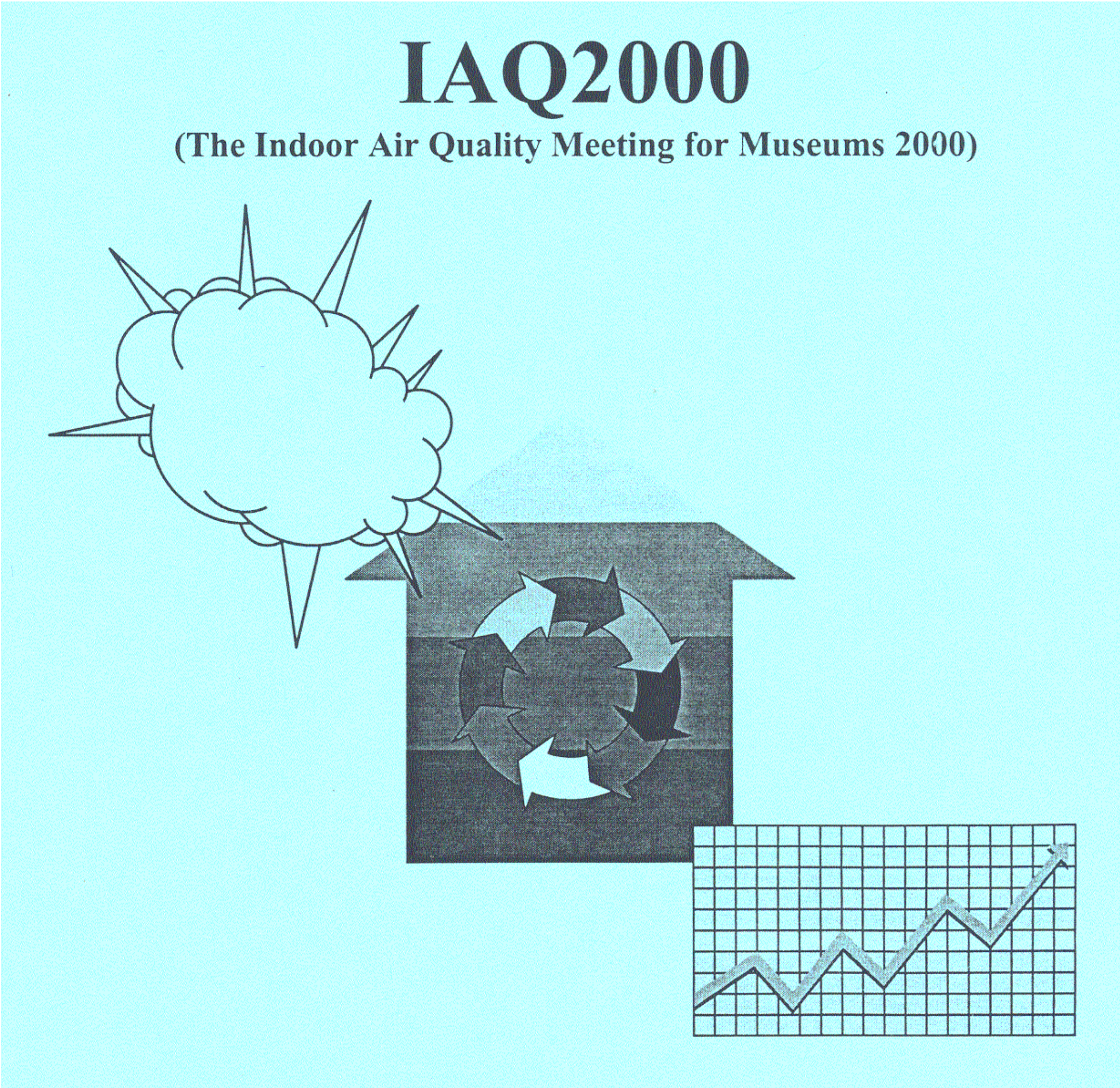



# Third Indoor Air Quality Meeting
## *Presentation Abstracts*

**Oxford Brookes University**
**10th-12th July 2000**

OXFORD BROOKES UNIVERSITY

**IAQ2000 – The Indoor Air Quality Meeting for Museums**
**Third Indoor Air Quality Meeting**

***Presentation Abstracts***

School of Biological & Molecular Sciences
Oxford Brookes University
10th -12th July, 2000

Enquiries and correspondence regarding the IAQ2000 meeting should be addressed to the meeting organizer:

*Simon F. Watts*
*School of Biological and Molecular Sciences*
*Oxford Brookes University*
*Headington, Oxford OX3 0BP, United Kingdom*
*E-mail: sfwatts@brookes.ac.uk*



This publication can be downloaded from the Internet in Adobe PDF format:
http://iaq.dk/iap/iaq2000/IAQ2000.pdf

All presentation abstracts in this publication can also be viewed online. The entry to all online IAP meeting abstract volumes (from 1998) can be found at: http://iaq.dk/iap.htm

Editor: Morten Ryhl-Svendsen
Conservation Department
National Museum of Denmark

# Table of contents

# Conference Report

September 3rd, 2000

IAQ2000 (Indoor Air Quality 2000) was held at Oxford Brookes University, UK, July 10th-12th 2000. It is the third meeting in the series of meetings that started in Glasgow (*Strathclyde University*) in 1998 with the meeting "Indoor Air Pollution: detection and mitigation of carbonyls", continued in Amsterdam (*Netherlands Institute for Cultural Heritage*) in 1999 with the meeting "Indoor Air Pollution: detection and prevention". These meetings have been organised by The Indoor Air Pollution Working Group (IAP) which was itself initiated by colleagues from Strathclyde University, The Getty Conservation Institute, The Netherlands Institute for Cultural Heritage, The Canadian Conservation Institute, and Oxford Brookes University.

This year's two day meeting focussed on three issues:

1. The basis and need for air quality standards in the museum world
2. The function of museum cases and the implications of this function for air quality measurements in cases
3. The funding of museum air quality research

The abstracts and contributions that follow show what can happen when a group of people start talking to each other. This meeting was not sponsored, nor was it subsidised. The aims of the meeting were to discuss the issues above and then disseminate the results of those discussions. Three different research clusters comprised of attendees from different international backgrounds are now operational - they are listed below (with their convenors). The aims of these groups are to initiate research proposals in these key areas:

1. Working Group on museum cases (Velson Horie)
2. Database of "change" in artefacts in Museum and Museum case environments (David Thickett)
3. Interlaboratory Comparison (Monika Fjæstad)

In addition to these groups, a statement is being developed amongst particularly the UK contingent on the funding of Museum Air Quality studies, probably in conjunction with a broader statement from the UKIC.
Finally, any meeting like this can only be facilitated, it is the participants who make or break it. About 70 people spent 2-3 days in Oxford discussing a closely focussed set of issues. Thanks are due to all of these people, especially our distinguished speakers from literally all over the globe who gave freely of their time and expertise, and to Oxford Brookes University who provided the facilities for this meeting. Finally, the meeting would not have run at all had it not been for the efforts of our conference administrator, Tracy Dickinson, whom I believe knows more about the nuts and bolts of exactly who runs what, how and when in this institution than many who have been here for years.

Simon F. Watts
Oxford Brookes University

# An approach to air pollution standards in museums

**Peter Brimblecombe**
**University of East Anglia, United Kingdom**

**Abstract**

THE ROLE OF STANDARDS
These seem to lie at the heart of preventive conservation and potentially offer enhanced protection...
They are also useful in:

- creating uniformity
- spreading the load
- offering justified goals
- offering peace of mind
- creating a sense of professionalism

CYNICAL VIEW OF REGULATION
One may take a very cynical view of regulation and see pollution control, consumer protection linked to the accretion of regulatory power
Within cultural heritage we should consider:

- external agencies keen to regulate
- cultural ministries have typically been weak
- European Commission keen to regulate in EC 62/96 and CAFÉ
- HVAC engineers favour regulation

COST OF REGULATION
It is important to recognise that the cost of regulation dispersed away from the regulatory agency, which may gain financially through licences, validation etc.
In urban air pollution:

- monitoring and enforcement costs borne by local authorities
- adaptation borne by industrial/consumer

PRECAUTIONARY PRINCIPLE
When knowledge is not perfect we should take precaution
Yet it is important to recognise the differences between weak and strong precaution - would one take precautions agains panthers loose in Norfolk and carry a hunting rifle?

REWARDS AND SANCTIONS
There are pressure to adopt or enforce standards:
- certification
- loan of exhibits
- insurance and indemnity

ACHEIVEMENTS
Regulatory agencies justify existence by claiming positive outcomes e.g. The UK Clean Air Act of 1956.
What drives improvements in museums?
- regulation
- attitudes/knowledge
- available controls
- external factors...?

THE FORM OF AIR POLLUTION STANDARDS
- Concentration/time dependent
- Risk factors - *carcinogens*
- AOT40 - *vegetation*
- Critical loads - *ecosystems*
- Target values - *if standards too difficult to meet*

THE BASIS of 96/62/EC AIR POLLUTION STANDARDS
- "limit values... based on findings of international scientific groups..." *from position papers*
- "reference methods... specified"
- "other techniques beside direct measurement" indicative monitoring
- "preliminary representative data" *cost benefit analysis important*

PRE-REGULATORY STANDARDS IN MUSEUMS
- Customary practice
- Ambient conditions
- Architecturally achievable
- Measurement limited

MUSEUM STANDARDS vs 96/62/EC
Can museums follow the pathway of the European environmental standards:

based on scientific findings in position papers
*In museums* - knowledge sketchy, so justification difficult

specified reference methods papers
*In museums* - some agreed methods

indicative monotoring papers
*In museums* - diffusion tube in use

preliminary representative data papers
*In museums* - representative data available

cost benefit analysis papers
*In museums* - little formal CBA

COMPLICATIONS
The talk then looked at many of the complications that arise in air pollutant damage to objects in museums and how the mechanistics complicate standards.

CONCLUSIONS
Standards offer no panacea!

- Complicated by: pollutant identification, damage issues, many targets, timescales, cummulation, synergisms...
- Standards would need to be built on rationalised justification: scientifically, economically...

---

Author:

Peter Brimblecombe
School of Environmntal Sciences
University of Est Anglia
Norwich NR4 7TJ
United Kingdom
E-mail: P.Brimblecombe@uea.ac.uk

# Appropriate standards for conservation

**Susan Bradley**
**The British Museum, United Kingdom**

**Abstract**

I am often puzzled by what colleagues mean when they talk about standards for conservation. Do they mean a written document, drawn up through a full consultation process of the industry it will affect and validated by a standards body such as the BSI?. Such a document would include both a specification and a method of measurement to show compliance. Do they mean a standard approach. Scientists use many standard approaches. A 1M solution of hydrochloric acid is a standard solution, and spot test defined by Vogel are standard analytical methods. When these are mentioned in publications they are instantly understood around the world. They are procedures which can be reproduced.

There are few specific Standards for conservation. BS4971 'Repair and allied processes for the conservation of documents' and BS 5454 'Recommendations for the storage and exhibition of archival documents' are the best known. Latterly there has been a tendency for books on environment for the conservation of collections to use the word standards in their titles. However they lack the clear definition and protocols for measurement which would normally be associated with a Standard.

This is not surprising given the non standard nature of the materials and objects dealt with in conservation. Objects come in varying states from completely degraded or corroded in burial, through worn in use, to brand new. Some objects need high levels of control of RH to limit alteration, others survive well in an uncontrolled environment, some are not effected by pollutant gases, and others are.

The damage caused by the indoor air pollutants, acetic and formic acid, formaldehyde and acetaldehyde and hydrogen and carbonyl sulphide has been documented through the conservation literature since the early 70s. We know that to prevent, or reduce the rate of corrosion of metals, and the formation of mixed salts on porous objects containing soluble salts we needed to eliminate materials which give off these gases. The most common material of concern is wood, but varnishes, paints, adhesives and sealants can also give off organic acids and aldehydes. A corrosion test was developed at the BM in the early 1970s to screen materials for use in the storage and display of the collection. Using this test it is possible to achieve an organic acid/aldehyde free environment. Because the reduced sulphur gases, hydrogen sulphide and carbonyl sulphide, are present in the ambient environment, even if materials which give off these gases are eliminated, it is not possible to provide a sulphur free environment without the use of air filtration.

Another source of pollutants is objects which out gas. Everything, but the objects can be eliminated from showcases and stores.

There are two possible approaches to specifying maximum concentration limits for indoor air pollutants. One is to specify an acceptable maximum, the other is to specify an acceptable corrosivity level. There are several problems with specifying a maximum level. The rate of out gassing is determined by ambient temperature and RH. Some objects are more reactive towards the pollutants than others, and as yet we do not know anything about rates of reaction for the very wide range of materials which could be effected. There is no evidence to suggest that reaction rates are proportional to concentration, and nor can there be when at least three factors are involved in the promotion of a reaction, the pollutant concentration, the temperature and the RH.. Yet another problem is the potential for symbiotic reactions where more than one gas, or the combination of gas(es), humidity and temperature promote a reaction. Such reactions are not predictable from measuring the level of one gas. The final hurdle is a cheap, easy to carry out measuring technique. Measurements at the BM suggest that even at very high pollutant levels reactions do not occur on object surfaces when the RH level is low, below 45%RH. That other workers have reported reactions occurring at RH levels as low as 30% suggests that the reaction mechanism may be even more complex than our observations suggest.

The advantage of measuring corrosivity of the environment is that it is a measure which takes into account all of the potentially harmful parameters. There is an international standard, ISO 9223 (currently being revised) which describes a classification of the corrosivity of atmospheres from NOEL (no visual effect level) to saturation. This is an approach developed by corrosion scientists who spend their lives trying to unravel and understand complex corrosion reactions, and may be a more appropriate way of classifying environments for objects. However there will still be a need to seek convergence between the corrosivity level as defined by the test materials, and the actual effect on the object substrates. There is also the problem that organic acids affect a number of different types of substrates and a range of sensors will probably be required.

There are a number of options for the control of indoor air pollutants. These are not to use materials which give off pollutants, to install filtered air conditioning to clean the air, or to use absorbents inside showcases and cupboards. Of these options the cheapest and most effective is to not use materials which out gas. For some museums, and the BM is one, there are certain situations in which wood cannot be removed. In the BM the Grand Rooms such as the King's Library which once housed library books are to be developed as exhibition galleries. Because the rooms are listed the glazed wood book presses will be used to display objects. This will be a challenge, but with careful selection of the objects, and implementation of control measures in individual presses the situation will be resolved.

Air conditioning is expensive, and only really useful to remove external pollutants, and those pollutants which are given off by the materials used in the construction of the gallery space. Indoor pollutants generated within a showcase will not be removed, or even diluted, by a gallery air conditioning system especially when the showcases are very well sealed. Such systems are excellent for visitors, providing comfortable conditions in the cold of winter, and the heat of summer; and for providing conditions for objects on open display which all need the same RH level. However the systems are space hungry, and cannot always be readily accommodated in an existing building.

Absorbents are cheap and useful in well sealed showcases. If used passively they will not remove all pollutants, but they can substantially reduce concentrations, potentially to below danger levels. Another approach is to circulate the air in a showcase through a filter bed containing the absorbent which improves the efficiency of the materials. These materials are useful in existing installations where materials which out gas cannot be removed.

Considering the factors discussed above, it appears to me that defining standards for pollutant levels other than zero, is not appropriate. Providing simple guidelines for other to follow is achievable.

---

Author:

Susan Bradley
Department of Conservation
British Museum
London WC1B 3DG
United Kingdom
E-mail: sbradley@thebritishmuseum.ac.uk

# Standards for levels of pollutants in museums: part III

**Jean Tétreault**
**Canadian Conservation Institute**

**Abstract**

A process to update the Indoor Air Quality standards for museums and archives was started two years ago at the Canadian Conservation Institute. The existing list of pollutants and the approach to developing the standards was revised. New pollutants, especially those generated indoors, have been added.

The "Best Knowledge" approach is used as the primary concept instead of the "Best Technology" approach. During the last decade, museum surveys and laboratory research have generated considerable data on the interaction between materials and pollutants in museums and simulated museum environments. This accumulation of data helps to narrow the range of critical levels of pollutants so that a "no observable adverse effect level" (NOAEL) and a "no observable adverse effect dosage" (NOAED) can be established [Tétreault, 1999].

Within the next two years, the first version of these IAQ standard for museums should be available. It will contain specifications for general museums, art galleries, and archives as well as a reference list of specific material - pollutant interactions for optimal control strategies. This improved understanding of pollutant/material interaction should lead to optimized specifications and control strategies.

*Reference*

Tétreault, J. "Standards Levels of Pollutant in Museums: Part II." Indoor Air Pollution: Detection and Prevention, Presentation Abstracts and Additional Notes. Instituut Collectie Nederland, Amsterdam, The Nederlands, 26-27 August 1999. On-line: http://iaq.dk/iap/iap1999/1999_05.htm

---

Author:

Jean Tétreault
Canadian Conservation Institute
1030 Innes Road Ottawa
Ontario K1A 0M5
Canada
E-mail: jean_tetreault@pch.gc.ca

# Exchange Rates in museum cases - a standard?

**Graham Martin**
**Victoria and Albert Museum, United Kingdom**

## Abstract

As the leader of a group of scientists in a national museum whose collection is varied, we often find ourselves as the 'in-between'. That is the in-between the customer (or client) and the manufacturer (or supplier). It is worth while just spending a little time analysing this position.

Firstly the customer. At the V&A this is typically a curator or senior manager that is given a budget to see a project through. This budget may vary from small amounts of around £10,000 to undertake a re-display of some particular objects to £32 million over five years for our largest project of the British Galleries that has a full project management team. The small budgets do not generally have project managers and are seen through to completion by an individual.

To give a scale of the task - it is estimated that there are 2,500 display cases in the V&A and the price for new cases varies from £5,000 (Euro 8,000) to £20,000 (Euro 32,000). An average price of £8,000 (Euro 12,800) is reasonable. The simple arithmetic dictates that the new replacement costs for all display cases would be £20 million (Euro 32 million). If we add in the storage case the V&A has 2,694 storage cases. The new price for one of these storage cases is £650 (Euro 1040). The arithmetic says that to replace all of our present storage units at today's prices would cost £1.5 million (Euro 2.4 million). You may ask for justification of this scale of costs. In one suite of recently refurbished galleries (the South Kensington site alone has 170 galleries) the objects were valued at £7.5 million (Euro 12 million) in only two of the approximately fifty display cases.

Now the manufacturers turn. Very business wise and contractually aware companies who are chasing sizeable international contracts. My experience is that they deliver exactly what the customer has asked for and quite right for doing so.

From outside of the V&A I am also aware that the scenario is very similar on both the customer and manufacturer sides.

The two main groups MUST learn to speak each others language if value for money is to be gained and given. So my challenge was to find such a suitable language. I know that I can do this from a base as a customer and use the concept that the customer is always right. The answer to this challenge was to employ a measurable parameter that would give some indication as to the quality of build but without specifying how to

achieve that quality of build. Trawls of the literature indicated that air transfer between inside and outside the cases could be such an indicator. Hence the concept of air exchange rates was encompassed. It is now V&A contractual obligation that the supplier of display cases will provide us with a certificate to demonstrate that the cases supplied meet the agreed specification. Normal procedure for areas such as electrical installations or plumbing.

So where to set the standard? The early literature work suggested that cases could quite easily attain 0.1 air changes per day (0.1 ac.d-1). Research was targeted towards this figure - the most obvious need was a means to measure the air exchange rate. The Building Services Research Industry Association (BSRIA) were contracted to a joint project team of the V&A and MGC to study the measurement technique. I am now happy to report that we have an accepted this target for the manufacture of our display cases.

This whole piece has been written without using the words quality control nor quality assurance.

---

Author:

Graham Martin
Victoria and Albert Museum
South Kensington
London
SW7 2RL
United Kingdom
E-mail: grahamm@vam.ac.uk

# What do the numbers mean?

**Lorraine Gibson**
**University of Strathclyde, Scotland**

**Abstract**

There are numerous ways to assess the quality of indoor air. The tests range from simple methods that provide subjective, qualitative assessments of indoor air, to highly sophisticated, expensive on-line methods for the determination of specific pollutants. In the museum environment, which type of test is necessary to ensure we are doing 'the best' to preserve and protect our valuable collections ? During the presentation, the range of sampling methods currently used in museums will be summarised, outlining the perceived advantages and limitations of each.

The choice of whether to use one technique over another depends simply on the questions which have to be answered in the sampling regime. If screening of cabinets for the possible presence of pollutants is the aim, then simple colourimetric tests suffice. However, if a corrosion problem has been observed inside a display case, then the source and identity of the pollutant must be ascertained to eliminate it from the microenvironment. This would require implementation of more sophisticated sampling regime that provides quantitative, selective information.

Even when accurate numbers are obtained, and we are sure we have 'contaminated' environments, what do the numbers actually mean ? In addition to the concentration of the pollutant, we need to understand what this concentration means in terms of damage to our stored artefacts. We need to think of the pollutant's deposition velocity, the accumulated flux, the air movement inside the case, the environmental conditions such as temperature and relative humidity etc., in order to assess the situation properly. There is a need for further research to determine the synergistic effects of all the parameters involved in pollution-induced material damage. This should take the form of laboratory and phenomenological studies.

---

Author:

Lorraine Gibson
Dept. of Pure and Applied Chemistry
University of Strathclyde
Glasgow G1 1XL
Scotland
E-mail: lorraine.gibson@strath.ac.uk

# Classification of museum environments as a tool to improve the air quality

**Monika Fjæstad**
**National Heritage Board, Sweden**

**Abstract**

Indoor air pollution has been investigated in campaigns time to time in Swedish museums. Metal coupons have always been used to detect the total impact of pollution. The Swedish Corrosion Institute has developed a standard procedure for production and analysis of the coupons. Most of the earlier tests have been executed in outdoor atmosphere, consequently the classification steps are wide and few. Usually the standards ISO 9223 and ISA S.71.04-1985 were used also for classification of indoor atmospheres. A new ISO standard is under development useful even to museums.
This spring the National Heritage Board started an exposure campaign on ten sites using SCI- coupons of carbon steel, copper, silver, zinc and lead. The content of organic acids and aldehydes are measured with passive samplers, particles are collected and the temperature and RH are monitored. The test station is placed in cupboards, showcases, storerooms and exhibition halls. The objectives are to investigate the range of effects, to provide the conservators with a classification of their museum environment and to propose countermeasures.

*Background*
At many museums in Sweden, the conservators, if any, are aware of the importance of controlling temperature and relative humidity. Often in the newly built exhibitions the ventilation system is under control, in the older rebuilt museums the system needs a kick, now and then, and in the ancient low frequented museums the staff believes in resurrection and eternity. In the last case you will probably find an abandoned thermohygrograph in a dusty corner.
Indoor air pollution is, even if you can sometimes smell it, an invisible ghost to many museum directors. There are seldom dramatic evidence, showing the existence of the pollution. The changes are slow but often uncurable. Now and then strange, anaesthetic changes occur. The first questions are usually - Is it poisonous? Or Is it mould? To be able to analyse the situation we need easy, inexpensive tools to assess the environment onsite, indicators - sensors which give us the clue for further investigations. When damage occurs, eventually, the problem will end up in our hands.

*The project*
At the National Heritage Board, we started in 1999 a four year research project to enlighten the risk of indoor air pollution. It is called Neutral Materials in the Museum Environment. We follow three main roads:

1. Defining the state of the art.
2. Collection of information and resources, etc.
3. Classification of environments

*Material tests*
At an early stage we got in touch with the Swedish Corrosion Institute (SCI) and their earlier survey of corrosive indoor environments. They have the best practice of producing and weighing metal coupons for corrosion tests. Silver strips are used to evaluate the air quality in ventilation systems in general. Monitors like the On guard micro crystal balance and resistance measurements are also available. We chose to follow the SCI method with some modifications. To detect the total range of pollutant's carbon steel-, copper-, silver-, zinc- and lead coupons are exposed.

As a member of the atmospheric corrosion committee at SMS, the Swedish standardising committee, I follow new standards in development. ISO/WD 118 44 is a work document on classification of corrosivity of indoor atmospheres. In November it will be circulated. It contains the SCI methods among others.

*Classification of environments*
The standard under development has three parts:

<u>Part 1.</u> Determination and estimation of indoor corrosivity. The determination of corrosivity is based on measurements on standard coupons of silver, copper, zinc and carbon steel. Mass loss or mass increase is used to determine the corrosivity category for each metal. This is the first step to classify the environment. The estimation of corrosivity is based on climatic influences, the quality of the building and risk for pollutants, etc.

<u>Part 2.</u> Determination of corrosion attack in indoor atmospheres. This part contains the standard production of the metal coupons. Also methods of measuring mass loss and mass increase and the calculation of the corrosion rate.
Determination of corrosion rate by using catodic reduction and resistance measurements are also described

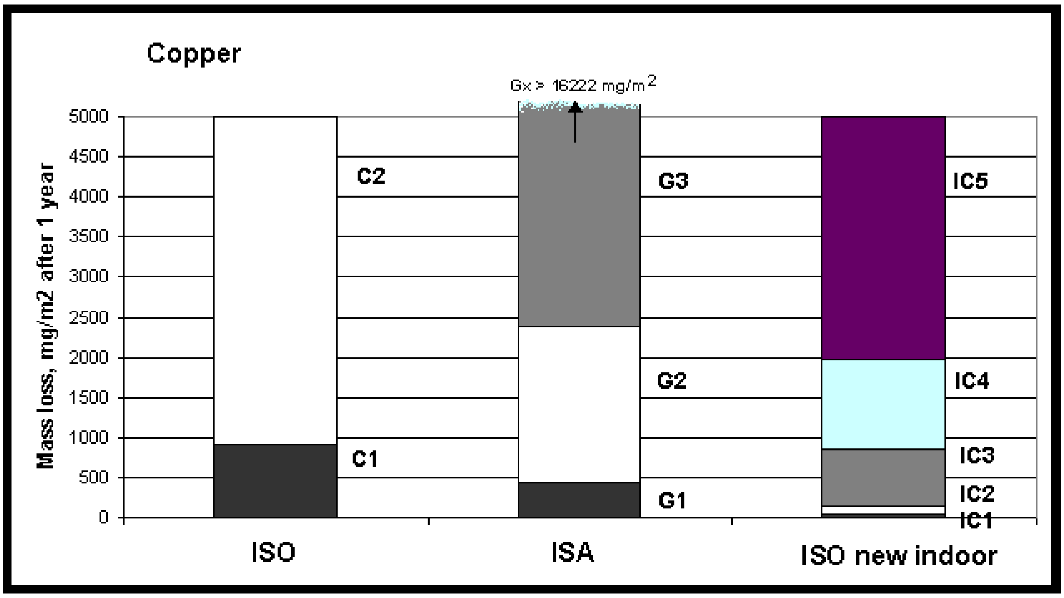
<u>Part 3.</u> Classification and measurements of environmental parameters affecting indoor corrosivity.
When the corrosivity is too high for the activity in the location, this is the next step. This part contains sampling methods for pollution measurements and reagents to use for active and passive samplers.

*A tool for preservation*

The standard can become a useful tool, with some modifications to predict future damage to museum collections. It will also hopefully be useful to provide evidence and arguments for better materials for interior fittings and filtration/ventilation systems.
The metal coupons indicates which pollutants are present and the specimens can be analysed by weighing and by scanning electron microscope. The indoor source has to be found and removed. A good particle and gas filtration system will remove the contaminants from outdoor sources.

*The test stations*

In our museum survey we have set up 12 stations.
At each station we expose carbon steel, silver, copper, zinc and lead coupons, passive samplers for aldehydes and organic acids, loggers for temperature and relative humidity and a particle sampler. To build bridges between classification and material tests we also expose lead coupons.
Six stations are located in shelves, cupboards in store rooms, three are placed in show cases and one in an exhibition hall. In some situations there is a controlled climate and in others the ventilation includes gas filtration and some have no ventilation at all. The exposure time for the metal coupons will last up to six months but the samplers are collected after one month and analysed by the IVL (Swedish Environmental Research Institute Ltd). With a six month's exposure we can co-ordinate our results with those of the SCI survey. One year exposure is too long for practicable use. Three months would be optimal.
In comparison with the standard we fear that most of the museum environments will be found in the class of very low corrosivity, the step IC1. We think that a mass increase up to 70 $mg/m^3$ (carbon steel) in one year is too high for museum collections. Maybe the half of the step IC1 will be the limit for a preserving museum environment. It must be taken into account that other materials in the collections are differently affected by the pollutants and have different demands on the environment. Next year the results from the survey will tell their story.




*References:*

Johansson, E. 1998. Corrosivity Measurements in Indoor Atmospheric Environments - A Field Study, Licentate Thesis, Department of Materials and Engineering, Royal Institute of Technology, Stockholm.

ISO/TC 156/WG 4 - N 338Rev. ISO/NP 11 844, Corrosion of Metals and Alloys, Classification of Corrosivity of Indoor Atmospheres.

---

Author:

Monika Fjæstad
National Heritage Board / Riksantikvarieämbetet
Box 5405
114 84 Stockholm
Sweden
E-mail: monika.fjaestad@raa.se

# Paint based dosimetry of the museum environment

**Oscar F. van den Brink, Gert B. Eijkel, and Jaap J. Boon**
**FOM Institute for Atomic and Molecular Physics, The Netherlands**

**Abstract**

Painted works of art on display in museums are subject to many environmental factors. Air pollutants that diffuse into the museum from the outside, and gases emitted from building materials and equipment inside the museum react with the works of art. Visitors of the museum are another source of air pollution. Other factors such as light intensity, temperature, and relative humidity determine the rate at which these reactions occur. As these factors can have both synergistic and inhibitory effects, the overall effect of the environment is a non-linear function of these factors. Hence, unless the nature and extent of interaction of the factors are known in detail, separate measurement of each of these individual factors does not result in an accurate assessment of the effect of the environment on the works of art.

Together with our European project partners at Birkbeck College, London and IROE-CNR, Florence, we have developed a test system based on traditional artists' materials to measure the overall effect of the museum environment on paintings. Changes in the chemical composition of these test systems are used as indicators of the environmental impact. Mock paintings were prepared using a mixture of whole egg and mastic as the binding medium. Non-pigmented test systems as well as systems pigmented with lead white, azurite, sienna, smalt and curcumin were used. A calibration set obtained by controlled exposure of the test systems to light, elevated temperature and to air pollutants (NOx, SO2). The chemical composition of the calibration set was analysed by mass spectrometric techniques. Changes in cholesterol, glycerolipids and triterpenoids, which point at processes such as hydrolysis, oxidation and polymerisation were identified. The mass spectrometric results were used to derive the degree of chemical change in the test systems. In the paper we present the methodology used to derive the degree of chemical change. Moreover, we present the comparative results of a 9 months' exposure of our test systems to the selected museum environments in the Rijksmuseum (NL), the Tate Gallery (UK), the Uffizi (It), the Alcazar (Sp), and Sandham chapel (UK).

A paper in press for Thermochimica Acta describes the work in more detail.

Author to whom correspondence may be addressed:

Oscar F. van den Brink
Unit for Mass Spectrometry of Macromolecular Systems
FOM Institute for Atomic and Molecular Physics
Kruislaan 407
1098 SJ Amsterdam
The Netherlands
E-mail: vdbrink@amolf.nl

# Damage assessment in test paintings: a means of evaluating museum-environmental risk?

**M. Odlyha*, N. S. Cohen*, R. Campana*, and G. M. Foster+**
**Birkbeck College, University of London, United Kingdom ***
**University of Exeter, United Kingdom +**

**Abstract**

One of the main concerns of conservators is to find a method for evaluating the damage incurred by works of art in major galleries and historic houses with differing indoor environmental conditions. For this purpose test tempera paintings were prepared and exposed at selected sites [e.g in the U.K at Sandham Memorial Chapel (in collaboration with The National Trust) and in the Clore Gallery (in collaboration with the Conservation Department, Tate Gallery]. The test paintings act as dosimeters and integrate the contributions from a range of factors which determine the overall environmental hazard to which paintings are exposed. Subsequent analysis involved an interdisciplinary approach using mass spectrometry (FOM Institute, NL), thermal analysis and infrared spectroscopy (Birkbeck College) and non-invasive spectroscopic analysis (CNR-IROE, It). These techniques gave a measure of the chemical changes and hence the resulting damage. In this paper the thermoanalytical and infrared data will be presented. Prior accelerated ageing of similar test paintings using controlled conditions was also performed to provide a comparison between artificial and natural ageing and a means for calibrating the test paintings. Further work is in progress to develop a simple and practical dosimeter for use by conservators.

Keywords: indoor environments, damage dosimeters, cultural heritage, thermal analysis, FTIR spectroscopy, natural ageing, artificial ageing.

---

Author to whom correspondence may be addressed:

Marianne Odlyha
School of Biological and Chemical Sciences
Birkbeck College, University of London
Gordon House 29 Gordon Square
London WC1H OPP
United Kingdom
E-mail: m.odlyha@bbk.ac.uk

# Modelling of mass transfer processes into display cases

**Frank J. Ligterink and Maarten van Bommel**
**Netherlands Institute for Cultural Heritage (ICN)**

**Abstract**

Inspired by Stefan Michalski's article 'Leakage prediction for buildings, cases, bags and bottles' (Studies in Conservation 39 (1994) 168-186) an attempt is made to explain the basic physics ingredients in the modelling of mass transfer processes, comprehensible to the non physicist. Special attention will be given to some underlaying assumptions. Their validity with respect to some real display cases will be discussed.

---

Author to whom correspondence may be addressed:

Frank J. Ligterink
Netherlands Institute for Cultural Heritage (ICN)
Gabriel Metsustraat 8
1071 EA Amsterdam
The Netherlands
Email: frank.ligterink@icn.nl

# A new look at soiling of contemporary paintings by soot in art museums

**James R. Druzik* and Glen R. Cass +**
**The Getty Conservation Institute, USA ***
**Georgia Institute of Technology, USA +**

**Abstract**

In the late 1980's the Getty Conservation Institute funded a research project carried out at the California Institute of Technology designed to investigate the risks to works of art from indoor airborne particles. At the time very little was known about the concentration and fate of indoor particles in museums and their rates of deposition onto surfaces. Of primary concern was the deposition of fine elemental carbon (soot) particles. These particles, being black, contribute to the slow aesthetic degradation of painted surfaces, and being small, 0.05 to 1.0 μm in diameter, tend to migrate deeply into porous surfaces where they are difficult to remove. Fine carbon particles are also hard to remove by the filters most commonly employed in standard heating, ventilating and air conditioning (HVAC) systems. Therefore, an assessment of indoor/outdoor particle concentrations and their deposition rates on vertical and horizontal surfaces was critical for estimating soiling rates and developing protective strategies for exposed museum collections.

During two-month periods in the summer and winter of 1988, five institutions in Southern California were investigated: the Norton Simon Museum, J. Paul Getty Museum, Scott Gallery of the Huntington Art Gallery and Library, the Southwest Museum, and the Sepulveda House. These institutions ranged from an historical house museum dominated by ventilation through open doors and windows with outdoor air exchanges ranging from 1.6 to 3.6 air changes per hour to museums with fully equipped HVAC systems having low outdoor air exchanges ($<1$ $hr^{-1}$) and high air recirculation rates (5-8 $hr^{-1}$).

In general, measured particle deposition velocities to vertical indoor surfaces ranged from $10^{-6}$ to $10^{-5}$ m/s depending upon particle size, and regardless of particle type, the fraction of outdoor air particles deposited onto all surfaces ranged from 0.l-0.5% for diameters in the vicinity of 0.15 μm, up to 90% for particles larger than 20 μm. The rate of elemental carbon particle accumulation on vertical walls ranged from 0.08-2.7 μg $m^{-2}$ $day^{-1}$. The measured indoor particle characteristics agreed well with predictions made from their mathematical model of indoor aerosol dynamics based upon measured outdoor particle characteristics and building parameters.

To estimate the soiling rates from the deposition characteristics in these building types it was necessary to relate surface deposits to the level where the soiling became "just perceptible" to a standard human observer. Efforts to determine this level had been carried out twice previously, once in the mid-1950's and then again in the 1970's. Both efforts agreed that a coverage of approximately 0.2% of the surface by black particles was just visible. As a result, the estimated soiling times associated with the five Southern California museums ranged from approximately 0.3-18 years. This study was published in two reports from the Getty Conservation Institute in 1992 and 1993. Individual chapters of these reports were subsequently published in the scientific peer-reviewed air pollution literature (Nazaroff et al.).

In the summer of 2000, "A Study on the Human Ability to Detect Soot Deposition onto Works of Art", was published in *Environmental Science & Technology* by Bellan, Salmon and Cass. Utilizing methods for depositing black particles and characterizing surface coverage that was far superior for modeling soot particles than earlier research, Bellan showed that, even with the ability to view a clean white area edge-to-edge with a soiled one, the onset of the point where a normal observer could just begin to detect that a surface was becoming soiled by microscopic soot particles occurred at approximately 2.4% surface coverage. This was a 12-fold increase over the earlier estimates. This new value expanded the soiling times for Southern California museums from 0.3-18 years to 4-216 years for the institutions previously studied.

In reviewing the original five museums it is clear that the Norton Simon Museum represents a unique class of institutions in its ability to provide a very clean indoor environment. The Simon Museum provides more than twice the protection from soot soiling than the Scott Gallery, yet both seem to be typical, modern air-conditioned museums. Both have fairly similar outdoor air exchange rates and indoor air recirculation rates. The main difference between these two buildings is that the Norton Simon Museum deposition velocity data agrees with predictions for deposition from a forced laminar flow of ventilation air along its walls owing to its use of the entire ceiling as an air plenum for the HVAC system (similar to the air flow system used in clean rooms.) This is not a common feature for museum design although the tendency is toward this in new museum construction projects. At the other extreme, the Sepulveda House with its completely unprotected ventilation strategy and 4 year time to the onset of soiling is so poorly controlled that it is unlikely to be used to house sensitive and extremely valuable art collections; indeed it is used as an historical house museum in which the building and its furnishings are on display. If the premise is true that the Scott Gallery, Getty Museum, and Southwest Museum with their mechanical ventilation systems are representative of the majority of structures that house contemporary art, then the exposure times prior to the onset of perceptible soiling of vertically-oriented surfaces ranges from 24 to 86 years with an average time to perceptible soiling on a white surface (based on an edge-to-edge comparison) of approximately 50 years.

The significance of this new figure is that turning the clock back 50 years puts us near the start of Color Field paintings. Thus the paintings of artists such as Morris Louis, Ellsworth Kelly, Jackson Pollock, Kenneth Noland, Mark Rothko, Helen Frankenthaler, Clifford Still, Franz Kline and Willem de Kooning, and the thousands of square meters of vulnerable canvas they have created, are now entering a stage where soot deposition will become an ever increasing problem for future conservators. That this new estimate may be a clarion of impending events is witnessed by the Tate Gallery in London which has recently begun a program to clean their Mark Rothko paintings.

---

Author to whom correspondence may be addressed:

James R. Druzik
The Getty Conservation Institute
1200 Getty Center Drive, Suite 700
Los Angeles, California 90049
USA
E-mail: jdruzik@getty.edu

# Mathematical modelling of pollutants in an enclosure

**Jean Tétreault*, Michel Therrien# and Patrick Olivier +**
**Canadian Conservation Institute ***
**Computing Devices Canada #**
**Imaging Diagnostic Systems, Inc., USA +**

## Abstract

Many models exist to simulate pollutants emitted by materials in test chambers for a short period of time or to simulate the evolution pollutants in large rooms. No model exists to simulate steady state concentration of vapors in enclosure close to adsorption equilibrium conditions. A model is on the stage of development to simulate evolution of pollutants in enclosure in preservation contexts in extended periods. The goal is to be able to simulate different situations such as leakage performance of display cases, efficiency of sorbents and harmfulness of emissive materials in enclosures.

The model is based into two combined principles: diffusion based on the first Fick law and adsorption isotherm. The first Fick law is based on the hypothesis that rate of mass transfer through unit area of a material section is proportional to the concentration gradient to the section. The adsorption isotherm expresses the equilibrium condition between a material and the vapor. Different empirical equations exist to express the equilibrium. Key equations used for the model are:

| | |
|---|---|
| Using Linear: | $dM_M/dt = s(-aC_M + bC_E)$ |
| Using Langmiur: | $dM_M/dt = s(-aC_M + b(gC_E/(1 + gC_E)))$ |
| Using Freundlich: | $dM_M/dt = s(-aC_M + bC_E^g)$ |

| | |
|---|---|
| $M_M$: | mass of the compound in the material |
| $C_M$: | concentration of the compound in the material |
| $C_E$: | concentration of the compound in the enclosure |
| s: | surface of the material |
| t: | time |
| a, b, g: | constants |

Since the model is based on first Fick law and adsorption isotherm, some assumptions have been made:
- negligible fluctuations of temperature and atmospheric pressure.
- the volume of the enclosure is not bigger than two cubic meters.
- uniform concentration of the compound in the material and in the enclosure.
- fast diffusion in the material: the material should be either a thin film or be very porous.
- hysteresis associated with sorption and desorption cycles are negligible.

A database contains a list of the best fit model for specific pollutant - material systems. Up to now, the model can simulate many scenarios: the evolution of pollutant can be done with the presence of up to three materials inside the enclosure. Information such weigh and surface of the materials must be provided as well as the initial pollutant concentration in materials. Generation or disappearance of pollutants can be done to simulate new pollutant formed during degradation processes or disappearance of pollutants associated to irreversible reactions. Leakage rates of the enclosure are variable and the outside concentration can be linear, cyclic or having a shape peak at a specific time. The duration of the simulation is variable from few hours to few years. Runge- kutta method is used to solve the differential equations and the model is written in C++ codes.

As future step, more experimental data on pollutant - material interactions must be obtained. There is also interest to improve the model by considering the second Fick law which deal with the diffusion into materials.

---

Author to whom correspondence may be addressed:

Jean Tétreault
Canadian Conservation Institute
1030 Innes Road Ottawa
Ontario K1A 0M5
Canada
E-mail: jean_tetreault@pch.gc.ca

# Standards specification for display cases

**Velson Horie**
**The Manchester Museum, United Kingdom**

**Abstract**

It is well known that the care of objects is improved considerably by putting them into a display or storage cabinet. Expectations have risen but have not been put into a widely agreed format. This has created problems for conservators in preparing specifications for such cabinets and particulary for the manufactures of cabinets who have to respond to the idiosyncratic requirements of client museums for cabinet performance. With the lack of a widely agreed "industry standard", both users and suppliers of cabinets are uncertain about specifications. This leads to misunderstandings, increased costs for development and retrofitting improvements to inadequate cabinets.
This discussion paper is to present, in draft form, a "menu" of requirements whose clauses can be drawn upon to write specifications acceptable to both suppliers and end users.

---

Author:

Velson Hoire
The Manchester Museum
Manchester
United Kingdom
E-mail: c.v.horie@man.ac.uk

# Measurements from a museum case

**Simon F. Watts and Max Libedinsky**
**Oxford Brookes University, United Kingdom**

**Abstract**

Measurements of organic acids, hydrogen sulfide and carbonyl sulfide from a number of real (anonymous) and test museum cases are presented, which seems extremely difficult to interpret. Factors which affect the distribution of such measurements are discussed, and a simple model which comprehends some of the effects of convective mixing is applied to assist in their interpretation.

---

Author to whom correspondence may be addressed:

Simon F. Watts
School of Biological and Molecular Sciences
Oxford Brookes University
Headington, Oxford OX3 0BP, UK
E-mail: sfwatts@brookes.ac.uk

# Direct measurements of acetic acid by SPME-GC/MS, and calculation of emission rates from emission chamber tests

**Morten Ryhl-Svendsen* and Jens Glastrup +**
**The School of Conservation, Copenhagen ***
**The National Museum of Denmark +**

*Introduction*
In museum environments it is desirable that all construction materials which are to be used near museum objects do not emit reactive pollutants. We describe a new method to collect emitted organic components from an emission test chamber. The method is fast and does not use organic solvents. It is possible to detect acetic acid down to approximately 5-10 ppb.

*Emission test chamber*
A specimen of the material to be tested is placed in a stainless steel chamber with a volume of 227 liters. The chamber is flushed with a constant flow of purified and conditioned air. Normal test conditions are 23°C, 45% RH, and an air flow through the system between 0.01 - 0.2 $m^3$/h. The chamber set-up is described elsewhere [Ryhl-Svendsen, 1999].

*Sampling media*
Sampling is performed using Solid Phase MicroExtraction (SPME)(Supelco). SPME consists of a fused silica fibre coated with a highly adsorbant polymer which is fitted in a syringe-like holder. The polarity of the needle coating is chosen to match the polarity of the components of interest.

**Figure 1: The SPME holder with the fiber exposed (left).**

**The size can be compared with the pencil.**

Sampling is performed by exposing the fiber to the air leaving the chamber. Analysis of collected components was performed by gas chromatography/mass spectroscopy (GC/MS) using the injector to desorb the components collected. No organic solvents are used during analysis, and the time used from start of sampling to analysis results is 35 minutes.

**Figure 2: The sampling setup, connected to the chamber by teflon tubings. The SPME fibre is in position ready for sampling, at the white Omnifit teflon holder next to the pump.**

The air sample is sucked out of the test chamber exhaust manifold by a personal sampling pump, past a teflon holder with the SPME fiber exposed (Fig. 2). Fifteen minutes was found to be a sufficient sampling time, during this less than 4 liters of air were sampled.

*Calibration*
The fiber was exposed to a range of standard concentrations of acetic acid in air, from 5 - 400 ppb (approx. 12 - 1000 $\mu g/m^3$). There is a linear relationship between concentrations and chromatogram peak area within this range.

*Emission rate vs. concentration*
The resulting chromatographic peaks are proportional to the mass of the given component collected on the SPME fiber. This can be converted to concentration. However, when making a comparative study of a range of different materials the emission rate of the pollutant from the material surface is a more useful measure.

The general equation for the area specific emission rate (ER) of a material is:

ER = (C x F) / A

Where:
ER = area specific emission rate [µg/$m^2$h]
C = chamber concentration [µg/$m^3$]
F = air flow rate [$m^3$/h]
A = surface area of material [$m^2$]

*Three examples of tested materials*

1. Drawer for coin collections, made of Masonite and sycamore wood

A drawer from the storage vault of the National Museum's Coin and Medal Collection was tested. Lead coins kept in these drawers were found to corrode heavily. At the time of the emission test the drawer was about 12 years old.

Emission of acetic acid from one drawer = (930 µg/$m^3$ x 0.102 $m^3$/h) = 95 µg/h

Taking the surface area into account:
ER = (930 µg/$m^3$ x 0.102 $m^3$/h) / 0.550 $m^3$= **173 µg/$m^2$h**

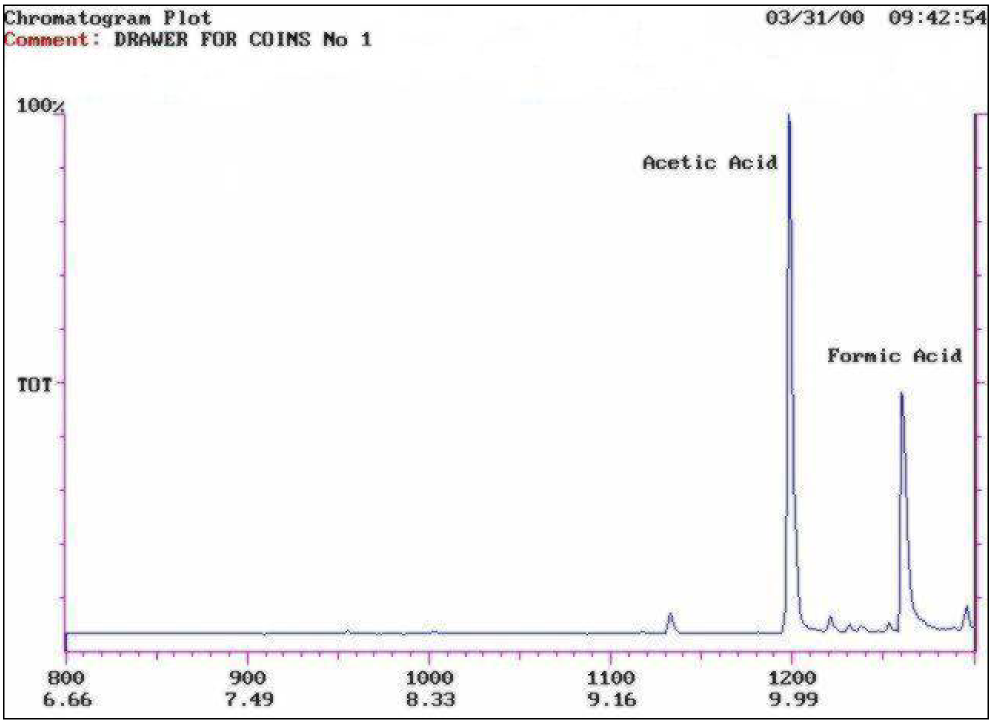



**Figure 3: Chromatogram of emission from the wooden drawer. The acetic acid emission was measured quantitatively but a formic acid peak is also visible.**

2. Cellulose acetate photographic negative

A cellulose acetate negative is of course not a construction material. However, it is an example of an object which acts as a pollution source, which is a difficult situation to cope with in museum environments. While bad construction materials can be discarded, museum objects or archival materials must be accepted within the collection. The air quality problems that may arise must be dealt with in other ways. This negative was chosen as an example of such objects. Cellulose acetate is found in a large number of modern cultural objects, unfortunately the material deteriorates, releasing acetic acid in large quantities. This is a well known problem for collections of photographic materials where it is known as "the vinegar syndrome". The tested negative is from the late 1950's, and shows signs of degradation.

Emission of one negative = (924 $\mu g/m^3$ x 0.096 $m^3/h$) = 89 $\mu g/h$

Taking the surface area into account:
ER = (924 $\mu g/m^3$ x 0.096 $m^3/h$) / 0.0190 $m^3$ = **4685 $\mu g/ m^2h$**

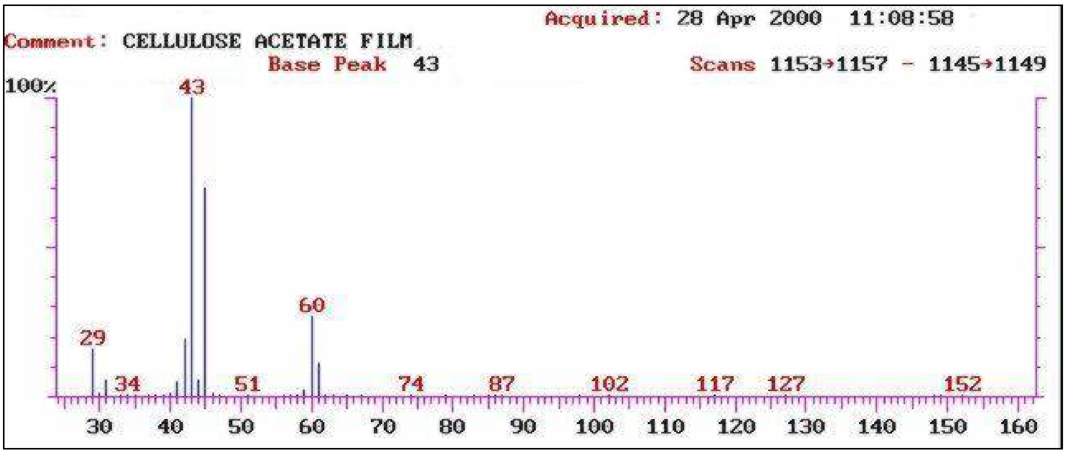



**Figure 4: Mass spectrum of the acetic acid peak from a cellulose acetate negative emission test. Together with the retention time from the GC chromatogram, a mass spectrum gives a high confidence in identification of compounds**

The two examples above illustrate well the usefulness of the emission rate concept. At first it seems that the two items are equal polluters, as they produce almost equal concentrations of acetic acid in the test chamber. However, taking the differences in their surface area into account (the negative is much smaller than the drawer) the cellulose acetate releases tremendous amounts of acid compared to the wood of the drawer. Actually the emission from the negative is so high that the base is deforming and shrinking, due to the deterioration process.

3. Silicone sealant (acid curing)
By monitoring the emission over time for a material, it is possible to estimate the time needed for the material to offgass until the emission rate of pollutants reaches a low enough level that the material can be considered safe.
As an example of this the emission profile for an acid curing silicone sealant (Bostik Silicone 2680) is shown below (fig. 5). The sealant was exposed in the chamber as a 0.5 m joint cast into an aluminium U-profile.

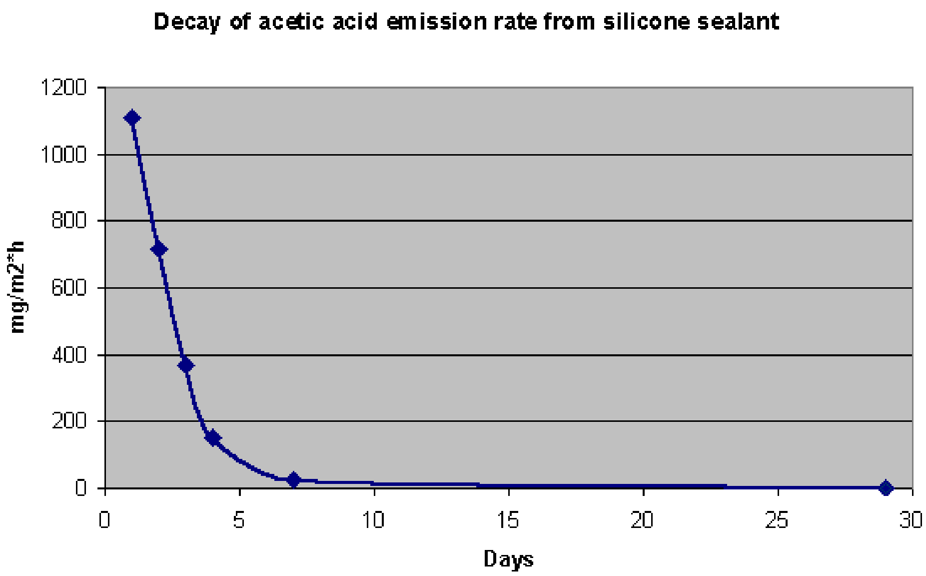



**Figure 5: Emission profile of Bostik 2680 silicone sealant over 29 days.**

*Concluding remarks*
SPME is a solvent free and cheap sampling method for acetic acid. Analysis is fast, and detection limit is in the low ppb level. The method seems promising also for formic acid: this will be the subject for further work. In general, SPME is useful for a large range of VOC's.

*Materials and method used*
SPME: 85µ polyacrylate (cat. no. 57304) from Supelco
Sampling setup: Omnifit Universal Septum (teflon) injector, nr. 3301 connected to a SKC model 222-3 personel pump by teflon tubing.
Analysis: 20 m J&W DB-wax column, 0.18mm id. 0.3µ coating, part nr. 121-7023.
Varian 3400 GC/MS

GC Method:

| Start (°C) | End (°C) | Rate (°C/min) | Time (min) |
|---|---|---|---|
| 30 | 30 | 0.0 | 3.0 |
| 30 | 230 | 15.0 | 13.33 |
| 230 | 230 | 0.0 | 3.0 |

*Related links*
The National Museum of Denmark, Conservation Dept. http://www.natmus.dk/cons/
The School of Conservation http://www.kulturnet.dk/homes/ks/
Sigma-Aldrich Supelco (SPME) http://www.sigma.com/supelco
Varian Inc. (GC/MS and SPME) http://www.varianinc.com/

*Reference*
Morten Ryhl-Svendsen: "The pleasures and pains of emission chambers - the construction of an emission test chamber at the National Museum of Denmark". In: Indoor Air Pollution: Detection and Prevention, Presentation Abstracts and Additional Notes. Instituut Collectie Nederland, Amsterdam, The Nederlands, 26-27 August 1999.
On-line: http://iaq.dk/iap/iap1999/1999_10.htm

---

Author to whom correspondence may be addressed:

Morten Ryhl-Svendsen
The School of Conservation
The Royal Danish Academy of Fine Arts

(Since 2001:)
National Museum of Denmark
Conservation Dept., Postbox 260,
DK-2800 Kongens Lyngby, Denmark
E-mail: morten.ryhl-svendsen@natmus.dk

# Soiling by coarse particles in the museum environment

**Young Hun Yoon and Peter Brimblecombe**
**University of East Anglia, United Kingdom**

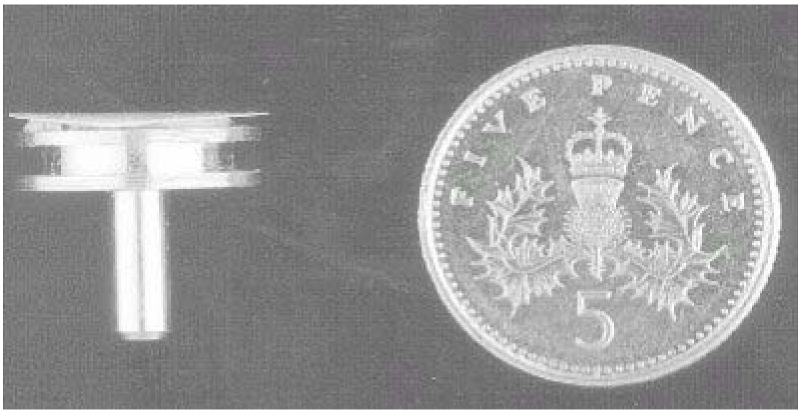
## Introduction

Soiling measurements are needed to address strategies for deposited dust control and to determine the source of the dust. There are many methods, which can be used to collect dust such as frisbee samplers, glass slides and sticky tape samplers. As we know, they have advantages and disadvantages. An important question related to this is what dust measurement technique provides the best proxy for soiling potential? At the moment, dust monitoring methods for museums and historic properties have no widely recognized standard method, although several methods could be developed in different situations. In our case, sticky samplers were used.

## Methodology

Our work has been concerned with COARSE PARTICLES because the particles deposited in dusty rooms are very large often in the 20-50 micron range. Such particles cannot be monitored as concentations in the air with conventional high volume samplers which are often unable to sample particles much above 15 microns. We have been interested in the way in which dust coveres objects and concerned with the area covered as a surrogate for soiling. Area proves relatively robust as an indicator because contrast change is dependent on area yet independent of particle brightness.

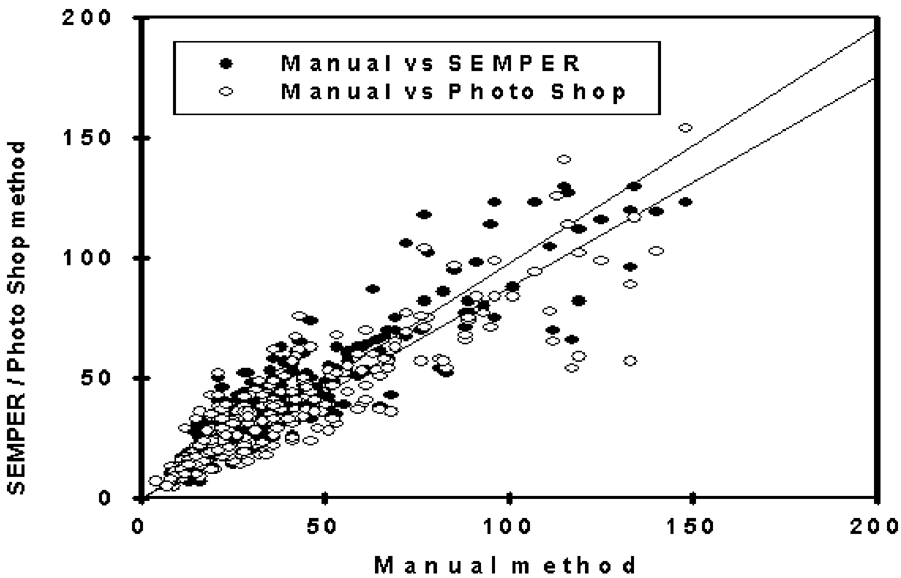
*Sticky samplers*




The sticky samplers were made with 1.3cm diameter circles of white sticky labels and attached to aluminum stubs using Blu-tack. The assembled samplers were attached to wall or panels in horizontal orientation with Blu-tack. These samplers were deployed ain three museums according to the sampling strategies such as vertical and spatial profile including different floor covering, different distance from visitor and different cleaning regimes. After exposing for about 2 months, these were analysed using two different approaches.

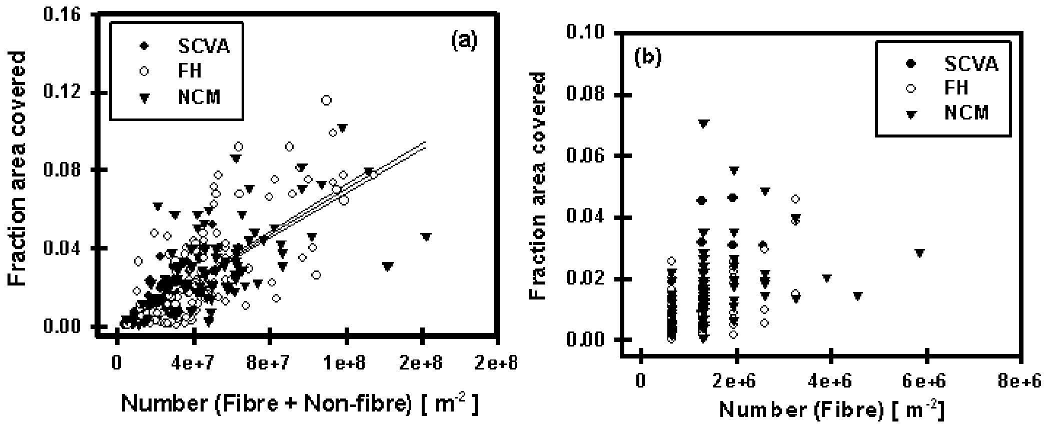
*Imaging*
As you know, optical microscope is a manual method, which is available to identify the particle types, colour and shape but there is a disadvantage; it is very time consuming. Adobe Photo Shop is a semi-automatic method. Fraction area covered can be measured automatically and counting through the monitor screen also available, but it does not offer the single particle sizing. SEMPER image analysis program allows particle counting, sizing and fraction area covered measurement automatically. To prepare the image samples, photo were made with same size and scanned with gray scale at high resolution. These have adjusted to the same brightness and contrast and converted to negative images using a Photo Shop. After this further image analysis used the program SEMPER. An important thing is that white or light colour particles such as quartz, gypsum, calcite and the white cloured fibres do not get detected. This required that these particles were re-painted again in the Photo Shop.

**Results**
*Correlation between manual and automatic method*
Correlation between the manual counting through and eyepiece and SEMPER was found to be 0.87 (n=247), which is reasonably good agreement. As might be expected, the counts witnessed by eye through a monitor screen also obviously showed good correlation ( $r^2$=0.81) also. These correlation are not perfect and some error might be caused by photographic quality, scanning bias or thresholding intensity in SEMPER, but



perfect agreement is not unexpected given the way in which we perceive fine particles under a microscope.

*Correlation between number and area*



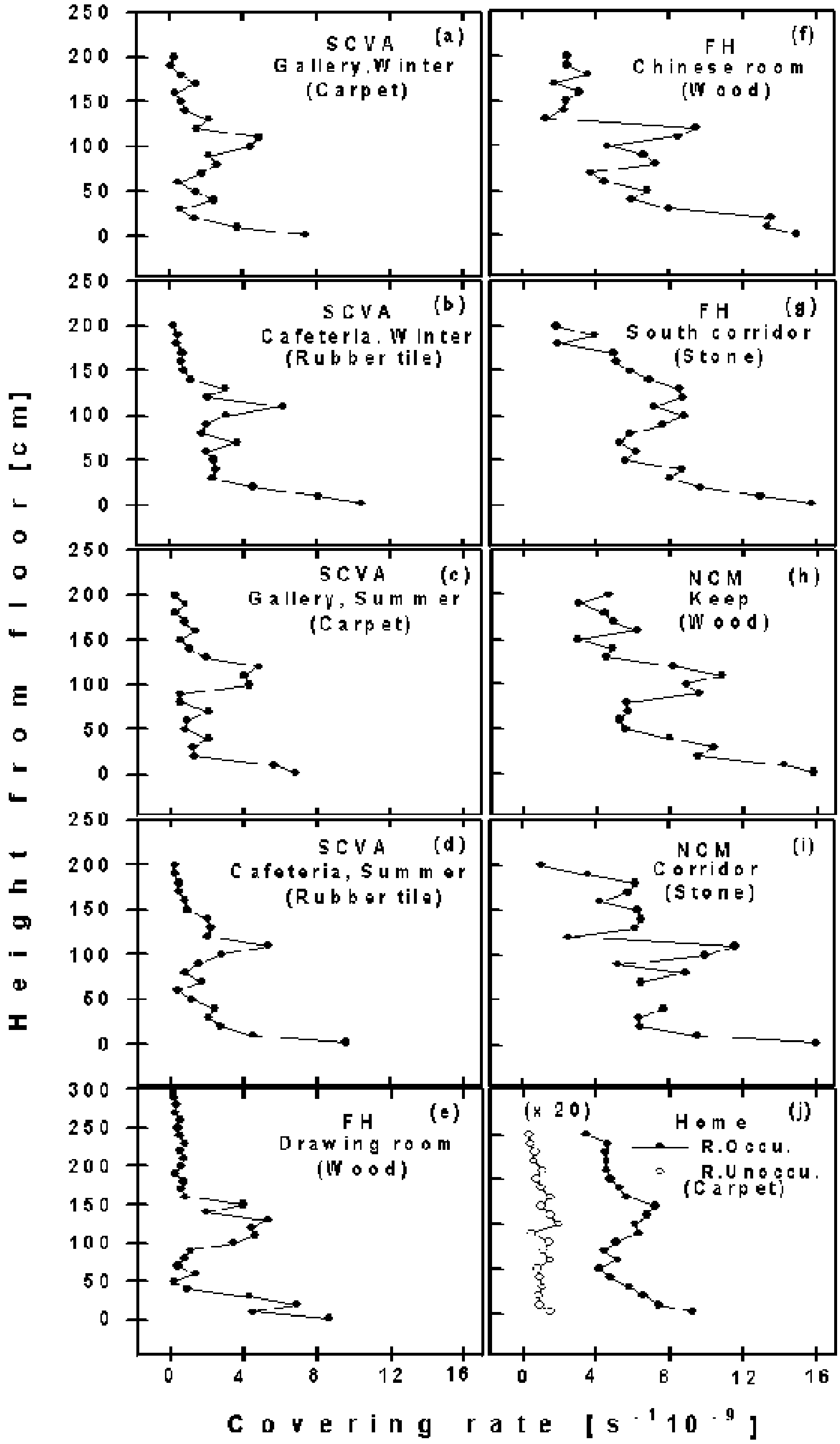

There is a reasonable agreement (R2=0.56) between fraction area covered and number of particles. Fibres which have highly variable length and so agreement is poor

*Vertical profile*

Particles deposited on the sticky samplers could be identified under the microscope, as: soil dust, soot, fibres and more rarely dandruff, plant and paint fragments, human hair, and insect parts (see figure next page).

All the profiles seem to have a similar characteristic shape, with elevated rates at floor level and typically 0.8-1.5m height above the floor. Our studies suggest that dust stirred from the floor by walking is most important in the first 30 cm above the floor. This does not seem to rise to any great height, perhaps only 20-30cm. This upward flux from the floor is probably of limited importance in soiling in historic materials, because such items are frequently found at eye-level. This means dust from the floor is not a primary source of coarse particles at eye-level.

At eye level the deposit appears to contain fibres shed from visitor's clothing, suggesting that they are the principal source. However, carpet fibres are only found in the very lowest levels about 2-20 cm and would clearly not affect normal eye-level objects on display. We can see the flux of particles and fibres are very much lower in the unoccupied room. The result shows that soiling decreases a factor of 14 and 17, for non-fibrous and fibrous dust deposition, when the room is unoccupied. Note that only the occupied room shows a clear maxima over the 80-150cm height range.

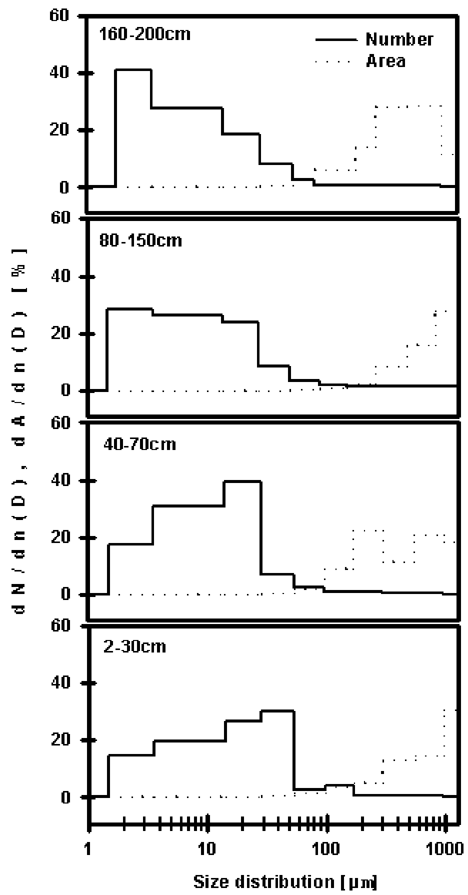

SCVA (a)
Gallery,Winter
(Carpet)
FH (f)
Chinese room
(Wood)
SCVA (b)
Cafeteria, Winter
(Rubber tile)
FH (g)
South corridor
(Stone)
SCVA (c)
Gallery, Summer
(Carpet)
NCM (h)
Keep
(Wood)
SCVA (d)
Cafeteria, Summer
(Rubber tile)
NCM (i)
Corridor
(Stone)
FH (e)
Drawing room
(Wood)
(x 20)
Home (j)
R.Occu.
R.Unoccu.
(Carpet)
Height from floor [cm]
Covering rate [s⁻¹10⁻⁹]

*Floor covering*

Conservators have long worried about the importance of floor covering in controlling interior dust level. We examined dust deposition in rooms with different floor coverings such as carpet, wood, stone, and rubber tile. The soiling on a per capita basis shows very similar, although thel sampling sites have different floors covering. An exception is the case of Drawing Room (Fig. e), where samplers were 3-4m from visitors shows much lower covering rates than in the South Corridor (Fig. g), where samplers were within 30 cm at the same flow of visitors passed. Therefore, this result could prove that floor type is not a significant factor.

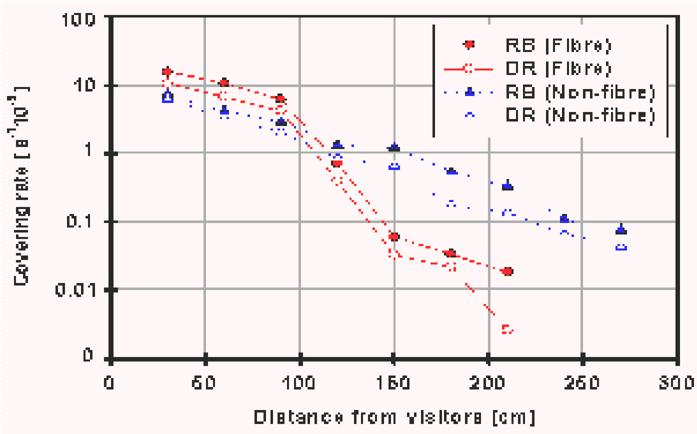
*Size distribution*

We also used SEMPER to class particle sizes on the sticky samplers in all the vertical profiles from the buildings studied. We can see that the smaller particles are most numerous in the highest elevation and the height of eye-level, although the very finest would not be observed in our light microscope. Close to the ground the most numerous particles are about 50 microns and also the coarse fibres almost a millimetre long predominate. In general it is fibres that make the largest contribution to covering the surface.




*Impact of visitor*

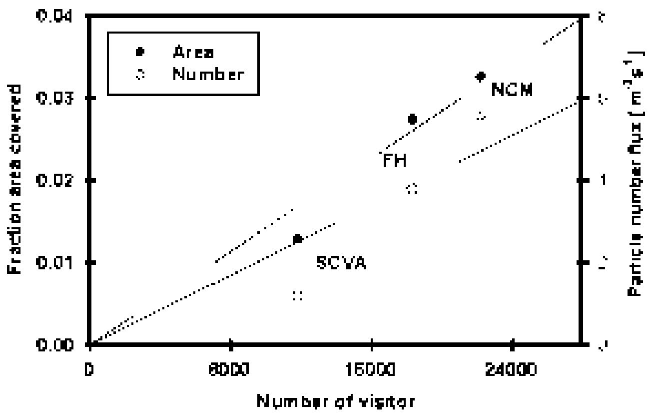
At the moment, we can have a question that where is the main contributor to increase the soiling degree at the eye level? To solve this question, we set samplers out at regular intervals on the floor in transects at right angles to the cordoned visitor pathway in the Felbrigg Hall.




The figure abowe shows the covering rate as a function of distance from visitors. It is plotted semi-ogarithmically to emphasise an apparent exponential decrease with distance of about 1m. Transects from both the Drawing room and Red bedroom show that the covering rate at floor level, declines by at least a half with every half metre from the visitor path.

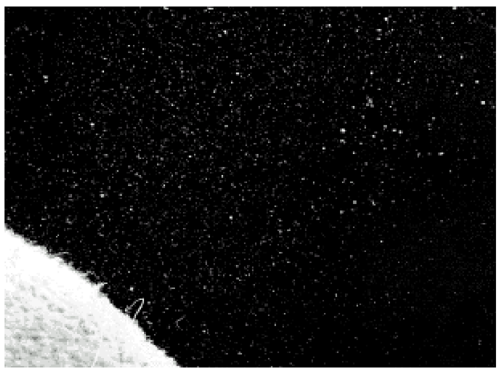
*Correlation between visitor and soiling (Soiling per capita)*

It was clear that visitor flow was a major contributor to soiling, such that soiling mechanisms in different museums could be compared on a per capita basis. The relationship between the average covering rate and particle flux at the three sites yields a satisfying relationship with visitor number. The high value in Norwich Castle Museum (NCM) seems to be an influence of the large number of visitors.




*Dust from clothing*

Clearly support for the source of dust that soiling derives from visitors comes from this close up photo of dust emerging from a woolen coat. (Scale about 10cm).



**Conclusion and discussion**

*Sticky sampler* - In this study, sticky samplers were used to measure the soiling potential in some museums and historic properties. Although sticky samplers have a problem if stickiness is lost, glass slides, which are frequently adopted in the museum environment, can lose larger particles. Furthermore sticky samplers have other advantages: 1) inexpensive 2) easy to make 3) high collection efficiency (stickiness of surface) 4) wide application (applicable for measuring particulate matter using SEM or image analysis) and 5) unobtrusive.

*Visitor* - It was clear that visitor flow was a major contributor to soiling, such that soiling mechanisms in different museums could be compared on a per capita basis. The proximity of visitors to objects was another important factor with the soiling declining which suggests soiling of objects on open display could be reduced by increasing the distance from visitors. It impact of visitors on coarse dust deposition declines rapidly by a half for each half metre from visitor pathways.

*Vertical profile* - Our studies suggest that dust stirred from the floor by walking is most important in the first 30 cm above the floor. At eye level the deposit appears to contain fibres shed from visitor's clothing, suggesting that they are the principal source. Thus carpetting may not necessarily be a critical source of dust for museums with eyelevel displays.

*Soiling unit* - The number of non-fibrous particles were always higher than fibrous particles, but of course they were much smaller, so simple particle counts expressed as particle number density and number flux are not necessarily a good estimate of soiling. Firstly, we adopt fractional area covered over the sampling period, but clearly this is better expressed as a covering rate with the units, s-1 *(i.e.* dividing the fraction covered by the number of seconds in the sampling period i.e. where eight weeks, 5.184x106s). Our early study indicated that the visitor is an important contributor to increase the dust level. Therefore, soiling could be expressed in final with fraction area covered, which is calculated per capita based.

---

Author to whom correspondence may be addressed:

Young Hun Yoon
School of Environmntal Sciences
University of Est Anglia
Norwich NR4 7TJ
United Kingdom
E-mail : y.h.yoon@uea.ac.uk

# A survey of wood based construction materials available on the Swedish market and their impact on metal objects

**Anders Karlsson**
**National Heritage Board, Sweden**

## Abstract

To give proper recommendations in selection of suitable construction materials for museums, we have recently started an inventory of products available on Swedish market. From these, ten products have been chosen. The selection is based on details such as production procedures, constitution and origin of raw materials, availability on market, construction properties etc. One board of each product, separately handled and sealed in a steady package during transport, will be ordered from the manufactures. The VOC emissions and their emission rate will be determined in chamber experiments in co-operation with the Swedish Institute of Wood Technology Research (Traetek) with the supply of gas samplers for small carbonyl compounds from the Swedish Environmental Research Institute (IVL). In parallel, the traditional material tests with metal coupons will be accomplished at the same conditions (23°C and RH 50%) to evaluate the emissions impact on copper, lead, silver, and zinc. The formed corrosion is evaluated by mass change in accordance to the method developed by the Swedish Corrosion Institute. In this way we intend to correlate determined emissions to the effects. With this knowledge we also intend to shorten the time needed for material tests with metal coupons in a controlled way, for a faster examination process in future.

---

Author to whom correspondence may be addressed:

Anders Karlsson
National Heritage Board / Riksantikvarieämbetet
Box 5405
114 84 Stockholm
Sweden

# Epidemiology of the museum world

**Jonathan Ashley-Smith**
**Victoria and Albert Museum, London**

## Abstract

*Introduction*
The title "Epidemiology of Museums" was suggested to me and I failed to change it in time, so it may not reflect the main thrust of this short paper. The subject that I will more nearly talk about was suggested by another of the organisers. This was the application of a cost-benefit approach to the introduction of standards for indoor air quality in museums.

Epidemiology is the study of epidemics. In medicine an epidemic is a disease prevalent among a community at a particular time, produced by some special cause not usually found in that locality. In a broader sense Epidemiology is a study of the appearance and behaviours of populations, aimed at determining whether any specific environmental factor tends to have a detectable effect on a significant proportion of that population. It is possible to identify components of indoor air that have some effect on the appearance and longevity of some objects inside museums. So taking the world population of the inanimate contents of museums it is reasonable to take an epidemiological approach.

Two basic rules are:

The behaviour of the whole population tells you nothing about the behaviour of one individual.

The behaviour of one individual cannot help you predict the behaviour of the whole population.

I will have to break the second rule and make some generalisations based solely on my own experience which is limited to one individual museum, the Victoria and Albert Museum in London. The main site of the V&A is a large building, constructed over a long period from the mid 1800s to the present day. Its outer surface is marked by a large number of doors, windows, light-wells, sky-lights and diverse roofing finishes. This porous structure is placed in a part of London that happens to have the highest levels of road-side pollution in the UK. Less than 10% of the gallery spaces are served by air handling facilities designed to remove pollutants. The trustees and director of the V&A are keen to promote the policies of New Labour which suggest that a greater emphasis should be placed on access than on preservation. Last summer the trustees passed a resolution that open display ( rather than display behind glass in a vitrine) should be the norm. The current enthusiastic interpretation of access is that there should be absolutely

no barrier between objects and people. Although this definitely does shift the emphasis away from preservation It is difficult to argue that it is in contravention of the UK Museums Association definition:
"Museums enable people to explore collections for inspiration, learning and enjoyment. They are institutions that collect, safeguard and make accessible artefacts and specimens, which they hold in trust for society." (my underlining)
So, for a great part of the V&A collections, far more pressing worries than pollutant gases in indoor air could be the effects of touching ( including theft) and the effects of use ( Fig 1), In terms of balancing risks it should be noted that at least one aggressive component of indoor air (acetic acid) really only becomes a problem when there is a barrier between visitor and object.

**Figure 1**

*The Behaviour of Museums*
The subject of IAQ with its attendant costs and benefits needs to be put into the context of observations about museums in general.
Figure 2 shows a graph applicable to a number of museum phenomena. The horizontal axis shows increasing time starting at a point about 100 years ago. The present date is shown by the vertical line marked "now". The vertical axis marked "numbers" could represent numbers of :

Museums- the idea of centrally held publicly accessible collections is quite recent. The number of museums increased dramatically in the last quarter of the 20th century and then began to decline due to lack of interest and finance. These days museum closures are more frequently, though less publicly, reported than new openings.

Visitors- interest in museums, especially art museums, and particularly decorative art museums, is declining. Last year visitor numbers at the V&A and at 'Tate - old fashioned' were down by 16%.

Objects- if politicians, who speak about making museums more efficient through the strategic use of the auction house and the skip, get their way, the decline could be dramatic.

Funds- Government funds for National Museums have been declining in real terms for some years. The V&A today has a grant that is 25% lower than ten years ago.

It is in this environment that the balance of access and preservation is being judged. It is in this light that the costs of increased mechanical or passive control for the alteration of indoor air quality must be assessed.

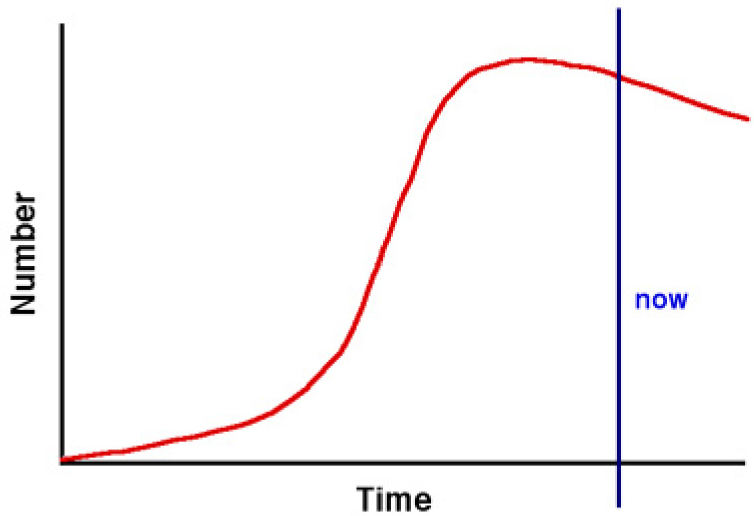



**Figure 2**

*The Introduction of a Standard*

There is a lot of talk about standards and whether they are in fact different to guidelines. People are afraid of standards because they tie you down and can be used as offensive weapons against an individual point of view. The reverse argument is that they tie your adversaries down and can be used as a defensive weapon against them. Either way it has to be decided whether the aim of introducing standards is generally to decrease the attack by pollutants on objects of cultural value or expressly to specify numerical targets that are independent of local conditions or constraints. Apart from a slightly greater sense of freedom, guidelines do not release you from this decision. The introduction of either standards or guidelines must be shown to have a net benefit.

Figure 3 shows a sensitive way of detecting any change in a range of measurable factors to do with museum performance. The horizontal axis shows increasing time. The introduction of, and compliance with, a standard for improved IAQ is marked by a vertical line at some specified date in the immediate future. The vertical axis marks positive or negative changes to the factor in question. No change whatsoever would be shown by a horizontal line starting at zero on the vertical axis. Any continuous change is shown as a horizontal line at some other value. Any discontinuity in the rate of change would be seen as a step between two horizontal lines.

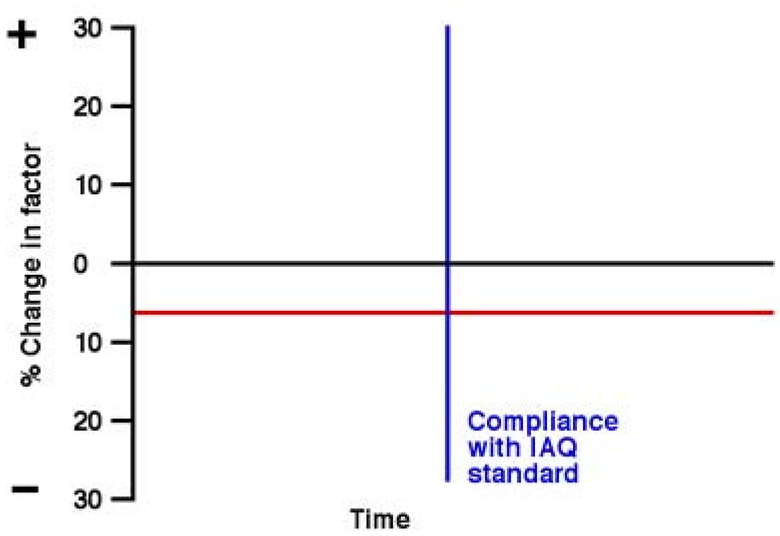



**Figure 3**

The red line shows a continuous slow decline in any number of museum performance indicators: Number of visitors, number of school parties, income from the shop, income from central government , income from sponsors. It probably also represents the overall state of the collection, and even the total value of the collection. All of these are completely independent of compliance with a standard. Even if compliance did lead to a lowering of the concentration of some airborne pollutants this would only be noticed as a very slight change in the rate of decay in the collections. The effect of this on public access and enjoyment in the immediate future is negligible if not actually zero.

Figure 4 shows one possible discontinuity. The small number of grants currently available for capital projects from the Heritage Lottery Fund might increase slightly because compliance with standards tends to ease the stage of the process where the environmental advisor is involved. This graph would then also respond to the change in running costs.

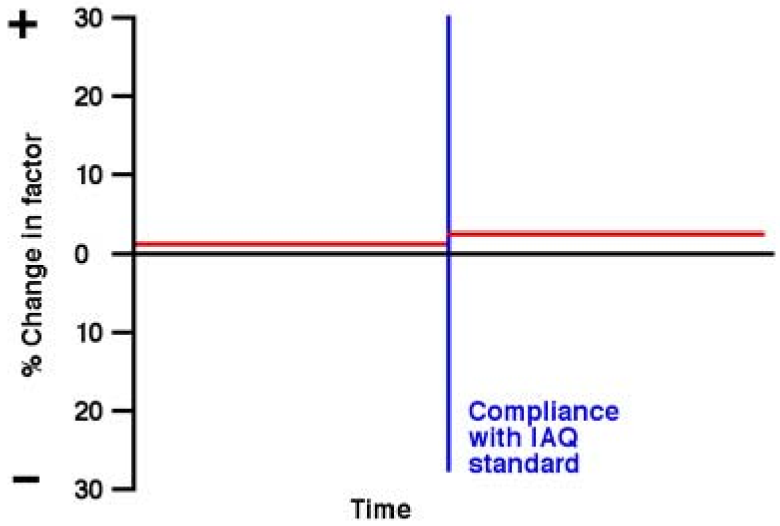



**Figure 4**

*The Need for Research*
This meeting is not only about the need for standards but about possibilities for research funding. It is possible to carry out a cost-benefit assessment for a research proposal just as easily as for the introduction of a standard. There are two reasons why a cost-benefit approach might not lead to the sudden release of funds for research into IAQ in museums. Firstly a slight decrease in pollutant levels is unlikely to have a provable effect on any of the criteria that are currently used as museum performance indicators. Secondly so much good work has already been done that it becomes increasingly expensive to make a marginal improvement.

This is shown in Figure 5. The costs of obtaining new information continue to rise with time yet the increase in valuable knowledge resulting from continued research in a specific area tends to tail off after a while. It is now perfectly possible to construct a very-low-exchange-rate display case in which the only non-inert material is the object displayed. Future research into the mathematical modelling of display case environments is unlikely to result in a sensational improvement. Research is only necessary to predict the result of poor management decision-making or to minimise the damage caused by designers who insist on using cheap or dramatically different materials. Only if the change in value of the whole world stock of museum collections is taken into account is there justification for further extensive research. And then this should be carefully planned with a limited number of partners and extensive communication of results.

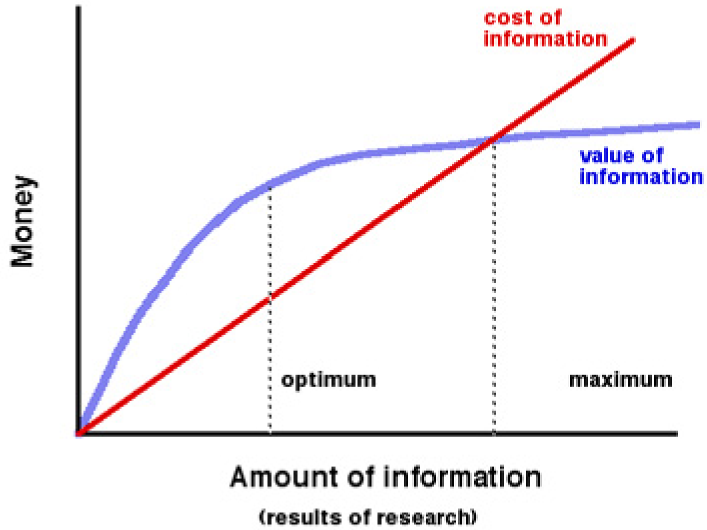



**Figure 5**

The necessary stages in any Cost Benefit Analysis (CBA) are shown in Fig 6. The most important step for museum collections is step 6, the calculation of net present value. This is the estimation of the value now of the expected future streams of costs and benefits, ( for a fairly clear and simple explanation of this see my book "Risk Assessment for Object Conservation"). If the benefits continue to be much greater than the costs, well into the future, then the net present value is high.

The tarnishing of silver gives a good example. In an environment where tarnishing is rapid, the cost of cleaning and protection continues to be high and the benefit to the viewing public of dirty silver objects is traditionally considered low. The annual cost of failure of protective measures for silver objects at the V&A is around £20,000 in cleaning expenses. Suppose that some mechanism was employed that reduced this by 90% it would be reasonable to expend at least £100,000 on plant that had a lifetime of 30-50 years ( the NPV of saving the cleaning costs but probably incurring new maintenance and running costs). However since the Museum has already recently invested in new showcases, which have not dramatically reduced the rate of tarnish, this money would have to be spent on unobtrusive modifications. and would need compelling evidence that the 90% saving would be made. Given the small likelihood of affordable new research quickly leading to confidence in the outcome of retrofitting existing cases the museum will probably accept the cost of cleaning for the time-being.

Figure 7 shows a flow-chart for the CBA approach adopted by The National Acid Precipitation Assessment Program ( NAPAP). By each of the stages is a letter which indicates whether in my view the process involves observation, measurement, calculation, development of theory or value. Although some of the stages rely on hard science there are just as many that require soft research into aesthetic values and the relationship between condition and continuing benefit. The same analysis is valid for indoor pollution and it suggests that application for research funding could equally be made to the Arts and Humanities Research Board as to any of the traditional science research funders. This research might possibly lead to a better valuation of changes in the state of collections which might in turn justify the expense of further scientific research.

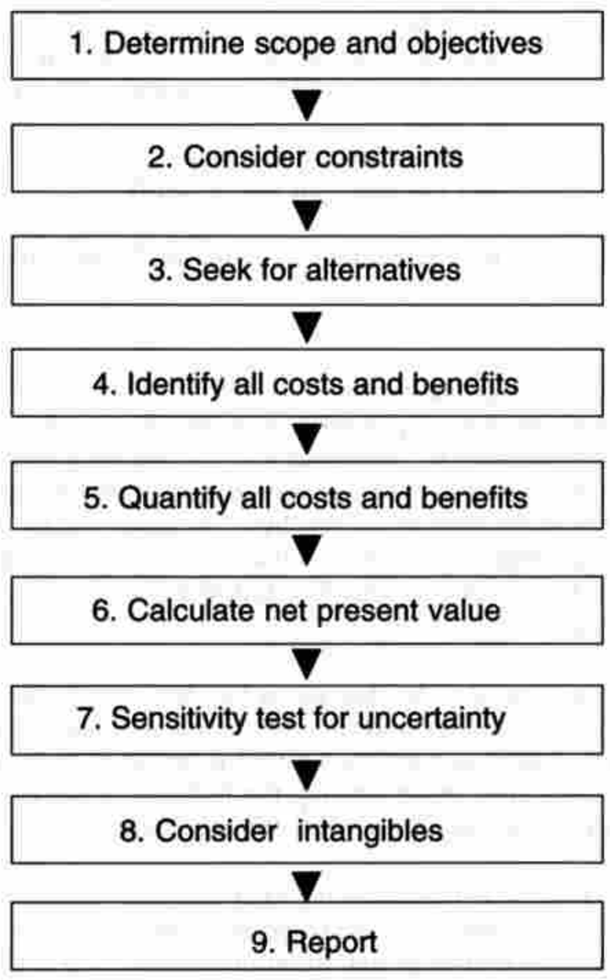



**Figure 6**

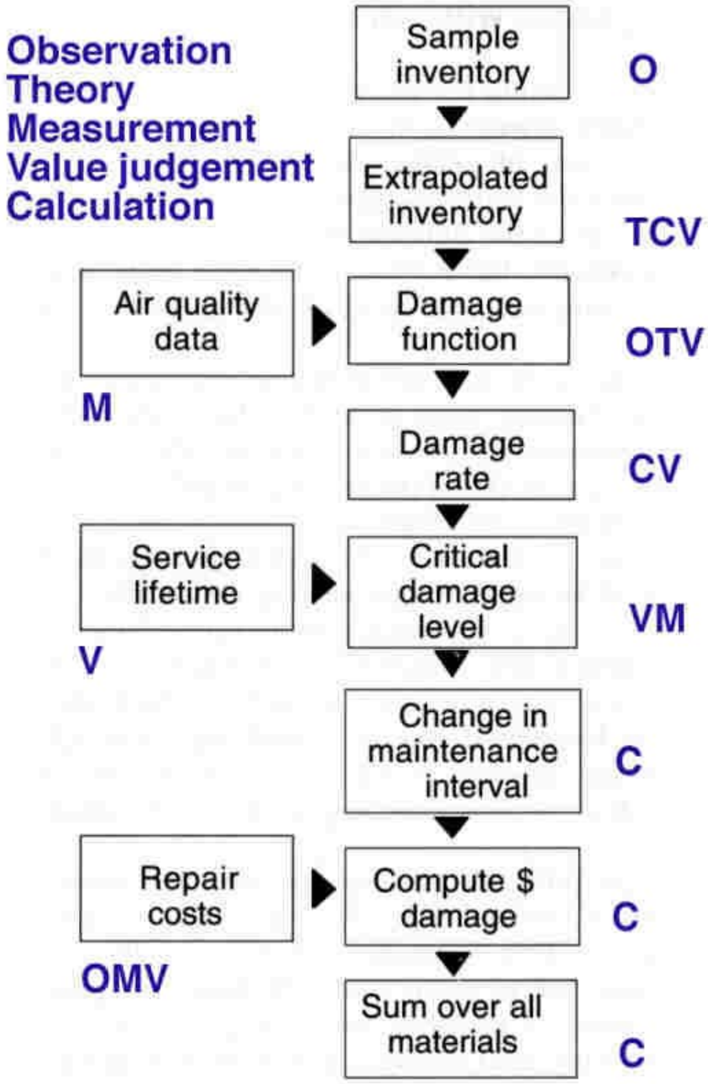



**Figure 7**

---

Author:

Jonathan Ashley-Smith
Victoria and Albert Museum
South Kensington
London SW7 2RL
United Kingdom
E-mail: Jonathan@vam.ac.uk

# Conservation, research and the budget - a sharp end view

**Andrew Calver**
**Museum of London, United Kingdom**

**Abstract**

The Museum of London as a museum of social history has a wide ranging collection displayed and housed in a thematic chronological format rather than in a typological or art historical arrangement. The museum opened in 1976 in a purpose built building with a full air conditioning system incorporating carbon filters. Externally generated pollutants were first measured in 1977 and regular monitoring has been undertaken since 1984. Recently this has included the monitoring of internally generated pollutants such as hydrogen sulphide and carbonyl pollutants. The museum has a small conservation department that prides itself on its practical and pragmatic approach to conservation. There is a 'can do' culture with an emphasis on problem solving - risk awareness and management rather than risk avoidance.

The museum has devoted considerable time and resources to tackling the 'problem' of indoor air pollution following the now familiar path of avoid, block, detect and respond. It also offers advice and guidance to many local and regional museums, many without conservators. The primary pollution strategy is a combination of material testing, reducing emissions with coating and barrier films and ventilating enclosures to dilute internally generated pollutants with the chemically filtered gallery air. Empirical observations of the objects and metal test coupons demonstrate that we have very few problems - therefore it could argued our methods work. However, it can also be argued that for large mixed collections the attention devoted to pollution is out of proportion to the resources devoted to this issue. At the museum compromises often have to be made that can effect the quality of the control measures or the content of an exhibition.

A rapidly changing temporary exhibition programme, proposals for new galleries and a new financial bidding system coupled with an acceptance of the cost benefit and risk management approach to conservation has ment that a review of our pollution mitigation strategies and standards is required to ensure that we can justify the considerable effort and cost involved.

The work that the museum has undertaken has been of a pracital nature backed up by observations and some monitoring data. The data set is often quite limited and some inferences have been drawn in the past that may not be justified. Some examples of the problem relating to our pollution mitigation strategies will be illustrated together with

our potential plans for further work and areas where we can feel collaborative work should be undertaken.

Many of the key questions about internally generated pollutants have been repeatedly raised over the past 30 years such the issue of ventilating or sealing enclosures. There is a considerable body of experience and research that should be used to produce sensible pragmatic guidelines - not necesserily fixed standards or thresholds - but as an essential guide to decition making that is required now. Co-ordinated research into certain key areas is important but the sharing of experiences and research with others cannot wait until some theoretical point in the future when we think we know all the answers as that point will never come.

---

Author:

Andrew Calver
Museum of London
150 London Wall
London EC2Y 5HN
United Kingdom
E-mail: acalver@museumoflondon.org.uk

# Universities and Museums: an account of work in progress - the UK DETR-funded research project 'Energy Efficient Pollution Control in Museums and Galleries'

**Tadj Oreszczyn*, Nigel Blades* and May Cassar+**
**Bartlett School of Graduate Studies, University College London ***
**Resource: The Council for Museums, Archives and Libraries +**

**Abstract**

The UK Partners in Technology project 'Energy Efficient Pollution Control in Museums and Galleries' was carried out with the aim of improving the energy-efficiency of environmental control in museums and galleries by developing sustainable pollution control strategies. The study was a collaborative one, involving a university, five museums, and a filter manufacturer, all as active partners.

OUTLINE OF WORK

The objectives of the project were met by the following programme of work:

1. Monitoring pollution concentrations in five buildings - two naturally ventilated (Dreadnought Study Collection Centre of the Horniman Museum and The Manchester Museum), two air-conditioned (Museum of London and the Theatre Museum) and one with a mixture of air-conditioned and naturally ventilated galleries (Victoria & Albert Museum).
2. Producing a hierarchy of potential improvements to the building fabric and services to reduce pollutant levels while monitoring the implications these have for energy use.
3. Performing intervention studies within four (Horniman Museum Dreadnought Study Collection Centre, Museum of London, The Manchester Museum and Victoria & Albert Museum) of the five buildings.
4. Developing methods and prototype components to reduce pollutant concentrations by passive and active techniques.
5. Produce design guidance for the heritage sector and the building services industry on how to choose the most appropriate pollution control strategy. (Guidance document to be published in December 2000. Details on how to obtain a copy are at the end of this abstract).

KEY RESULTS

1. Monitored pollution levels in several naturally ventilated storerooms at the Horniman Museum Dreadnought Study Collection Centre were found to be as low as in air-conditioned galleries with carbon filtration, such as those at the Museum of London.
2. Internal surface deposition of pollutants reduced internal pollution concentrations by up to 90% in naturally ventilated storerooms, such as those at the Horniman Museum Dreadnought Study Collection Centre.
3. Novel materials, such as the carbon-impregnated fabric tested at The Manchester Museum may act as passive pollution scavengers, reducing internal pollution concentrations in a naturally ventilated gallery or storeroom. More research is required to confirm this result.
4. In air-conditioned carbon-filtered buildings, for pollution control to be effective the system must be correctly operated and maintained, and filters must be replaced with high-quality units at appropriate intervals.
5. Air-conditioned buildings often operate at higher ventilation rates than naturally ventilated buildings and hence if they are not equipped with carbon filtration, higher internal pollution concentrations than in naturally ventilated buildings will occur.
6. Localised carbon filtration can control internal pollution concentrations significantly even in buildings with high ventilation rates. The power consumption of one unit tested was 10.5 W m-2 of conditioned area, based on an area of 64 m2. The annual cost to run this, assuming continuous operation would be 5870 kWh. This is 1% of the estimated energy cost of a full museum air-conditioning with filtration system. Clearly, where it is necessary to control only a few localised zones it is more economic to install local units rather than a central system.
7. Monitored external concentrations of nitrogen dioxide can be up to 50% higher at the front of a roadside building compared to the rear.

MAJOR CONCLUSIONS ARISING FROM THE PROJECT

- The main method of pollution control in current use i.e. centralised carbon filtration, is not the only viable method of reducing pollution in many museum buildings, although it is often perceived as such.

- Current guidance for building services engineers does not take into account surface deposition, which can significantly reduce the need for active pollution control.

- The measured energy consumption of air-conditioned museums is approximately twice that of naturally ventilated museums per m2 of display area. We estimate that approximately 25% of the energy consumed by the air-conditioning fans in a system such as the Museum of London's is expended in overcoming the pressure drop caused by the filter bank. Clearly, there is the opportunity for large energy savings, reduction in maintenance costs and plant size through the use of alternative pollution control strategies, as described in the technical report ('Energy Efficient Pollution Control in Museum s and Galleries Milestone 6: Closing Technical Report', March 2000).

- Localised filtration can provide highly effective pollution control for smaller galleries and rooms in an energy-efficient manner. It would be most appropriate to use this method in situations where it is important to provide clean air to a few critical zones. The energy cost per zone treated (based on a room area of 64 m2) could be as low 1% of the cost of a fully centralised system. If it is necessary to treat a large number of zones, diminishing returns apply as penalties in terms of maintenance and capital cost come into play. In this situation a centralised system may be the better option.

- The naturally-occurring process of surface deposition, either to existing surfaces, or to purposely-introduced absorbing materials will significantly reduce reactive pollutant concentrations, provided the ventilation rate of the room or gallery is low, ideally below 0.5 air changes per hour for effective control of nitrogen dioxide. This approach has no energy or maintenance costs but some capital costs in terms of the absorbing materials and measures that may be necessary to reduce air infiltration and achieve a low ventilation rate. This approach can be made to work well in stores, archives and perhaps some less visited galleries. It is less appropriate for galleries with large numbers of visitors, which require a high ventilation rate for human comfort.

These conclusions are not only important to museums and galleries. They are equally relevant to other heritage buildings, such as libraries and archives. They are also important conclusions for designers and operators of more mainstream building types such as commercial and domestic premises.

FURTHER INFORMATION
For further information please contact:

May Cassar
UCL Centre for Sustainable Heritage
The Bartlett (Torrington Place Site)
University College London
Gower Street, London WC1E 6BT, UK
E-mail: m.cassar@ucl.ac.uk

Tadj Oreszczyn
Bartlett School of Graduate Studies, (Torrington Place Site)
University College London
Gower Street, London WC1E 6BT, U.K.
E-mail: t.oreszczyn@ucl.ac.uk

Nigel Blades
Bartlett School of Graduate Studies, (Torrington Place Site)
University College London
Gower Street, London WC1E 6BT, U.K
E-mail: n.blades@ucl.ac.uk

The guidance document developed from this project, "Guidelines on pollution control in heritage buildings", will be published as a special supplement to the journal Museum Practice, and will be sent free to subscribers in December 2000. Further copies are available at a cost of £15 from: *The Secretary, Bartlett School of Graduate Studies, (Torrington Place Site), University College London, Gower Street, London WC1E 6BT, United Kingdom*

# Quest for that pot of gold

**Agnes W. Brokerhof**
**Netherlands Institute for Cultural Heritage (ICN)**

### Abstracts

Listening to presentations on conservation research in the UK and hearing the remarks about funding, the UK seems to be familiar with a situation that we in the Netherlands are slowly getting used to. Conservation research in the Netherlands grew up in a protected environment of government funding and only the last decade one can see a change in attitude due to a change in funding.

Contrary to the UK, The Netherlands is a rather small country with a rich history and a high density of cultural institutions. Distances are short, both travel distances within the country and distances between people. It is a small world and lines of communication are short. This has favoured the development of a central conservation research facility to support all the museums, archives and libraries in the country. Early '60s the Central Research laboratory (CL) was founded which in 1997 integrated into the Netherlands Institute for Cultural Heritage (ICN); a government funded organisation, drawing its money from the 'culture' budget.

During the '60s thru '80s conservation research was a centralised affair, based on primary funding, the CL providing its services to museums free of charge. Museums themselves did not really have the facilities to do laboratory research; they were the partners and clients. Money was guaranteed and there was a great degree of freedom in selecting topics and time frames for carrying out research projects. In those days there were some other research initiatives, mostly university projects, which drew their primary funding from the 'Science and Education' budgets.

The move towards efficiency and the cutbacks of the late '80s, early '90s brought a change in attitude and in funding in the entire science world. At the same time 'arts' and 'conservation' became fashionable topics that worked well to interest financers in research projects. Meanwhile, the profession had developed and the awareness had grown.

In The Netherlands we have the National Science Foundation, the organisation which awards extra research funds based on a system of peer judgement, especially for more fundamental research. Research institutes that already had a history with this funding body picked up the study of the arts and conservation as topics to carry on their work. Cooperation between university science institutes and museums came to existence of which the MOLART project is probably the best known example. The CL and ICN are

not directly eligible for these funds as the research is too applied, yet we can participate in projects.

Another source, becoming available after 1993, was the EC which did offer opportunities to fund conservation research, promoting international efficiency through cooperation accross the borders. Conservation science also found the way to tertiary funding. The concept of sponsoring was discovered. Industry became interested in funding or providing services for art research and conservation science. Examples are the Rembrandt Research Project (sponsored by DSM) and Shell's involvement in the technical examination of art works with SEM.

If we look at some figures of the past five years the change in funding of conservation research in the Netherlands is quite distinct. The CL in the past and the ICN nowadays have about 30 people working in conservation research: study of historical and contemporary sources, of material degradation, developing methods for conservation, diagnosis and consultancy in situ, collection management advice. While 5 years ago conservation research was funded 100% by primary sources and staff was mainly employed on permanent positions, it now is funded for 25% from secondary and tertiary sources with about 25% of staff on temporary contracts.

| | | **CL 1995** | **1996** | **ICN 1997** | **1998** | **1999** |
|---|---|---|---|---|---|---|
| Staff | I | 4.0 | | | 4.1 | 3.8 |
| Material | I | 0.4 | | | 0.2 | 0.1 |
| | II | - | | | 0.5 | 0.7 |
| | | - | | | 0.2 | 0.3 |
| | III | - | | | 0.33 | 0.45 |
| **Total** | | **4.4** | | | **5.03** | **5.75** |
| **% primary** | | **100** | | | **80** | **75** |

Table 1: A rough estimate of funding of conservation research in The Netherlands (in million DFL; 1 Euro=2.20 DFL)

These developments have some implications that become slowly visible, some of which are positive, others perhaps less so. The new financers want results for their investments and projects have become more outcome oriented. The number of players has increased, making the competition tougher. At first sight this may look as a drawback as the chances of projects being awarded decrease, but it has the positive spin off that the quality of the proposals has grown with the years. Yet again, with the wider interest, the content of projects has become more diffuse. The diffusivity is also promoted by the development of the profession, which urges us to dig deeper and look in a wider perspective, and the technology drive behind projects.

One of the hidden dangers of the change in funding is that the increased external funding does not provide arguments for increasing the primary government budget. In a traditionally non-commercial field it is exactly that budget that guarantees continuity. Permanent staff of our institute are paid for by the primary budget which also covers the basic material needs. The increase of research capacity comes from project funds. Our conservation science department for example has grown about 25% in the last years, matching the increase in budget. These new, young, enthusiastic scientists are working on temporary contracts. That follows the trend towards a flexible working force but it worries me because conservation science is taught on the job, there is no specific training program, at least not in The Netherlands. When the projects finish and money runs out, the young conservation scientists either have to get a new project or try to find permanent employment elsewhere, taking the expertise with them. So, as a centre of excellence, which we want to be, we have to ensure that we store their knowledge, but much rather we would like to keep the people as well because they have grown into the team.

To guarantee continuity new projects have to be brought in on a regular basis which carries the risk that projects are designed for the sake of the project rather than the relevance of the research. If you want to stay in the game, you are almost forced to design big projects, large cooperations, politically correct, which may be a challenge to some, but are usually a monster to those who want to roll up their sleeves and get to work. I do not say that big projects do not generate new knowledge, but keeping in mind the demands of the conservators and restorers we do it all for, we need to deliver practical results and applicable solutions to their problems as well. It has to do with the balance between operating pro-active or re-active. When our institute worked pro-active, pioneers in the field, it was urged to become more re-active, responding to the demands of the museums. While now, with the move towards finding alternative funding, the risk exists of drifting off towards being too pro-activite again.

At our institute another development took place as well. With the semi-privatisation of the state museums, the free of charge service, which had always been taken for granted, disappeared. The more commercial way of thinking even made it to our institute. We now have the policy that research which tries to find solutions for general problems and gains general knowledge is carried out at our own expense; investment in knowledge. But research that is a direct consequence of a problem in a particular collection, short term contract research, is charged for, be it still highly subsidised. That way we generate a tiny bit of extra revenue to do a bit extra, go to a conference. Not too much, a few percent tops, because we do not want to scare away the customer with a high cost threshold.

Most of these developments are irreversible but do not really form a threat for the relevance of conservation research as long as we realise what we are doing and why. It has everything to do with knowing ones core-business. I am of the old school that believes that conservation research bridges the gap between more fundamental studies

and the conservators/restorers with their problems. Transforming the question into research, translating results into applicable methods and useful advice.
Nowadays, conservation research cannot rely on primary funding alone, we need a bit of pragmatism and creativity to generate those extra funds required in an expanding research field where development goes hand in hand with the need for expensive equipment. The quest for that pot of gold is going to require more of our precious time, but at least there are pots to be found! However, we have to stay in close contact with those for whom we gain our knowledge, to prevent us from drifting away with the flow of the big bucks.

---

Author:

Agnes W. Brokerhof
Netherlands Institute for Cultural Heritage (ICN)
Gabriel Metsustraat 8
1071 EA Amsterdam
The Netherlands
E-mail: agnes.brokerhof@icn.nl

# Stamina and persistence, the keynotes to successful grant applications for conservation science funding

**Norman Tennent**
**Netherlands Institute for Cultural Heritage (ICN)**

Greetings!
I hope the IAQ Meeting is going well. I am sorry not to be with you. It is ironic that I have to deal with some planning problems associated with the EC SILPROT Grant rather than talking in Oxford about the potential of EC Funding for Conservation. I would much rather be in Oxford!

I hope that a few thoughts from someone who has been seeking funding for conservation science for 25 years may be helpful to today's discussions. My remarks are personal ones and my perspective is by no means comprehensive but these words come from the heart. Conservation science needs greater funding and, in Britain, more coordination is necessary.

I think a little background about my own successes and failures in getting funds for conservation science research may be helpful.

In the past ten years I have obtained packages from various sources amounting to more than half a million pounds. This sum was made up of a dozen or so grants, consisting of several modest amounts and a couple of large sums.

The success rate in applications has been about 50%. That's a pretty respectable figure and I shall give an explanation for this in a moment.

The range of sources for theses funds include:
1. Conservation-related bodies (eg Scottish Conservation Bureau and The Conservation Unit)
2. Grant awarding bodies with categories relevant to conservation (eg British Academy)
3. Private Trusts
4. The Science Research Councils in the UK (eg NERC, EPSRC)
5. The European Commission

These five categories are still relevant. But the present situation in Britain seems to me less optimistic now than for many years. Some bodies, such as the Conservation Unit, have vanished and the resources of the British science research councils are so stretched that, because it has no special umbrella council, conservation science applications will be doomed to failure as misfits. Conservation science in Britain has always been a difficult hybrid for research council funding. There was a point where the Science-Based Archaeology Committee funded several projects, but many conservation projects - especially those not concerned with archaeology - were ineligible. I well remember the meeting attended by representatives from the main funding bodies, held in London several years ago. Gerry Hedley lamented that an application of his for research on paintings has been turned down by the Science-Based Archaeology Committee because the paintings had not been excavated in an archaeological dig!! Interestingly, this work subsequently scored funding success from the Leverhulme Trust.

At present, when alpha-rated projects do not always get UK research council funding, I personally do not give serious consideration to the possibility of funding from this source. Until conservation science is recognised as a valid field of endeavour, in need of special support, I believe the competition with other, better-established branches of science will spell failure for conservation science applications.

I do not know, and it would be interesting to hear of the situation in other countries. Interestingly, in The Netherlands, research council funding from NWO has given a great boost to painting research through the MOLART project, funded to the tune of several million guilders. A second project will soon get underway. I see this as a good starting point for other European countries. NWO has already expressed interest in working with sister organisations in other countries with a view to the possibility of bilateral funding.

In Europe, however, the most obvious source of major funds for conservation research is the European Commission. Several of you have had success and will know that preparation of EC applications is a forbidding process. My estimate is that a research grant application will need at least 2 person months work to prepare. Three or more months may be a better commitment for an application to succeed. I estimated that, at the recent funding round, the applicants had spent a total of approximately 20 person years seeking the EC pot of gold. Less than ten projects were actually funded. But the pot is there, and the EC Directorate General XII category "Preserving Europe's Cultural Heritage" is specifically designed for our field.

For our small indoor pollution group, the notion of EC funding for a Network seems to be a category worthy of pursuing. Of course, EC funding is for Europe's cultural heritage and it may be that there are two problems in obtaining funding for a Network:

1. The group already exists. (Does the EC only fund already-existing Networks?)
2. The group is international.

Certainly it is worth seeking advice from Brussels.

This brings me to my last point. Applications for funding are most likely to achieve success when the application fits the specified priorities of the bodies, be they private trusts, national research councils or EC sources. I believe my own successes are due to the good fortune of having a portfolio of dozens of research interests. It is better to tailor the research to the funding requirements than to hope that a marginally relevant project will get funding. It won't. I know that to my cost because my first 2-month effort to secure EC funds failed - not for anything to do with quality but because the notion of an application on indoor pollution was unexpected in the mid 80's. Although the call for applications had specified the effect of air pollution on cultural heritage (and did not exclude indoor pollution) it was envisaged that applications would be concerned with outdoor pollution. There was, therefore, an unspecified restriction to the scope for funding.

All was not in vain. My application helped re-define the categories for the next round of applications and at least one indoor pollution project was funded in that round. However, it took another few years before I had the energy to make the effort again. Stamina and persistence are the most valuable qualities for funding success....but the odd bright new idea also helps!

Have a great brainstorming session - I wish I were there!

---

Author:

Norman Tennent
Netherlands Institute for Cultural Heritage (ICN)
Gabriel Metsustraat 8
1071 EA Amsterdam
The Netherlands