, a multi-scale degradation model is discussed that links chemical deterioration of cellulose fibres to macroscopic mechanical behaviour under environmental loading. This framework enables the prediction of long-term property evolution and lifetime. In addition, a parametric model forlocalized buckling (cockling) is introduced, capturing moisture-induced instability and identifying critical conditions for its onset and its development in the post-buckling regime.

Overall, the seminar illustrates how coupled multi-physics models provide a mechanistic basis for predicting damage evolution and for supporting conservation strategies through the definition of safe environmental conditions.

The seminar is organized by the Solid and Structural Mechanics Group [D. Bigoni, F. Dal Corso, L. Deseri, D. Misseroni, M.F. Pantano, A. Piccolroaz, N.Pugno, R. Springhetti]