Preventive Conservation in Historic Houses and Palace Museums: Assessment Methodologies and Applications

SilvanaEditoriale

Preventive Conservation in Historic Houses and Palace Museums: Assessment Methodologies and Applications

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Preventive Strategies for Neuschwanstein Castle

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Abstract
Due to 1.3 million visitors per year, the interior decoration of Neuschwanstein Castle is not in a good state of preservation. It suffers from unfavourable climate conditions, the impact of unfiltered daylight as well as from dust accumulation and from the intentionally (touching) and unintentionally erosion of surfaces.

The first fundamental conservation-restoration campaign ever started in April 2017 and is scheduled to finish in 2021. It is embedded by various preventive strategies to reduce the impact of the visitors to a minimum and to increase the sustainability of the conservation works.

Previous years of climate-monitoring as well as the following comprehensive damage and risk assessment led to the development of mitigation strategies in order to improve the situation of the interiors:

• installation of an air-ventilation system using the hot-air ducts of the original heating system;
• installation of storage facilities;
• installation of a visitor-guiding path;
• installation of adequate light-protection.

The first part of the installation already started. The implementation of all preventive strategies will be completed in 2021.

Keywords
High humidity, condensation problems, light damage, dust, climate monitoring, visitors as moisture source, ventilation system historic air-ducts, low-tech depot.

"Fairytale-King" King Ludwig II started building Neuschwanstein Castle in 1868. Due to the early dead of the king in 1886 it was never entirely finished. Most of the decoration of the precious state-rooms was already completed (fig. 1), but a lot of the subordinated rooms are still in a brick-wall stadium.

Just seven weeks after the Kings passing the castle was opened to the curious public and has since been used as a museum. For this reason, the building and the interior originate from only one short period and are still in their original condition. Most of the unfinished rooms were transformed to offices and common rooms for the staff or into touristic facilities like toilettes and gift shops. With more than 1.3 million visitors per year, especially the interior is exposed to a massive

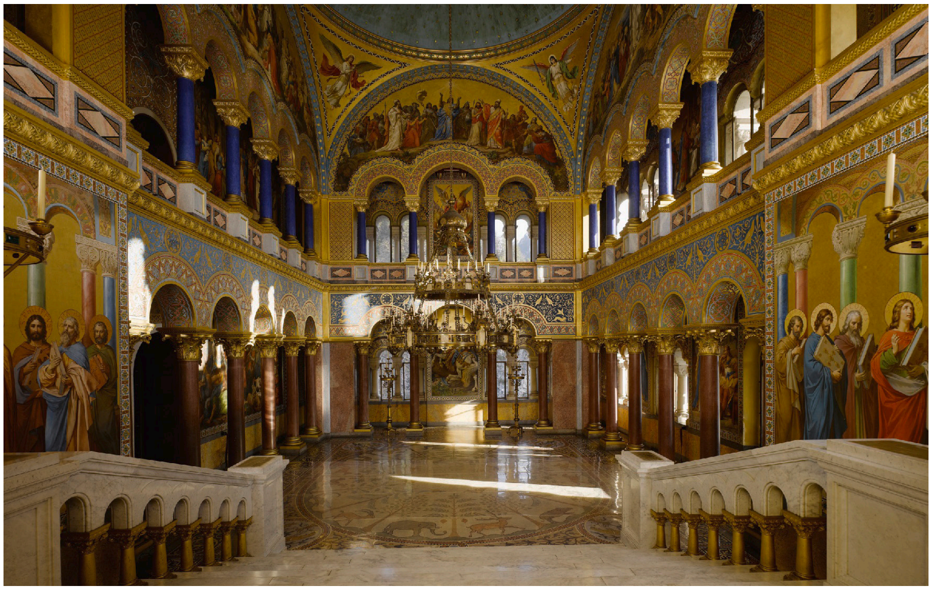

Fig. 1
Neuschwanstein Castle, Throne Hall. The Throne Hall is one of the most precious state rooms in the castle. (© Bayerische Schlösserverwaltung, Rainer Herrmann)

"usage-pressure." The interior decoration is not in a good state of preservation, suffering from unfavourable climate conditions and the impact of unfiltered daylight as well as from dust accumulation and the intentionally (touching) and unintentionally erosion of surfaces.

The climate indicated damages originate from a very high humidity. Condensation problems on the glazing and the outer walls were obvious, mould, salt damages and tracks of liquid water on wall paintings are common (fig. 2). Most of the fabrics on display show heavy light damages, from deterioration of colour to a complete loss of filament stability (fig. 4). Efforts to establish a better light-protection failed, because the need for fresh air for the visitors led to constantly open windows and therefore to direct sunlight exposure. Visitors produce a high amount of dust; textile fibres, skin flakes, hair and dirt trickle off people and sediment on the surfaces. Every dusting cycle "sands" the surfaces and leads to a loss of original substance. Most of the gilded metal surfaces and the varnished oak panels and furniture have lost their original cover over the past decades. To give back some gloss to the surfaces they were improperly treated with different non-siccative oils which embedded the dust completely; dark and sticky, even "furry," surfaces are the consequence (fig. 3). For years the barrier situation along the visitor path was insufficient, erosion because of touching and even vandalism is the result (fig. 4).

Since its opening to the visitors the interior of Neuschwanstein Castle has never been restored or renovated. The first ever conservation campaign started in April 2017 and is scheduled to finish in 2021.

As part of the damage and risk assessment preliminary climate data were collected. The previously mentioned condensation problems were

obvious on the first sight; following detailed surveying and mapping of the damages especially on the wall paintings identified not only the existing damages but also not apparent local touch ups notably on the outer walls (fig. 2). The big amount of damages and losses of the paint layer shows that the condensation is really a high risk for the wall paintings.

The climate monitoring confirmed the assumed desperate climate conditions: due to the fact that the castle is located in an alpine surrounding 900m above sea level, it faces quick weather changes, lots of rain and snow and very cold winters. The castle is unheated, the detected minimal temperature was -4.3°C, the highest temperature measured was 28.9°C. The range of relative humidity is extremely wide spread with daily fluctuations from 30% to 85% relative humidity (RH) (fig. 5).

The conservators aim is to reach a corridor from 45%-65% RH with daily fluctuations lower than 15% RH.

Despite the cold temperatures the castle has around 2000 visitors per day even in winter. In summer it is about 6000 per day. As a result of the bad air quality windows are kept open.

Evaluation of the climate data led to the conclusion that the absolute humidity inside is much higher than outside. The diagrams show that the daily rise of humidity is to 100% connected to the opening hours hence the visitors are identified as the main moisture source (fig. 6). As a result of the high humidity level condensation problems occur leading to big damages on the wall paintings, showing salt problems, mould, etc. On freezing cold winter days the condensed water leads to formation of ice on the surfaces of the cold windows and outer walls (fig. 7).

It is a well-known fact that the presence of visitors increases humidity levels in sites. Nevertheless the high level of the impact is remarkable. Evaporation of humidity from humans originates from the

Fig. 2
Neuschwanstein Castle, Singers Hall, southern oriel. Vis- and UV-picture of the wall painting. In visible lights salt damages, flaking and already lost paint layer are the obvious damages. The different UV-fluorescence shows various phases of local retouches and repairs. (© Bayerische Schlösserverwaltung, Armin Schmickl)

Fig. 3
Neuschwanstein Castle, Dressing Room, wood panel and carved door frame. Years of improper treatment with non-siccative oil led to a sticky surface with embedded dust. (© Bayerische Schlösserverwaltung, Tina Naumović)

Fig. 4
Neuschwanstein Castle, Dining Room. The fabric on the upholstery shows heavy light damages. Formerly the silk was pink, the colour faded via a light rosé to beige. The original vivid colour now can be found only at one area, which was light-protected by an (now stolen) appliqué. (© Bayerische Schlösserverwaltung, Tina Naumović)

Fig. 5
Neuschwanstein Castle, Living Room. Climate sheet showing temperature and relative humidity during 2012. The highlighted green area shows the corridor of 45-65% relative humidity, which correlates to the corridor liked to reach. (© Bayerische Schlösserverwaltung, Tina Naumović)

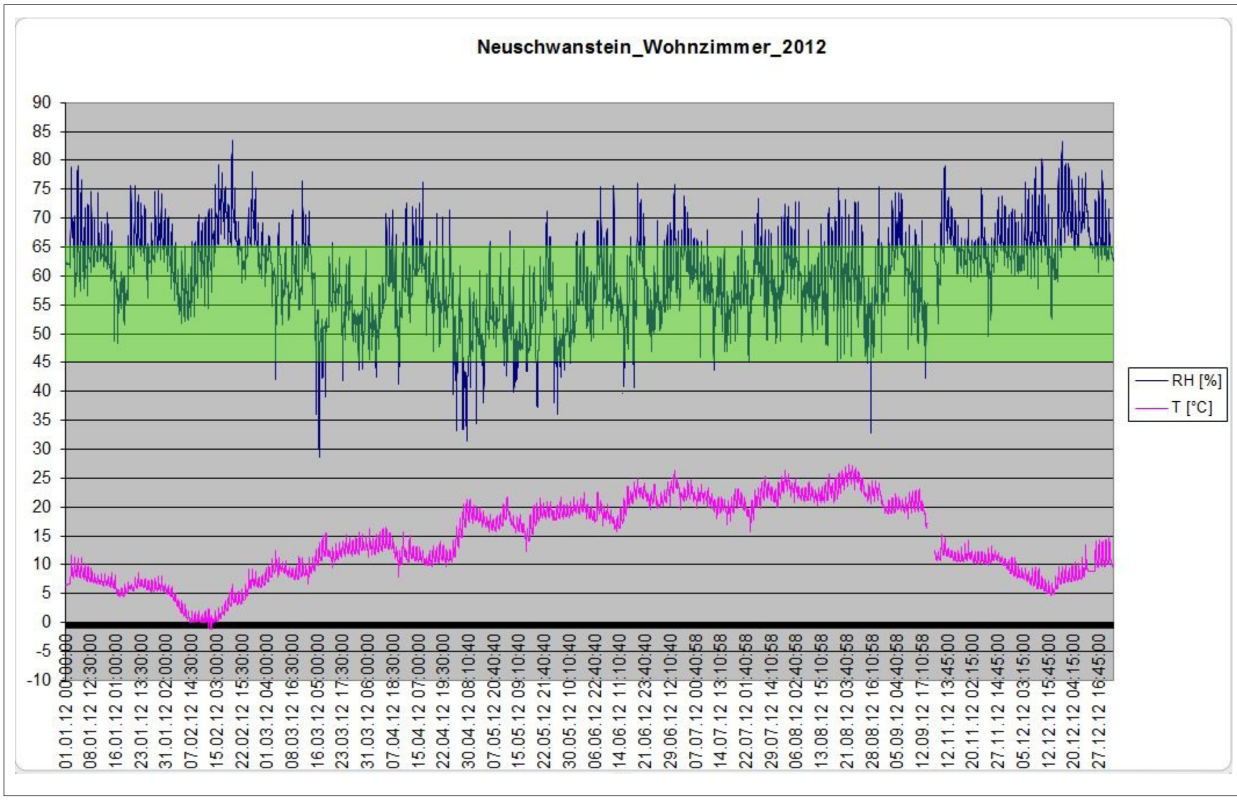

Fig. 6
Neuschwanstein Castle, Living Room. Climate sheet showing the absolute humidity inside and outside in February 2014. The daily rise of the humidity level is entirely connected to the opening hours. Outside the absolute humidity is much lower. (© Bayerische Schlösserverwaltung, Tina Naumović)

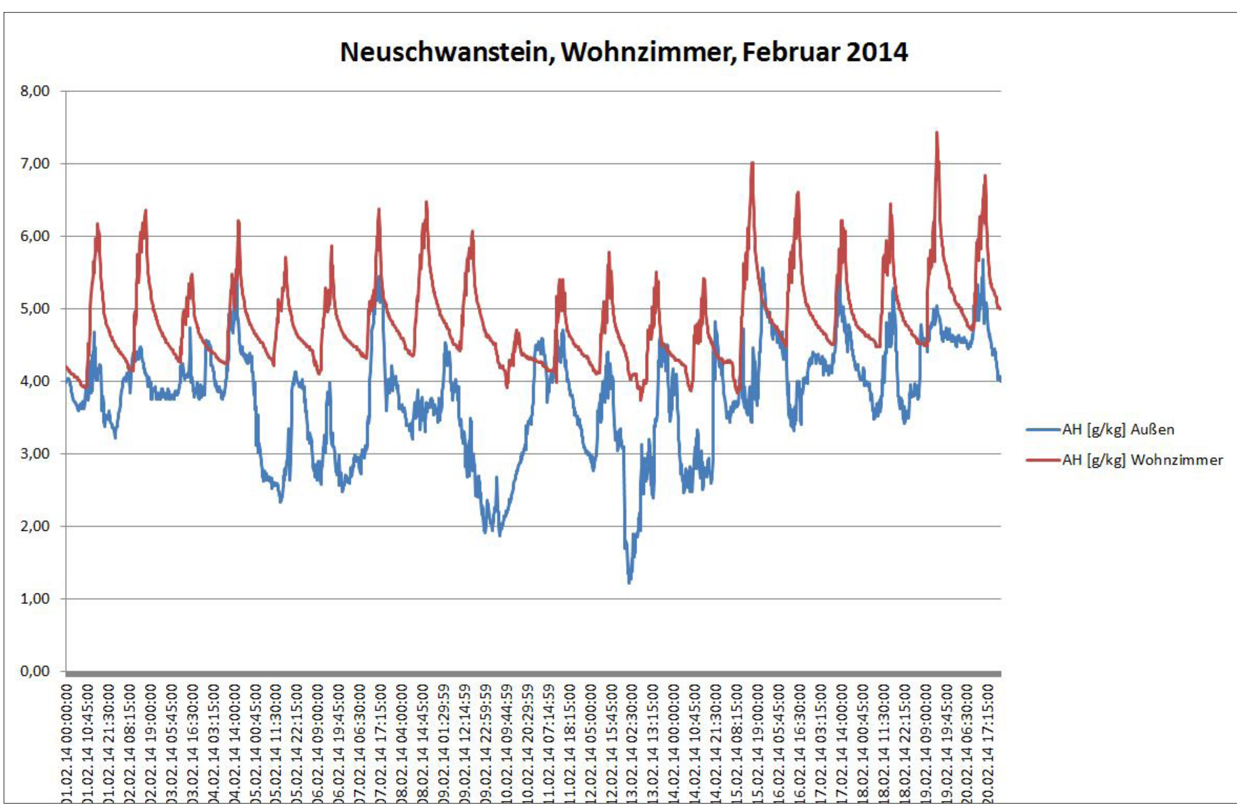

Fig. 7
Neuschwanstein Castle, Living Room, northern oriel. Ice formation due to condensation problems on the painted surface of the outer wall. (© Staatliches Bauamt Kempten, Ralf Gehrke)

metabolism, thus breathing and sweating. In addition, visitors have to enter with their wet jackets and soaked umbrellas on rainy days, because there are no lockers or cloakrooms installed. Due to the visitor tour new facilities cannot be established: entrance and exit are far away from each other to cope with the endless stream of visitors. The threat to the climate conditions in the castle through the wet clothes seemed very obvious on the first sight. Unexpectedly the matching of the climate-data of rainy and sunny days did not show a significant difference.

To develop the most effective mitigation strategy, the Fraunhofer Institute for Building Physics was asked to carry out a comprehensive analysis about the impact of dry visitors compared to wet visitors.[1] Implementing an improved climate monitoring system, tools of climate modelling and test series the Fraunhofer came to interesting results (fig. 8).

The high level of absolute humidity compared to the outside was confirmed and transformed into the absolute amount of water carried inside by visitors. Only for the throne hall there is an impact of more than 13 tons of water per year. Ten tons are caused by the metabolism, only three tons are caused by wet clothes. The practical recommendations were to higher the air exchange rate with the outside air, which mostly is less humid than the air inside. In case that the environmental conditions are inadequate, dry air has to be produced to achieve a sufficient climate control. As a consequence, the installation of a ventilation system with fresh air ventilation, dehumidification and slightly heating was suggested as best solution for the state rooms. The goal is to soften the impact of the visitors in stabilising the relative humidity. To reduce the amount of imported water from the wet clothes, the visitors should be "blow-dried" in the waiting section before entering the state-rooms.

The biggest challenge of installing a ventilation system in historic buildings has its roots in avoiding to ruin the building along the way,

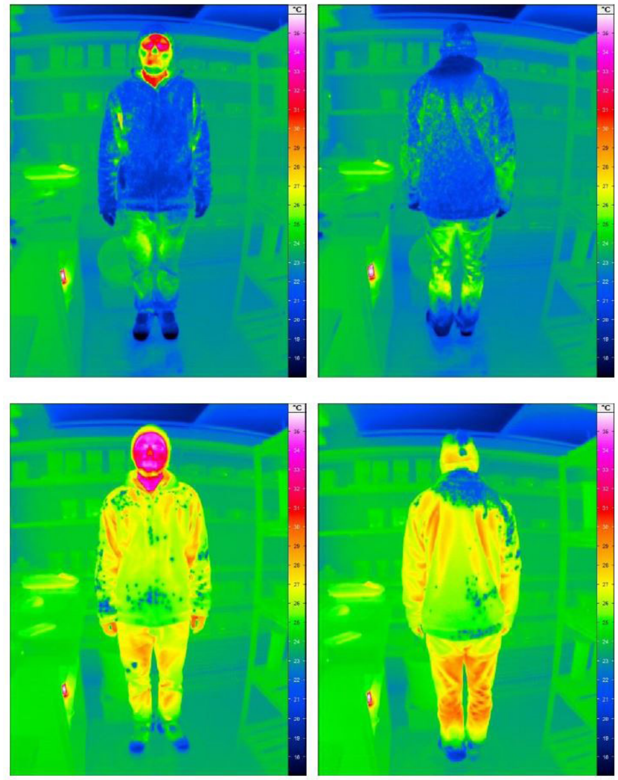

Fig. 8
Research report "Bauphysikalische Voruntersuchung und Klimadatenauswertung in Schloss Neuschwanstein," Fraunhofer IBP, Stefan Bichlmair und Martin Krus, Valley 2016. Infrared picture of a sprinkled volunteer in a climate chamber. The changing surface temperature because of the cooling by evaporation from the wet clothes is shown in different colours. (© Fraunhofer IBP, Stefan Bichlmair und Martin Krus)

especially in the state rooms of Neuschwanstein Castle which, so far were untouched by building services. For this reason a clear guideline has been established: the priority in planning the ventilation system will not focus on the climate conditions that conservators find appropriate as a museum standard (20 °C / 50% RH) but on the possibilities the building structure is offering. The popular idea of installing massive air-ducts to connect every room with a central HVAC-system in the attic or basement was definitely no alternative.

Fortunately, Ludwig II already installed an inventive hot air heating system including three heating chambers and several hot-air-ducts leading to the main state-rooms. Obviously the still existing technical equipment in the heating chambers is declared as technical cultural heritage and has to stay untouched. At the moment new technical rooms are established in the undecorated unfinished floors in the castle (fig. 6). For the involved engineers the development of the ventilation system was quite challenging because the building structure determines the size of the technical devices.[2] Ventilation, dehumidification and fire protection flaps have to be squeezed in the historic construction in a minimal invasive way.

The installation of the ventilation system in the state-rooms will be completely finished by the end of 2018; hopefully its effectiveness can be proved during 2019. The ongoing climate monitoring will escort the implementation of the ventilation system to ensure that the indoor

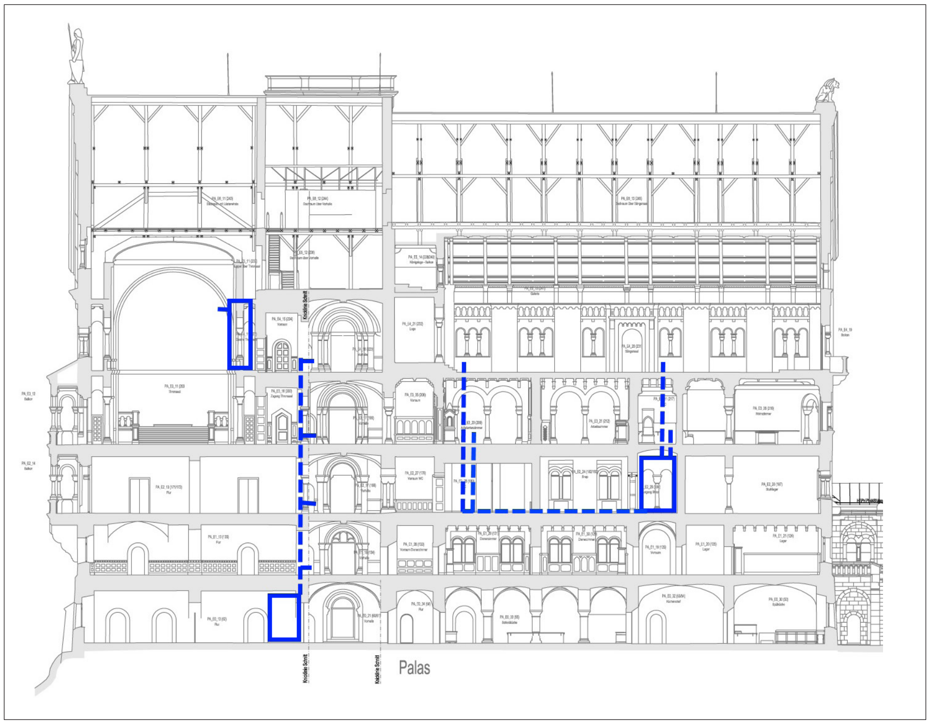

Fig. 9
Neuschwanstein Castle, longitudinal section. Three new technical rooms are established to reach the historic hot-air ducts on the shortest way. (Longitudinal section © Staatliches Bauamt Kempten, Josef Linsinger)

Fig. 10
Neuschwanstein Castle, Ritterhaus, new storage. Unfinished rooms are turned to low-tech storages. Conservation heating and dehumidification will keep the RH under 65%. (© Bayerische Schlösserverwaltung, Heiko Oehme)

climate is affected in the right way.

In addition to the ventilation system in the state-rooms a hot air-heating system has been installed in the waiting section. While queueing for audio-guides and the start of their tour in the undecorated waiting corridor prior to the state-rooms, the visitors get “blow-dried.” The system is in charge since February 2018 and although needed climate gates are not yet constructed and the evaluation of climate data is still in process, positive effects are striking: on rainy days the floor is no longer soaked with water, the absolute humidity is lower and on top the visitor comfort in the former cold, wet and windy corridor has improved a lot.

Another example for the aim of a low-tech solution for climate stabilization in the castle is the construction of the new depot. While preparing the conservation-restoration campaign it was obvious that the storage condition for the pieces of art have to be improved. A lot of textiles and furniture are placed into stock to save them from touching and to get enough space for the guided tours. Although the storage situation has "grown" over many years and was therefore a bit chaotic and undefined the climate monitoring in the unvisited rooms showed mostly satisfying climate conditions regarding a stable and mostly adequate relative humidity (45%-65% RH). A new depot was established in an unfinished part of the castle in 2017/18 (fig. 7). For climate control an electric heating cable for *conservation heating* was installed along the outer walls, an insulating cover was put on floor and ceiling and two mobile dehumidifiers were mounted. These devices guarantee low climate fluctuations and help to avoid relative humidity over 65% in order to eliminate the risk of mould for the textiles.

More preventive preparations are currently planned. A visitor-guiding-path which includes a "touch protection" (handrails/glass walls) and a dust-absorbing carpet will be installed after the restoration is finished. It will help to reduce dust-accumulation and to protect the original wooden floors from erosion as well as the artworks and decoration from touching.

The development of an adequate light-protection to eliminate UV-radiation and to reduce daylight exposure is in process; long lasting and elaborate test-series on different UV-protection-films and the non-destructive mounting of light protection screens via magnets on the iron window frames are carried out.

It will take several years to show the effectiveness and sustainability of the applied preventive strategies, though the first results are promising. The close collaboration of architects, engineers and conservators led to satisfactory results on all sides.

Endnotes

[1] Research Report, *Bauphysikalische Voruntersuchung und Klimadatenauswertung in Schloss Neuschwanstein*, Fraunhofer IBP, Stefan Bichlmair und Martin Krus, Valley 2016.

[2] The ventilation system was planned by Büro Jochen Käferhaus, Vienna, in close collaboration with the building authority Staatliches Bauamt Kempten.

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