Indoor Climate and Tourist Effects: The Situation in the Netherlands

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1. Introduction

In The Netherlands, the circumstances for conservation measures have been unusually advantageous. In the past decade approximately 400 millions guilders have been made available for the preservation of museum, archival and library collections, under the umbrella of the project we call the “Deltaplan for the Preservation of Cultural Heritage”. As I think that it may be of relevance, I include a short summary of the Deltaplan project (paragraph 2).

A large part of the Deltaplan funding has been devoted to measures aimed at improving the environment for objects and collections. Although this has resulted in greatly improved conditions in storerooms and galleries, it doesn’t imply that everything is now in perfect working order. The decisions had to be made on the basis of the available knowledge and technology at the time. Over the past decade that knowledge has greatly improved, but there are still many questions left to be answered. I think that in general we are quite aware of the potential hazards that threaten our cultural heritage. The climate and circumstances surrounding objects and collections are amongst the most important ones: temperature (changes), (relative) humidity (changes), pollutants, fungi, insects and rodents, light and the most lethal of all: visitors. However, the exact workings of all these factors on the stability of historic materials still puzzle us in many ways. Ongoing research in these areas is therefore considered to be of high priority. Not out of scientific curiosity, but in order to find practical solutions and guidelines for those who take care of cultural property everyday.

2. The Deltaplan project: a brief description

In 1988 the National Audit Commission reported to Dutch Parliament that the care for the State collections was in bad shape. Dutch museums and archives were to improve their collection registration, the storage conditions for their collections as well as the actual conservation of those objects that were considered to be of specific cultural value. It turned out that this report was perfectly timed: elections were coming up and a sum of about 40 million guilders per year for cultural policy had been made available, without specifying what it should be spent on. A small group of young, bright and eager civil servants at the ministry of Culture saw the possibilities and quickly set up a large-scale inventory of conservation backlogs in public institutions. It resulted in an estimate of over 1 billion guilders to bring collections into perfect working order.

It was obvious that it was not very likely that that kind of funding would be made available, so a selection model was adopted. Collections were categorised by their cultural value on a national level and conservation measures were linked to it: no work on so-called category D-collections, preventive conservation for category C-, B- an A-collections and hands on conservation only for category B- and A-collections. Restoration was excluded all together. It was realised that preventive conservation was the cornerstone of any policy, aimed at reaching a lasting positive effect on the condition of collections. In 1990 the execution of the Deltaplan started, as a 4-year programme. It became clear very quickly that more time and money was needed, so the project was extended twice. By the end of 2000 it officially ended, even though a number of specific projects, e.g. the conservation of library collections, film and AV-collections, university collections and others will be continued until at least 2004.

A final evaluation was presented last year in which the results were summed up. I give you some of the highlights:

- In the national museums about 230.000 square meters of floor space were fitted with modern climate control systems. At least 10.000 square meters of new storage space was created, along with at least 4.000 square meters of exhibition space. The Deltaplan proved to be the catalyst for a number of large scale renovation projects, most of which have been completed by now with the re-opening of our National Museum for Ethnography earlier this year. Lastly I would like to mention the design and implementation of air purification systems in all state archives.
- The preventive conservation of collections is on the whole under control: there are good storage rooms, the basic cleaning and packing of objects have been done. Some backlogs remain in remedial conservation, the most time consuming of all operations. But as most museums were allowed to keep a good size part of the Deltaplan money as structural funding, they seem to have the remaining problems well in hand. About £80 million of the Deltaplan funds have been spent on the national museums, apart from the cost of the major building exercises I mentioned.
- About 525 conservation projects in non-national museums were funded with approximately £12 million Deltaplan subsidy. Other parties have contributed as much as £30 million. Today, 50 to 60% of the non-national museums say they are in control of the situation.
- The infrastructure for conservation has been improved: Facilities for conservation training and research were extended. Specialised consultants have helped a lot of museums on their way. An independent Inspection was formed, that checks the collections management in the national museums on a yearly basis. Last but not least, “my” institute, the Netherlands Institute for Cultural Heritage, was founded on the first of April 1997 as a strong, national supporting agency for collections management.
- In the course of the Deltaplan project, the care for the moveable cultural heritage has emancipated and professionalised. Statistical methods of approach, scientific research, project management, protocols, decision making models and other instruments have been developed and will help collections managers in the future.

I realise that the Deltaplan has been an extraordinary project and it could only have happened because of the specific circumstances of the late 20th century in my country. Why I dwell on it is because we spent enormous amounts of money on climatisation, air purification, UV-filtration and the like, based on a relatively rudimentary knowledge of these factors. In many cases we decided to go for strict guidelines: 50 lux lighting level, 50% rH with limited deviations allowed, air as clean as in the high Alps in Switzerland et cetera. Often buildings had to be altered considerably to achieve this as many museums and archives are housed in historic buildings that were not designed to meet these parameters. In some cases the implementation of climate control systems had all kinds of negative side effects.

Before I go into some more concrete research areas that we are interested in, I first want to give you an overview of the research landscape in The Netherlands, of the institutions that are or may be interested in research in our field.

3. Preventive conservation research institutions in the Netherlands

This paragraph can be short as there are only very few institutions active in this area. The most important one is “my” institute, the Netherlands Institute for Cultural Heritage (in Dutch: Instituut Collectie Nederland - ICN). In its current form it exists since 1997, but its predecessors go back to before World War II. You’ve probably heard of the Central

Research Laboratory, founded in 1963.The ICN is 100% part of our national Ministry for Education, Culture and Science. The activities in the area of preventive conservation are concentrated in two departments of the ICN: the collections management department (about 10 full time staff) and the conservation science department (about 20 full time staff), where I work. We focus on research for and consultancy to collecting institutions in The Netherlands (and sometimes abroad). This means that we are looking for the development of applicable knowledge, not for knowledge for knowledge sake. Museums, archives and other collecting institutions come to us with questions like: what materials do I use? How can I optimise the climate in my building, given my limited amount of money? How do I get rid of these infestations or mould explosions? We try to give them straightforward and "tailor made" answers that they can implement.

Our three sister organisations, for historic buildings (RDMZ), archaeology (ROB) and archives (RAD) all recognise the importance of preventive conservation, but their possibilities to do actual scientific research in this area are very limited. They call on us or on other research organisations.

All other knowledge is concentrated within the Dutch universities and the national research organisation for applied sciences, TNO. In general they are pre-occupied with building physics in relation to present day architecture or with theoretical modelling.

Sometimes they apply this knowledge to cultural heritage, but often they are not aware of the specific needs of heterogeneous historic material that cannot be replaced when it is lost. This does not mean that they cannot be of great value for us. They possess the time and the means to expand the scientific foundations on which we can develop our scientific applications.

4. Research

If you would ask me what our ultimate aim should be, I would say that I would like to see integral and all encompassing collections management system. By this I mean a systematic approach to all factors that are of importance for the well being of collections and buildings. From acquisition to restoration, from risk management to de-accessioning. After all, it doesn't make a lot of sense to know pollution levels up to parts per trillion level if you cannot properly protect your collection from fire, theft or vandalism. So we have to try to address as many threats as we can, with many different methodologies, e.g. art historical, sociological, scientific.

The focus for this ARCCHIP ARIADNE meeting is mainly scientific. I will therefore stick to that area. Again I want to state the ultimate aim of such research activities: concrete guidelines for collections keepers: what is right to do or to use and how do I achieve the optimum in my specific situation.

In the research efforts of the ICN I think there are two main streams: one is the buildings we use, be it historic buildings we need to adapt for modern use or buildings we design especially for cultural heritage storage and display. The other is the influence of (construction) materials, pollutants and (micro)climates on objects. I will try to describe our efforts and interests in some more detail below. As an annex I will enclose a number of abstracts about ongoing research projects.

The ICN houses a well-equipped laboratory for testing and evaluating the influences of the environment on (historic) materials. Amongst others, we have a large climate chamber (25 square meters) where we can do real life testing. Furthermore we are equipped with a pollution chamber, an ISO certified testing chamber for paper quality and all kinds of analytical equipment (SEM-EDX, XRD, XRF, GADDS, HPLC, py-GC/MS, optical microscopy, ageing chambers, both light and temp/rH, FTIR to name the most important).

4.1 Buildings for collections

In the course of time we've gathered an extensive body of knowledge in the following areas:

The heating of large spaces, e.g. churches. We've worked on the definition of the parameters and the modelling necessary to design optimal heating systems that meet the needs of both the historic buildings, including their content, and the comfort of the visitors.

For museums we have developed guidelines for climate installations (temperature and rH control), filtration of air of chemical and biological pollutants. Guidelines for the acceptable level and spectral composition of natural and artificial light, including acceptable UV- and IR-radiation levels as well as the possibilities to reduce radiation levels to an acceptable maximum.

The same goes for guidelines for buildings, interior design and use of materials in museums, libraries and archives. The ICN acts as a consultant for many or even most of the major building or renovation projects in collecting institutions in The Netherlands.

At the moment we are working on guidelines and benchmarks for display cases. We are looking at materials, ventilation and absorbents.

By 3-D NMR measurements we are trying to gain more knowledge about the hygroscopic behaviour of wood as a construction material: the absorption, transport and release of moisture.

We have recently finished a European project in the tarnishing of silver (SilProt, see annex) and continue to work on the pro's and con's of the backside protection of paintings. For certain categories of objects, some for of packing appears to be a very effective preventive conservation strategy for objects in storerooms.

Many of these subjects will remain on our research list for the future. We will continue to improve guidelines and materials. The establishment of dose-response relations is in many cases a relevant subject of study. In the future we want e.g. to study the impact of visitors on the museum environment.

Below you'll find a number of project descriptions.

Emission of organic acids from wooden construction materials in a small test chamber; preliminary results of optimisation of the Solid Phase Micro Extraction technique

Maarten van Bommel, Bart van Elst and Francien Broekens

Wooden construction materials, used in storage and exhibitions, are known sources for low molecular organic volatiles. The amount of organic volatiles depends, among others, on the type of wood. Especially particleboard and other composits such as MDF, are known to emit formic acid, acetic acid and formaldehyde, but other types of wood emit these organic compounds as well. In the last decades, much effort has been put in determining the effects of these emissions on objects of culture and art, e.g. by the well-known "Oddy test". Furthermore, methods to reduce emission have been investigated. Appropriate lacquers, absorption materials or sealing the wood with impermeable films can reduce the emission significantly.

The damage to objects depends on the concentration of harmful gasses, the sensitivity of the material of the object, exposure time and environmental conditions. In the case of organic acid vapours and formaldehyde, the wooden construction material of the showcase is often the emitting source. The concentration organic volatiles does not only depend on the emission rate of the construction material, but also on the ventilation of the showcase. A high air exchange rate will in principle lower the concentration organic vapour, assuming that the outside air does not contain organic vapour. However, the exchange rate does also affect the emission rate of the construction material; a higher exchange rate will increase the emission.

At the ICN, research is focussed on predicting the final concentration of organic vapours in a showcase, in order to provide guidelines for the use of construction materials and the need of mitigation methods. For this, it is necessary to determine the emission rates of materials at different exchange rates. Usually, construction materials are placed into a small test chamber with the possibility to control the air exchange rate by flushing the test chamber with a variable airflow. The concentration organic vapours in the air is determined using various sampling and analysis techniques, however, none of these techniques is satisfactory in terms of sensitivity and speed. Lately, a new sampling technique, Solid Phase Micro Extraction (SPME), is introduced as a fast and sensitive method.

This presentation focuses on the sampling technique itself, in particular on establishing the relationship between the uptake by the SPME fibre and the flow rate of the air. Using a calibration gas, two different sampling techniques were compared: static and dynamic sampling. Static sampling is performed by flushing a glass jar with the calibration gas. Next, the glass jar is closed and the SPME fibre is introduced through a septum and exposed to the stagnant air. The advantage of this technique is that the sampling rate of the SPME fibre is independent of the airflow. Dynamic sampling is performed by sampling directly in the gas stream through an in-line injection valve. This presentation discusses the application of different SPME fibres, the effect of the airflow rate during SPME sampling on the amount of organic vapour collected, evaluation of the different sampling techniques and the calibration of the sampling technique used.

Non-spherical holes and wavy tracer gas decay curves.

A comparison of theory and real life with respect to leakage of display cases.

Frank J. Ligterink, Hubertus A. Ankersmit and Maarten van Bommel,

Conservators and curators from time to time will have to decide on the design of new display cases or the implementation of measures to improve existing display cases. Sometimes cases have to be well sealed in order to prevent penetration of harmful components from the external environment. In other situations a certain level of ventilation is preferred in order to avoid the accumulation of harmful components emitted either by objects or construction materials the interior of the case.

To guide the design of cases, at least a crude quantitative estimate of the effects of various measures that influence the leakage/ventilation rate of a case is necessary. In principle the equations and graphs in Stefan Michalski's article 'Leakage prediction for buildings, cases, bags and bottles' {1] allow for such an estimations.

In his article Stefan Michalski distinguishes three basic transport mechanisms which determine the leakage of display cases: 1) air flow through holes and cracks, 2) diffusion through (stagnant air in) holes and cracks, and 3) permeation through case wall materials. The airflow through holes and cracks is driven by pressure differences across the holes. Equations are given for pressure differences caused by air density differences between inside and outside due to temperature and relative humidity differences (stack pressure), and pressure differences caused by thermal and barometric pumping. The equations developed in the article are based on the assumption of homogeneous conditions within the case. Stack pressure is considered constant. Flow and diffusion equations through the holes and cracks are developed for simplified geometry's, that is tube shaped holes and rectangular cracks.

In real life, display cases have seldom simplified geometries and temperature and relative humidity differences are not constant. It is tempting to create more precise models that can account for this level of detail. From a practical (non-physicist) point of view, however, the current set of equations is already complicated to work with. In this study the practical use and the validity of the leakage predictions made by Michalski are tested experimentally. Exchange rates of a display case with holes and cracks of different sizes, shapes and positions are measured using carbondioxide as a tracer gas, while internal and external temperatures, relative humidities and air speed are measured simultaneously. The decay in the carbondioxide concentration allows for calculation of the actual exchange rate, which is compared with values calculated with the theoretical ones. Aim of this work is to produce a ready-to-use set of equations that can be implemented in a spreadsheet program to predict exchange rates of display cases.

[1] Michalski S., Leakage prediction for buildings, cases, bags and bottles, Studies in conservation 39 (1994) 169-186.

Corrosiveness and silver tarnishing

Bart Ankersmit, Norman Tennent, Simon Watts et al.

As part of European funded program called SilProt[1], hydrogen sulfide concentrations were determined in several locations on different occasions. During these investigations questions were raised on the influence of the presence of silver objects and showcase geometries on these concentration measurements. It was decided to investigate the:

1. Study the tarnishing of silver
2. Exchange rate of showcases in greater detail

The tarnishing of silver has been evaluated by colour analysis using a standard spectrophotometer. It was found that fine silver samples, placed inside a "Palmes diffusion tube", exposed to known amounts of hydrogen sulfide provided a calibration method to quantify the reflectance and colour change. The outcome of these investigations provided a new method to assess the corrosiveness of a museum atmosphere.

Since the exposure of these kinds of silver samples are relatively long (approximately 60 days), it was hoped that silver objects could provide the same information. Curators in museums were asked to select tarnished silver objects, in different grades of tarnish (from yellow to black). The colour of these objects and the time it took for the tarnish to be formed enable an assesment of the hydrogen sulfide concentration.

Dataloggers were put inside wetted (show)cases and the (show)cases was closed. The dataloggers measured the change of RH in time, which provide data on the exchange rates. Different cases with different geometries were investigated and the model proposed by Michalski was validated.[2] Variations include, different volumes of (show)cases, crack size and pressence/absence of lightning.

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[1] Funded by the European Commission DG XII Environment Programme, the team consists of:

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[2] S. Michalski, Leakage prediction for buildings, cases, bags and bottles, *Studies in Conservation* **39** (1994) 169-186