Preventive conservation strategies for organic objects in museums, historic buildings and archives

Elin DAHLIN

Summary

Preventive conservation strategies should be the responsibility of all museums, but it will take a long time before these strategies will become a part of a museum's daily routine. So far the monitoring of light, relative humidity and temperature have been commonplace but there is very little knowledge about the deterioration processes of the objects, especially of objects made of organic materials. The impact of the indoor environment that organic objects are exposed to remains to be assessed. This paper presents the main environmental risk factors and some examples from projects dealing with the development of new preventive conservation strategies.

Introduction

All over Europe a broad range of cultural property in museums, historic buildings and archives is being affected either by display or by storage conditions. The key to the survival of these objects is achieving an acceptable indoor environment. Vital to this is the sustainable management of the cultural property, which includes preventive conservation strategies defined by ICOM (ICOM, 1991) as follows:

'The provision of suitable environmental protection against the known natural or artificial causes of deterioration of museum specimens and works of art'.

Preventive conservation began to be recognised as a distinct discipline of conservation in 1975 when ICCROM was among the first to offer courses on the topic (PUTT, 1999). The main aims of preventive conservation have also been well described by May Cassar in her book 'Environmental Management' where she points out that preventive conservation, which should be the responsibility of all museums, has two important aspects: *The technical,* dealing with monitoring and controlling the museum environment, and *the organisational,* involving all staff working in the museum (CASSAR, 1995).

The aim of this paper is to present the state-of-the-art of preventive conservation strategies for organic objects in museums, historic buildings and archives and to present some examples of projects dealing with this topic.

State-of-the-art of preventive conservation

Recapitulating the EC-funded research, it was not until 1991 – and the STEP initiative within the 2nd EC Framework Programme, that projects began to focus on the effects of indoor environments on organic materials such as leather (LARSEN, 1997) and paper (HAVERMANS, 1997). The results from these and other projects were presented in 1994 at the EC Workshop, 'Effects of Indoor Environments in Museums', which was the first large meeting dealing with the protection of indoor cultural heritage in Europe.

However, 'Preventive Conservation' as a research area was not included as a Key Action in the EC research programmes until 1999 in the 5th FP, Key Action 4.2.2:

'Preventive Conservation Strategies for Indoor Cultural Assets'.

Even since, however, there has been a gap between preventive conservation work in museums and the awareness of implementing results from research (e.g. EU research projects) into preventive conservation strategies.

Thus, there is still a long way to go before preventive conservation will be a part of daily routine in museums, historic buildings and archives. Up till now the monitoring of light, relative humidity (RH) and temperature has been commonplace, but there is, however, very little knowledge about the deterioration processes of objects, especially of objects made of organic materials. Preventive conservation strategies will involve the application of knowledge, skill and judgement to achieve the right balance between the need to protect the heritage and the increasing demand for access or use.

Organic materials such as leather, silk, paper and wood form a large proportion of the total number of heritage assets in museums and historic buildings. They are not only a significant part of Europe's moveable cultural heritage, but they often cover the internal surfaces of historic rooms in the form of wall hangings, wall coverings, curtains and carpets. These objects are prevalent in historic buildings preserved with their original contents that are found throughout Europe. These materials are considered to be among the most vulnerable to deterioration and the following types of impact may be observed (BRIMBLECOMBE, 1990; BLADES, 2000):

- Paintings: Discolouring, cracking and soiling.
- Textiles: Reduced strength, fading and colour change.
- Paper: Embrittlement and discolouration.
- Wood: Cracking, rotting and surface powdering.

– Leather: Weakening and surface powdering.
– Rubber and polymers: Cracking and fading.

For this reason, leather, silk, paper and wooden objects in museums have traditionally been presented to the public in display cases. In historic house museums on the other hand, organic objects have always been placed in open displays because their historic context within a room is considered to be as important as their preservation. In order to protect the latter objects from deterioration it is important to be aware of the risk factors and to develop an appropriate preventive conservation strategy.

What are the risk factors?

The impact of the indoor environment in which organic objects are exposed has to be assessed by evaluating the risks posed by the overall environmental conditions on site.

The main environmental risk factors in the indoor environment of museums, historic buildings and archives are:

– *Climate;* inappropriate humidity, temperature and light.
– *Gaseous and particulate pollution,* outdoor and indoor sources.
– *Microbiology*.

Climate

Relative humidity, specific humidity, temperature and light are all important factors that are habitually monitored in most museums, historic buildings and archives today. Limiting relative humidity fluctuations is important in the preservation of organic materials. Organic materials should be stored at appropriate relative humidity (RH) ranges between 40–70 % (ERHARDT, 1994). Light and ultraviolet radiation are monitored for light-sensitive objects (THOMSON, 1986). Studies of the microclimate and air velocity have been done in several museums and historic buildings (CAMUFFO, 1983; CAMUFFO, 1998; BRIMBLECOMBE, 1999). Results from several studies have shown that the indoor climate is impacted by: wall thickness (insulation), air leakage, ventilation systems, heating, solar radiation and the number of visitors.

Gaseous and particle pollution

In defining indoor air quality in museums there is a focus on the following components; SO_2, NO_X, O_3, H_2S, soot, acid and alkaline particles, HCHO, and volatile acids. For organic materials, SO_2, NO_X and O_3 are the most hazardous gases (BAER, 1985; BRIMBLECOMBE, 1990). Results from monitoring in museums show that indoor concentrations of outdoor pollutants depend on building type and use. For example, results from monitoring both the inside and outside of the Historic Museum in Oslo, Norway, show that NO_X values were found at equal amounts indoors and outdoors, while the SO_2 concentration indoors was reduced compared to the outdoor values (DAHLIN, 1997). From the monitoring of ozone in museums in Cracow, it was found that museums rapidly ventilated, through many open doors and windows, obtained indoor ozone concentrations of about 42–44 % of the outdoor values (SALMON, 2000).

Microbiology

Fungal attacks on objects on display in exhibitions or stored in depots with high humidity have long been a problem in many countries. Some researchers and conservators have found that bacteria may also present risks (BRIMBLECOMBE, 1999).

Museum collections are also at risk from handling and use of the objects and from different activities within the museum. The impact of visitors may cause environmental implications to the objects and the building. For example, the presence of humans may alter the conditions of temperature and humidity in the air (CASSAR, 1995).

However, the total effects of the complex synergistic interaction of pollutants, relative humidity, temperature, light and UV-radiation and its effects are not elucidated by the measurement of individual parameters. The primary interest of conservators rests in the total impact of the conditions on the organic objects.

Projects aiming at better preventive conservation strategies

The IMPACT – project

The EU-project ‘Innovative Modelling of Museum Pollution and Conservation Thresholds’ (IMPACT-EC-EVK4-2000-00695) illustrates how an ongoing project is currently dealing with the development of tools in order to contribute to a better preventive conservation strategy. The aim of the project is to:

– Develop a web-based software tool to help museums deal with pollution problems.
– Develop innovative materials for use as passive pollution absorbers inside buildings.

In order to develop innovative materials for use as passive pollution absorbers it has been necessary to study the dry deposition velocities of gases present in the indoor air on material surfaces. As a participant in the ‘IMPACT’ project, the Norwegian Institute for

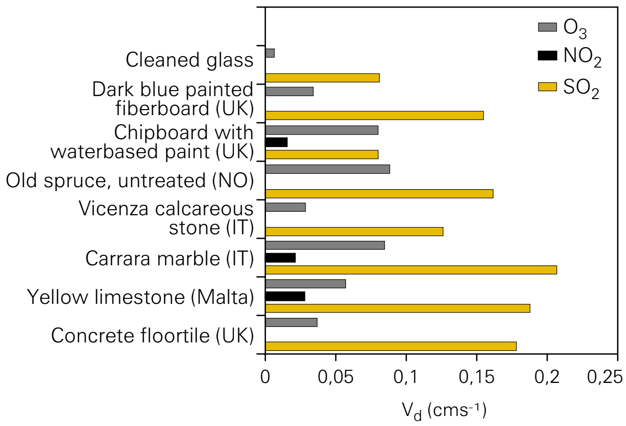

Figure 1. Deposition velocities of SO_2, NO_2 and O_3 on materials at RH = 90 %. All gases were tested on all samples and if no reaction on the material was detected, no bar was indicated in the figure (GRØNTOFT, 2001).

Air Research (NILU) has measured the deposition velocities of three gases, O_3, SO_2 and NO_2, on selected materials which have been used in museum buildings. The measurements of the different material samples were performed in a climatic test-chamber at NILU under near laminar airflow conditions. Deposition velocities on materials were measured at varying air humidities and at varying temperatures between 20–30°C (GRØNTOFT, 2002). Figure 1 shows the measured deposition velocities for the three gases, on a number of different materials, at RH = 90%. The general trend seen in the figure is a low deposition velocity (0–0,03 cms^{-1}) for the slightly water-soluble NO_2 gas. The deposition velocity was considerably higher (0,05–0,10 cms^{-1}) for the somewhat more water soluble and more reactive O_3 gas, while a twice as high deposition velocity (0,1–0,2 cms^{-1}) was measured on alkaline surfaces for the easy soluble and reactive SO_2 gas (GRØNTOFT, 2001).

Knowing deposition velocities and reaction mechanisms, NILU has developed a model that gives mean deposition velocities indoors. This model will be included in the wider IMPACT project model, which will calculate indoor concentrations of gases in museum buildings from measured outdoor concentrations. The IMPACT model will be of great help for the museum staff in evaluating the indoor environment and undertaking preventive conservation work.

The MASTER project

A new EC project: 'Preventive Conservation Strategies for Organic Objects in Museums, Historic Buildings and Archives', otherwise known as 'The MASTER Project' (EVK-CT-2002-00093) began on February 1, 2003.

The main aim of this project is: *To provide the conservator staff of museums, historic buildings and archives with a new preventive conservation strategy for the protection of cultural property, based on an early warning system assessing the environmental impact on organic objects.*

This aim will be carried out according to the following objectives:

- Revise and refine existing preventive conservation strategies for protection of organic objects, based on the end-users' identified needs.
- Develop a classification system for risk assessment of organic objects in museums, historic buildings and archives.
- Evaluate decay on organic objects in different test environments.
- Develop an early warning system based on an effect sensor for organic materials (EWO-sensor), assessing deterioration of indoor organic materials, based on the end-users' identified needs.

The early warning system including the EWO-sensor that will be developed within the MASTER-project will provide a relatively cheap and easy way for museums and other cultural heritage organisations to take the first step of evaluating the quality of the environment they provide for organic objects. This represents a considerable step forward, as previously museums had to rely on analysing a wide range of diagnostic parameters, such as light, RH, temperature and pollution to answer this question. These factors are still very important, but the EWO-sensor strategy will provide a simple and rapid means of surveying many different environments, both in storage and display areas. This is particularly important for organic objects that are often present in large numbers in collections, such as those of historic buildings with original textile furnishings and decorations; or in libraries and archives, which hold large numbers of paper documents (MILLS, 1994).

Conclusions

At the moment, there are several EU-funded research projects going on in Europe dealing with problems concerning preventive conservation, but there are still research gaps which remain to be filled.

A working paper for the European Parliament (the STOA-project) stated in October 2001 that there is still a need for research within the following topics (CASSAR, 2001):

- Response of materials to microclimatic changes.
- Measurements of indoor emissions from materials and humans in cultural heritage environments.
- Secondary reactions among gases and secondary products of indoor chemistry.

– Dry deposition of particles and the ways in which particles age or react with surfaces.
– New and multi-functional sensors for air pollutants in museums and archives.
– Development of integrated management strategies.

A main challenge must be to ensure that research projects will be relevant to the museum staff, so that they can be implemented into their preventive conservation strategies.

References

BAER N.S. and BANKS P.N., 'Indoor air pollution: Effects on cultural and historical materials', *International Journal of Museum Management and Curatorship,* **4**, 9–20, 1985.

BLADES N., ORESZCZYN T., BORDASS B. and CASSAR M., *Guidelines on Pollution Control in Museums Buildings*, MUSEUM PRACTICE, Issue 15, Museum Association, London, 2000.

BRIMBLECOMBE P., 'The composition of museum atmospheres', *Atmospheric Environment,* **24B**, 1–8, 1990.

BRIMBLECOMBE P., BLADES N., CAMUFFO D., STURARO G., VALENTINO A., GYSELS K., VAN GRIEKEN R., BUSSE H.-J., KIM O., ULRYCH U. and WIESER M., 'The indoor environment of a modern museum building, The Sainsbury Centre for Visual Arts, Norwich, UK', *Indoor Air*, **9**, 146–164, 1999.

CAMUFFO D., 'Indoor dynamic climatology: investigations on the interactions between walls and indoor environment', *Atmospheric Environment,* **17**, 1803–1809, 1983.

CAMUFFO D., *Microclimate for Cultural Heritage*, Developments in Atmospheric Science No 23, Elsevier, Amsterdam, 1998.

CASSAR M., *Environmental management. Guidelines for museums and galleries*, Routledge and Routledge, London and New York, 1995.

CASSAR M. (ed.), *Technological Requirements for Solutions in the Conservation and Protection of Historic Monuments and Archaeological Remains*, unpublished working paper to the STOA Unit, European Parliament, 2001.

DAHLIN E., HENRIKSEN J.F. and ANDA O., 'Assessment of environmental risk factors in museums and archives', *European Cultural Heritage Newsletter on Research,* **10**, Special issue, 94–97, 1997.

ERHARDT D. and MECKLENBERG M., 'Relative humidity re-examined', in *Preprints of the Contributions to the Ottawa Congress, Preventive Conservation: Practice Theory and Research*, ed. A. ROY and P. SMITH, International Institute for Conservation of Historic and Artistic Works, London, 32–38, 1994.

GRØNTOFT T., *Deposition velocities of SO_2, NO_2 and O_3 on materials*, unpublished progress report to the EU-project IMPACT, project meeting 6–7 December, Kjeller, 2001.

GRØNTOFT T., 'Dry Deposition of Ozone on Building Materials. Chamber Measurements and Modelling of the Time Dependent Deposition', *Atmospheric Environment,* **36**, 5661–5670, 2002.

HAVERMANS J., 'Effects of SO_2 and NO_x on the accelerated ageing of paper', *European Cultural Heritage Newsletter on Research,* **10**, Special issue, 128–133, 1997.

INTERNATIONAL COUNCIL OF MUSEUMS, *ICOM-statutes. Code of professional ethics*, Norsk ICOM, Oslo, 1991.

LARSEN R., 'Deterioration and conservation of vegetable tanned leather', *European Cultural Heritage Newsletter on Research,* **10**, Special issue, 54–61, 1997.

MILLS J.S. and WHITE R., *The organic chemistry of museum objects*, 2nd Edition, Butterworth Heinemann, Oxford, 1994.

PUTT N. and MENEGAZZI C., 'ICCROM preventive conservation experiences in Europe', in *Preprints of the 12th Triennial Meeting of ICOM-Committee for Conservation,* Lyon, 29 August – 3 September, 1999, James & James, London, 1999.

SALMON L.G., CASS G. R., BRUCKMAN K. and HABER J., 'Ozone exposure inside museums in the historic central district of Krakow, Poland', *Atmospheric Environment,* **34**, 3823–3832, 2000.

THOMSON G., *The Museum Environment*, 2nd Edition, Butterworth Heinemann, Oxford, 1994.

Elin DAHLIN

Norwegian Institute for Air Research (NILU)
Instituttveien 18, P.O. Box 100,
NO-2027 Kjeller, Norway
e-mail: elin.dahlin@nilu.no

Graduated in Nordic archaeology at Oslo University, Norway in 1982. Over 20 years of experience in the field of cultural heritage, working with exhibitions at different museums and with international projects (including EU projects). Since 1990 working as a scientist at NILU with different projects dealing with environmental impact and deterioration of indoor and outdoor cultural property, such as deterioration of rock carvings and stone monuments and monitoring of indoor air in museums and historic buildings.

Preventive conservation of historic buildings in temperate climates.Â Preventive conservation strategies for organic objects in museums , historic buildings and archives. E. Dahlin. VIEW 3 EXCERPTS. Highly Influential. A generic approach to calibrate building energy models under uncertainty using bayesian inference. Qi Li, L. Gu, G. Augenbroe, C. Wu, J. Brown. 2016. A methodology for building energy modelling and calibration in warm climates. A. Pedrinia, F. S. Westphalb, R. Lambertsb. 2002.