Wooden objects in historic buildings

Effects of dynamic relative humidity and temperature

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Academic dissertation in Conservation, to be publicly defended, by due permission of the Faculty of Science at the University of Gothenburg, on Januari 26 2018, 1 P.M. at the Department of Conservation, the Auditorium, Geovetarcentrum, Guldhedsgatan 5c, Gothenburg.

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Abstract
Cultural heritage objects and interiors are found not only in museums but also in historic buildings, often with less climate control. The indoor environment in such buildings may be colder and more humid, and can fluctuate. The research presented here aims at better understanding the effect of such dynamic indoor environments on wooden objects housed in them.

There are five papers covering three complementary parts of this research project:

1) Paper I examined how existing recommended climate ranges are interpreted and used by the cultural heritage sector, using two risk-assessment websites. The risk for wooden objects was interpreted by the two websites using data from buildings with different degrees of climate control. The two websites showed low agreement for the risk of mechanical damage in historic building environments, suggesting that knowledge of dynamic environments and the influence of low temperatures are not sufficiently studied.

2) Papers II and III aimed to relate damage of painted wooden objects to past and present indoor environments in historic buildings, starting with whether such damage to painted pulpits in churches can be related to past and present energy consumption. The total heat output 1900-1990 was revealed from archives on fuel costs and heating systems of each church and used as a proxy for energy consumption. These data were correlated with damage assessments performed for the painted wooden pulpits in each of the churches. Results suggested that more damage, in terms of craquelure in the paint layers, was present in churches with a higher heat output and there was increased damage in churches which used background heating compared to churches which did not.

3) Papers IV and V aimed to record moisture diffusion in wood and hence the impact of dynamic environmental conditions. Various indoor environments were simulated in a climate chamber using the selected method to estimate the rate and distribution of moisture in wood over time. Low temperatures were shown to reduce moisture transport and increase response delay, resulting in a smaller mechanical impact on wood.

The thesis shows that low temperatures are beneficial for the preservation of wooden objects. While lower temperatures could help in saving energy on climate control in historic buildings, the results need to be validated. Further research projects are required linking field studies, laboratory experiments, analysis and modelling.

This doctoral thesis is based on the following articles:

I. **Bylund Melin, C.** Comparison of two risk assessment websites for evaluating the impact of indoor environments on objects. *[Manuscript]*

II. **Bylund Melin, C. & Legnér, M.,** 2013. Quantification, the link to relate climate-induced damage to indoor environments in historic buildings. In J. Ashley-Smith, A. Burmester and M. Eibl, eds. *Climate for Collections Standards and Uncertainties, Post Prints of the Munich Climate Conference, 7-9 November 2012*. London: Archetype Publisher Ltd.; 2013:311-323. Available at: http://www.doernerinstitut.de/downloads/Climate_for_Collections.pdf.

III. **Bylund Melin, C. & Legnér, M.,** 2014. The relationship between heating energy and cumulative damage to painted wood in historic churches. *Journal of the Institute of Conservation 37(2):94-109,* doi:10.1080/19455224.2014.939096

IV. **Bylund Melin, C., Gebäck, T., Heintz, A. & Bjurman, J.,** 2016. Monitoring dynamic moisture gradients in wood using inserted relative humidity and temperature sensors. *E-Preservation Science, 13:7-14.* Available at: http://www.morana-rtd.com/e-preservationscience/2016/ePS_2016_a2_Bylund_Melin.pdf

V. **Bylund Melin, C. & Bjurman, J.,** 2017. Moisture gradients in wood subjected to RH and temperatures simulating indoor climate variations as found in museums and historic buildings. *Journal of Cultural Heritage, 2017, 25:157-162,* doi: 10.1016/j.culher.2016.12.006

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