From IAP to IAQ
An evaluation of six years getting together

Agnes W. Brokerhof
Netherlands Institute for Cultural Heritage/Insituut Collectie Nederland (ICN)
PO Box 76709
1070 KA Amsterdam
The Netherlands

Abstract
The first Indoor Air Pollution meeting took place in 1998 in Glasgow. Ideas were shared, research discussed and goals were set for future work. The focus of the meeting was on volatile air pollutants, their determination, the interaction with museum objects and the possible strategies for mitigation. Through the years 'Indoor Air Pollution' evolved into 'Indoor Air Quality', studies on particulate matter became incorporated in the discussion and the field of topics widened. The meetings that started as a platform for the exchange of knowledge and ideas for the core group involved in active research, have gained value as moments to disseminate knowledge to a broader audience and gain attention for IAQ in collections care. Looking back on the original aims and goals, what has been achieved? What still needs to be achieved? How does IAQ fit in the bigger context of preventive conservation and collection risk assessment? From IAP to IAQ, what is next?

Six years IAP/IAQ meetings - a short review

Much has happened in six years of IAP/IAQ meetings. We have come a long way, but which way are we heading? We seem to have reached a point that requires a moment of reflection.

The first Indoor Air Pollution meeting took place in 1998 in Glasgow, organised by Lorraine Gibson at the University of Strathclyde. Those were the days of the 'Carbonyl Girls' (Gibson, Grzywacz and Brokerhof), a trio that was chaperoned by gentlemen like Tétreault, Ryhl-Svendsen, Ligterink, Watts and Cooksey. It was a research meeting where methods and results were compared by a small group of people who had been involved with IAP studies for some years already and were facing similar practical problems. The following two days a larger group of interested people with experience in IAP joined in. Ideas were shared, research discussed and goals were set for future work. The focus of the meeting was on volatile organic compounds (VOCs), their determination, their interaction with museum objects and the possible strategies for mitigation. The shortcomings of active air sampling became clear and passive sampling became common practice. The badge type samplers made way for diffusion tubes. Based on the results of his studies into the susceptibility of copper, lead, zinc and paper to acetic acid, Tétreault challenged the group with the observation that there are gas concentrations below which corrosion is formed at a much slower rate. Although threshold levels were doubted, one thing was obvious: a low RH slows down air pollution damage. Brimblecombe raised the question whether it was feasible to set standards or at least guidelines. There was general doubt, though not by Jean Tétreault.

The next year the meeting took place in Amsterdam, organised again by Lorraine Gibson, as she was working at ICN. Individual researchers reported on their progress, presented examples of damage and the EU-funded SILPROT project generated results on the interaction of sulphur-containing gases with silver, concentration measurements and mitigation methods.

Co-operation projects were set up to compare sampling methods. The theme was still VOCs and other IAPs, there were discussion in a large 'family setting', informal but serious. Ligterink and Di Pietro frightened the group with spherical horses, Hoetjer equations and the physics of sampling, just to ensure us that we were doing very difficult work. Fortunately Bradley and Thickett always led us back to the reality of IAP problems in a large museum. Tétreault presented progress on the issue of standards and introduced the concept of NOAEL (no observed adverse effect level). At the same time he tried to open our eyes to the risk assessment approach. It did not quite sink in yet, so he also gave us the integrated approach to dealing with IAP problems in practice – 'Avoid/Block/Detect/Respond/Treat'.

The year 2000 saw the group meet in Oxford where Simon Watts had put together a program with much discussion time. Behaviour of display cases and ventilation became a topic and Andrew Calver introduced his first gadget to measure the ventilation rate of display cases. Also the theme 'Dust' made its entry. There were group discussions, attempts to co-ordinate work, directing research into certain areas, but that did not really happen. The IAP meetings remained a platform to compare and connect work, inspiration rather than coercion. There were a number of more general presentations, especially on funding as most research projects were individually funded. Jonathan Ashley-Smith dazzled us with a philosophical presentation on comparing various risks. How did the IAP risk compare to other risks like climate or light? How much time, effort and funds should be invested in IAP research? We did not really want to answer that question yet and kept on going our ways.

In 2001 Morten Ryhl-Svendsen invited the meeting to the National Museum of Denmark in Copenhagen where Dario Camuffo made his entry highlighting microclimate as a difficult variable in museums. Peter Brimblecombe and Barry Knight dived deeper into dust and outdoor pollutants. IAQ was born and so was the website for which all credit goes to Ryhl-Svendsen. Since then, the website has become an important instrument to disseminate the group's experiences to the conservation world; such as Calver's progress with his gadgets and Odlyha's egg tempera covered piezoelectric quartz crystal multi-effect dosimeters. Tétreault involved almost every conservation laboratory in a study on copper and lead corrosion in carbonyl environments in an attempt to convince the world that if there is no NOAEL, then there is at least such a thing as a LOAED (lowest observed adverse effect dose).

In 2003 Peter Brimblecombe moved the meeting to the University of East Anglia, Norwich, setting a new standard for IAQ, not so much in concentration values, but in professional organisation of a growing conference. 'Dust' had become a fully incorporated theme. A few climate studies made their way into the program, a rather full program; there were more and shorter presentations than previously and discussions took place during lunch or in the pub. For the first time we realized that the meeting had developed from a group discussing work into a presentations conference. We had also generated an audience, thanks to the publicity on both the IAQ and the University conference websites. The meeting was now serving a dual purpose: the original exchange forum and a new dissemination instrument. It was time for Tétreault to disseminate the guidelines for indoor air quality. Not just a simple table with numbers but a book compiling all the available literature on materials interaction, providing data on NOAEL and LOAED, introducing the risk assessment philosophy in indoor air quality, providing information on sampling and monitoring and suggesting mitigation solutions.

This year we have had the 6th IAQ meeting in Padova, thanks to Dario Camuffo and his team. A next step has been made. Climate and light have found a place in the program. Tétreault has

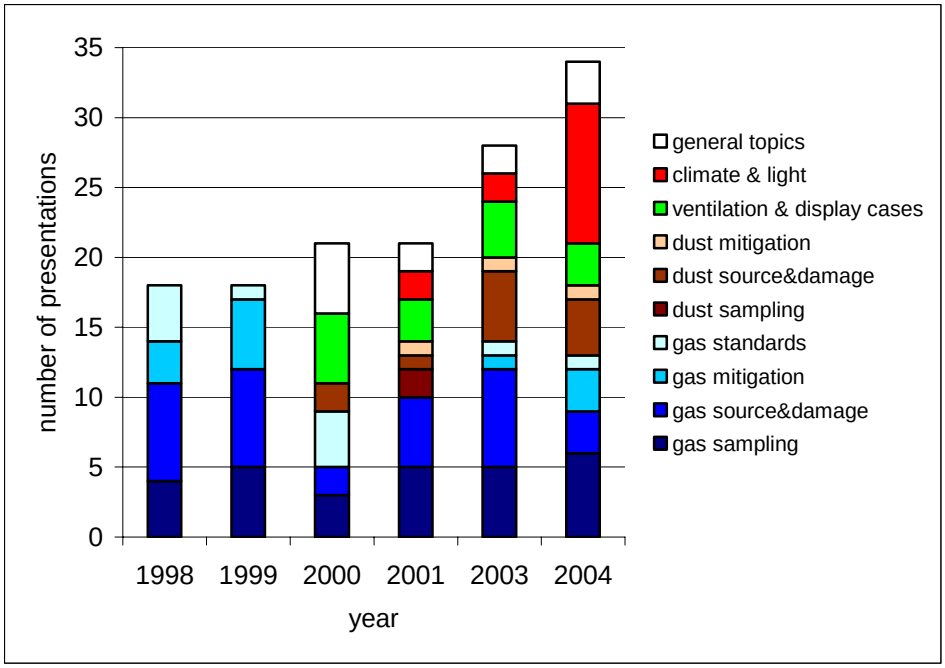

Figure 1. Development in 2-day program of IAP/IAQ meetings from 1998 to 2004, showing an increase in number of presentations and a shift in topics.

moved on from laboratory work to management and now stresses the importance of the risk management approach for dealing not only with IAP problems, but with conservation problems in general. The presentations show an increased activity in the development and application of dosimeters that indicate interaction of various risks. Again we notice that this meeting has taken us further away from the work discussions, deeper into presenting a range of topics to an audience that has grown even more. It is no longer exclusively about IAP, it has even gone beyond IAQ, the meeting is getting rather close to being a 'Preventive Conservation' Conference.

Where are we now?

Now that Calver et al. have presented their (almost) final report on comparing pollution levels in ventilated and non-ventilated display cases it is time to look back at the original aims and goals that were formulated at the Glasgow meeting. What has been achieved?

1. Developing standard methods of analysis for VOCs – with the comparison study by Van Bommel et al. presented here, we may not have standard methods, but we have a fair idea of how to interpret results of various analytical methods.
2. Better understand the relationship between pollutant concentration/dose/damage – the data is never complete, but we have collated much data that enable us to make reasonable estimates of the magnitude of risk. Our original idea of setting up a database has not been achieved but in stead Tétreault presents a comprehensive list of data in his book.
3. Determine 'acceptable' concentrations as critical control levels – we have guidelines, and although the NOAEL/LOAED levels may be contested by some, at least we have values to contest. These levels are only as low as the sensitivity of our analytical methods allows us to observe effects and the existence of thresholds is still questioned, but a reduction in the rate of degradation by a factor 10 has important consequences for the preservation of collections.

4. Provide mitigation methods – we have focused on selection of low-emission construction materials, are still working on classification of materials and on reducing emission with barrier materials. We have looked into the use of sorbents and ventilation to lower concentrations in closed spaces. We have the technology to improve storage and display conditions in a practical way.
5. Forming a working group, collaborate and discuss protocols for sampling and materials testing – we have gone beyond that and this meeting is proof of that. Around the original working group a critical mass has been formed that has an impact on the entire conservation society.

Where do we go?

What still needs to be achieved, apart from agreeing on the common grounds and arguing over details? We have seen a development from IAP to IAQ. More topics have been introduced in the discussion. Yet it appears to me that, with a few exceptions such as the dosimeter studies, many are still looking at these topics separately. The big challenge is in looking at the integration of these topics, at the interaction of various risks, enabling thoughts about efficient and combined solutions. At the previous IAQ meeting we discussed future trends, looking at IAP in the larger context, in relation to and in interaction with other risks. That takes us back to the question that Ashley-Smith asked in 2000: how relevant is IAP? How relevant is it in the context of IAQ, in the context of preventive conservation, in the context of preservation management?

A non-scientific experiment

How does the risk of IAP compare to the risk of light? What happens if you exhibit a light sensitive drawing or print in an MDF display case with a high acetic acid concentration? Does that enhance light damage? It takes 8 Friday afternoons to do a completely non-scientific investigation.

Expose a set of Blue Wool Standards (ISO1-8), copy paper and newspaper at 20-35°C and 50-60% RH to daylight with an average of 2.5 Mlxh per week. One set is exposed in a box with a high acetic acid concentration [HAc] > 1 ppm; one set is placed in an identical box without acetic acid (Fig.2). Is there a difference in rate of colour change?

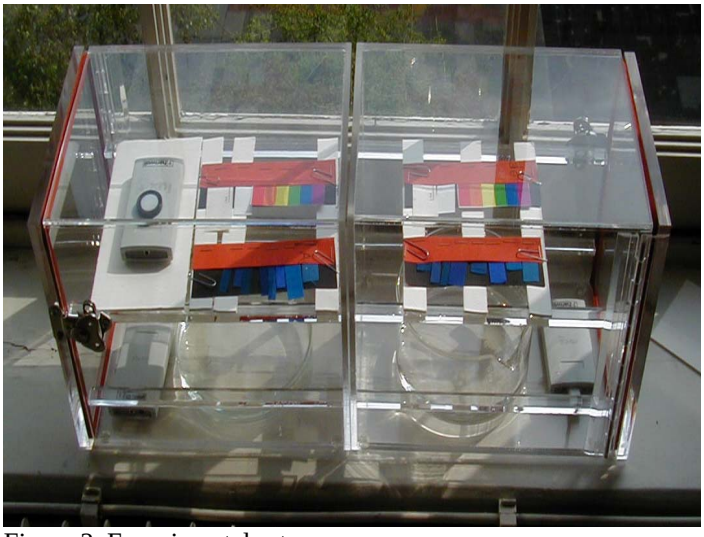

Figure 2. Experimental set-up

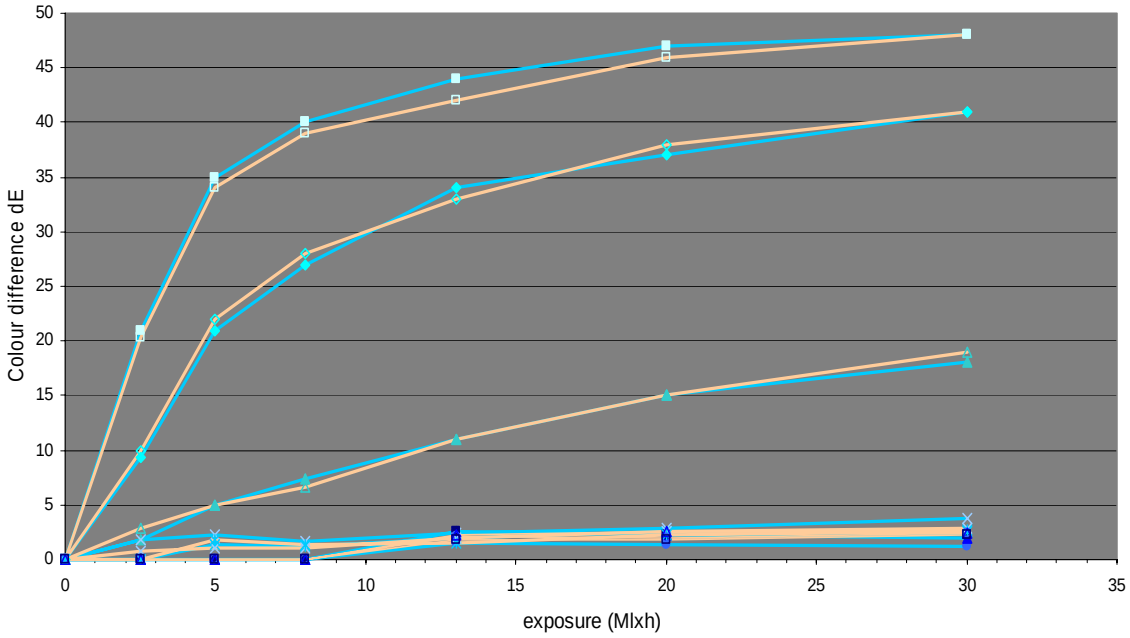

Figure 3. Colour difference in BWS upon light exposure in environment with HAc (orange) and clean air (blue). Order of curves from top to bottom: ISO1 (squares) -ISO2 (diamonds) - ISO3 (triangles) - ISO4-8.

The results of this little experiment (Fig. 3-4) show that the BWS dyes on wool, that have been chosen because of their susceptibility to photo-oxidation, undergo no synergistic or additional colour change in an acidic environment with this high light exposure and high [HAc]. Or the effect is too small to notice. Newspaper, known to be sensitive to oxidation, behaves indeed like a material that is preferentially susceptible to photo-oxidation. Copy paper is only moderately susceptible to photo-oxidation and here we observe increased degradation in an acidic environment, a synergistic effect rather than an additional effect.

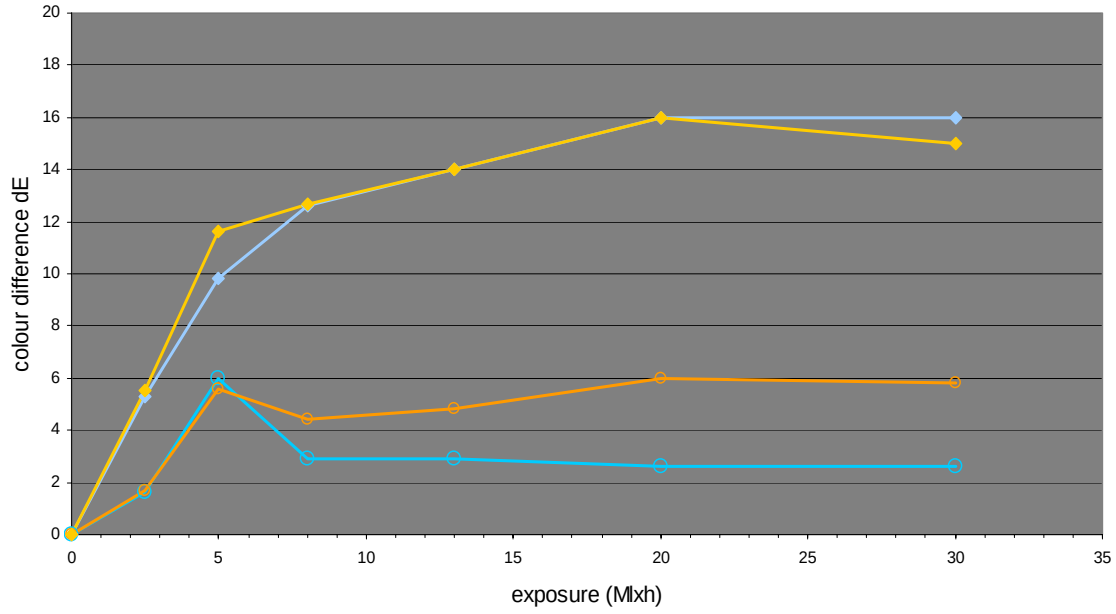

Figure 4. Colour difference in newspaper (top, diamonds) and copy paper (bottom, circles) upon light exposure in environment with HAc (orange) and clean air (blue).

Looking at the covered parts of the copy paper samples that were not exposed to light but only to acetic acid and compare those to the non-exposed, non-acid blanks, there is only small change in colour. The discoloration due to light is about twice as large as that due to acetic acid (at the high light levels and high acid concentration of this experiment). The discoloration due to the light and acid vapours is four times as large. For light sensitive materials the effect of IAP is comparatively small, but for medium and low sensitive materials the effects are the same order of magnitude. Although the experiment is rather coarse, the results actually are in line with the recent publication by Bacci et al (2004). This is the kind of information that is useful if one needs to decide how to spend the budget to improve conservation conditions. Can we display the drawings or prints in an MDF display case? The main risk is light, most benefit comes from decreasing light exposure, which probably means exhibition rotation, hence the time inside the display case will already be reduced and IAP damage might very well be limited concurrently.

Conclusion

After talking to various people attending this year's meeting I come to the conclusion that there is still a demand for a 'working group' kind of meeting for researchers to get together and discuss specialised topics; not just IAP but other topics as well. There is a wish to revisit the guidelines for RH and T to name just one discussion topic. The interactions of various risks and their relative importance are other topics.

Then there is a growing audience that is not directly involved in research and the generation of knowledge, but that applies the knowledge in their museum or related work. This group is best served by presentations of the latest knowledge on a broad range of topics.

Scientists and conservators involved in risk assessment need data on susceptibility of materials for the various risks and for interacting risks to calculate magnitudes of risk. On the other hand, when performing a risk assessment, the lack of knowledge and the needs for further research reveal themselves very clearly.

At present the IAQ meeting serves as an exchange forum but with limited time for discussion. It serves as a source for those seeking the latest information. It serves as a platform to present research that apparently cannot be presented elsewhere. Once every three years the ICOM-CC meeting has an overloaded Preventive Conservation Working Group session. That proves to be insufficient. It is time to consider taking the next step: from IAQ to preventive conservation. The time has come for a 3 or 4-day meeting with 1 or 2 days individual topic working sessions and 2 days of interacting topics in the context of risk management. An additional day could be included to discuss (European) Standards. Such a large meeting should be a combined effort of the IAP working group, the larger IAQ forum and the next ICOM-CC PC interim meeting.

The challenge will be to push the envelope and break away from the restraints of individual risks. A high quality meeting should provide us with the answer to the following, highly provocative, question:

> *If we agree that the risk of damage due to IAP is smaller at low RH; if we agree that the risk of damage due to light is smaller at low RH; if we agree that the risk of damage due to pests and fungi is smaller at low RH, then why not seriously look into the risks, costs and benefits of lowering RH? Why not let go of the restricted 50% RH view on life and solve conservation problems in an integrated manner?*

References

Bacci, M., Cucci, C., Mencaglia, A.A., Mignani, G. and Porcinai, S. (2004) 'Calibration and use of photosensitive materials for light monitoring in museums'; *Studies in Conservation*, **49**:85-98.

Ryhl-Svendsen, M. (2000) 'IAQ in Museums and Archives', www.iaq.dk

Ryhl-Svendsen, M. (2000) 'Homepage of the IAP Working Group', www.iaq.dk/iap.htm (contains abstracts and postprints of all IAP and IAQ meetings)

Tétreault, J. (2003) 'Airborne Pollutants in Museums, Galleries, and Archives: risk assessment, control strategies, and preservation management; Canadian Conservation Institute, Ottawa, 168 pp.