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Case study

Evaluation of display conditions of the Ghent altarpiece at St. Bavo Cathedral

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ABSTRACT

Due to an uncontrolled indoor climate or a poorly designed climate system, the environmental conditions in historical buildings are often suboptimal for the preservation of works of art. This is also the case for Jan and Hubert Van Eyck's Ghent altarpiece, which is located in one of the chapels of the Saint Bavo Cathedral in Ghent, Belgium. Years of poor conservation conditions have led to an urgent conservation treatment in 2010 and a conservation and restoration campaign that started in 2012 and will continue through 2019. In order to contribute to a better understanding of the state of preservation of the altarpiece and the display conditions and to assess damage risks related to the current location, this paper presents the results of a two-year monitoring campaign of the climate conditions in the glass cage in the Saint Bavo Cathedral in which the altarpiece is displayed. Based on the results of the first year, measures were taken to improve the indoor climate, including the installation of a local heating and humidification system. These new conditions were monitored during the second year of the measurement campaign and are representative for the display conditions today. The results of the second year showed that exposure to high humidity's was effectively reduced but conditions with large short-term humidity variations still occurred. However, given a correct management of the new heating and humidification systems, risks for mechanical damage may be largely eliminated.

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1. Introduction

The panel painting "The Mystic Lamb", painted by Jan and Hubert Van Eyck in 1432 is generally accepted to be among the most important surviving artworks in the world. The so-called Ghent altarpiece is exhibited in its historic location, the Saint Bavo Cathedral in Ghent, Belgium. A multi-year preservation project was set up when a thorough examination in 2008 raised concerns about the state of conservation of the altarpiece and the inadequate display conditions. After an urgent conservation treatment, an assessment of the condition of the altarpiece established the need for a full restoration treatment [1]. The restoration and conservation campaign of the Ghent Altarpiece started in 2012, whereby one-third of the panels is consecutively treated in a restoration studio in the Museum of Fine Arts. Although there are plans to rehouse the altarpiece and create optimal display conditions when a new visitor centre will be constructed in the cathedral [1,2], until that time the panels are still exhibited in the glass cage where they were housed since the 1980s, also the ones that have already been restored. Therefore, in 2011, some modifications to the exhibition chapel were made in order to reduce the most problematic variations in indoor climate.

In order to document the display conditions in relation to the state of preservation of the altarpiece, and to assess damage risks related to the current location, this paper presents the results and evaluation of an indoor climate monitoring campaign of the current exhibition space. The indoor climate was assessed using different criteria for conservation relating to the main cause of damage initiation observed in the altarpiece: mechanical response to climate fluctuations, with as result that the ground and paint layers of a panel painting tend to crack or delaminate with age [3,4].

ASHRAE's classes of control of indoor climate in museums are well known [5], not only as a prescription for avoiding various risks in new HVAC-designs, but also as an assessment of risks, given existing levels of climate control [6]. The classes of control

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Table 1
ASHRAE specifications for collections [5].

Set Point or Annual Average	Class		Temperature		Relative humidity		Risks
			ΔT_{short}	$\Delta T_{seasonal}$	ΔRH_{short}	$\Delta RH_{seasonal}$	
50% RH or historical annual average	AA		± 2 °C	± 5 °C	± 5%	No changes	No risk of mechanical damage to most paintings
	A	As	± 2 °C	+5 °C −10 °C	± 5%	± 10%	Small risk of mechanical damage to high-vulnerability artefacts
		A	± 2 °C	+5 °C −10 °C	± 10%	No change	
Temperature set between 15 and 25 °C	B		± 5 °C	+10 °C max. 30 °C	± 10%	± 10%	Moderate risk to high-vulnerability artefacts, tiny risk to most paintings
	C		< 25 °C (< 30 °C)			25–75%	High risk of mech. damage
	D		–	< 75%			Avoid mould and high-humidity deformations

define ranges of acceptable fluctuations of temperature and relative humidity (RH) for collections, as a function of the damage risk to the collection, including mechanical damage, based on a review of deterioration science (Table 1) [6]. To prevent risk of mechanical damage to most artefacts, seasonal changes or short-term fluctuations of RH should be at maximum ± 10% RH.

To come to a more specific assessment of microclimate fluctuations, the monitored data are further compared to criteria, which are derived from strain limits in the pictorial layers of the panels. Uzielli et al. [7] and Hunt et al. [8] emphasize that due to the specificity of each art work, in terms of geometry, structural characteristics and history, these criteria can only be defined in a reliable way by means of the simultaneous mechanical and microclimatic monitoring of the original panel paintings. However, since this data does not exist for the Ghent altarpiece, criteria available in scientific literature are used here, with the purpose to document the climate variations to which the panels have been exposed at different time scales in comparison to limits described in literature.

Lukomski [4,9] defined the yield point of the gesso ground layer as the safe strain level for the pictorial layer in a panel painting. Using experimental results of fatigue damage in gesso coated wood and numerical simulations, he showed that a sinusoidal RH-cycle duration of 14 days represents the most critical duration for 10 mm thick panels, while a duration of 90 days is the most critical for 30 mm thick panels. These thicknesses are representative for the side and central panels in the Ghent altarpiece respectively. Fracture of the gesso layer may not occur as long as the amplitude of the RH-cycle remains below 15% RH and 13% RH respectively.

Further, Bratasz et al. [10,11] established a method to calculate a climatological risk index for panel paintings based on the rain flow counting method [12], a method used in fatigue analysis. Using this method, they reduced simulated time series of relative humidity into simple RH-cycles of known damage impact. The definition of the risk index was based on 30-day averaged RH-values, a time span that exceeds the response time of 10 mm thick panels, and the range of 12% RH (or amplitude of 6% RH) was assumed as a very conservative threshold value for fracture of the pictorial layer.

Finally, EN 15757 [13] presents a methodology to specify acceptable temperature and RH fluctuations to limit climate-induced mechanical damage of organic hygroscopic materials, based on an analysis of the particular historical microclimate. When this microclimate has been proved not to be harmful, it should be maintained, except for improvements that exclude 14% of the largest historical fluctuations. However, since the historical display conditions had been shown to be inadequate [1], the EN methodology is not applied in this paper.

2. Research aim

It is the aim of this study to document the display conditions of the Ghent altarpiece in Saint Bavo Cathedral and contribute to a better understanding of its state of preservation, both in the original situation without climate control and in the modified situation which is representative for the display conditions today. It is the aim to assess potential risks related to the current location, using available criteria for conservation relating to the main cause of damage initiation observed in the altarpiece: mechanical response to climate fluctuations.

3. Monitoring campaign

3.1. Description of the case study

Since the 1980s, the Ghent altarpiece has been located in the baptistery chapel (Fig. 1, location B) situated on the ground floor in the western tower of the Saint Bavo cathedral. The altarpiece is housed in a bullet-proof glass chamber, called "shrine", constructed of 34 mm thick glass panels, mounted in a steel frame. The frame also contains the lighting system for the polyptych. Access by the public is only allowed during opening hours in the day, with sometimes up to 800 visitors on a daily basis.

Because of its negative impact on the display conditions, the original lighting system had been shut down and replaced by a temporary energy-efficient lighting system already in 2009. In February 2011, additional modifications to the baptistery were made in order to reduce the observed variations in indoor climate (Fig. 1). Between the baptistery and the cathedral, an airlock was installed to reduce draught. The air tightness of the shrine was improved by sealing seams between the glass panes and installing a climate barrier in the ceiling of the shrine. Radiant heating panels (6 × 1700 W) were placed at the ceiling of the baptistery in order to control temperature and reduce relative humidity during cold winter conditions. The heating system controls consisted of a room thermostat, with a set-point temperature of about 14 °C, aiming at tempering extreme conditions in winter. To avoid too low relative humidities at times of heating, a portable humidifier was installed in the shrine, with a set-point relative humidity of 40%. Until the moment that these modifications were made, the baptistery and shrine had never been heated nor conditioned.

3.2. Measurement campaign

The monitoring campaign in the cathedral started in February 2010 and lasted for two years. Data loggers of the Hobo H8 Pro Series were used for registering temperature and relative humidity with an interval of 10 minutes. The measuring accuracy of these

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