APPLYING THE OUTCOME OF CLIMATE RESEARCH IN COLLECTION RISK MANAGEMENT

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ABSTRACT

Studies into the deterioration of materials due to interaction with their surroundings can provide insight into the mechanisms and rates of decay and lead to the development of solutions for conservation problems. The ultimate application of our understanding seems to be the definition of guidelines and standards, but the direction of collection risk management is a much more interesting way to use the outcome of our research. The need for data to predict future change in material confronts us with deficiencies in knowledge in the areas of statistics on probability of catastrophes, incident frequencies, rates of decay, the severity of the consequence or dose-effect relationships, and sustainable solutions. These are the areas in which collection risk management tells us to focus our research efforts. Does that make sense?

INTRODUCTION

Over the past decades, numerous studies have been published on the changes in materials due to interaction with the museum climate. These studies provide information on why, how and how fast those changes happen. They help us explain what we observe in our collections or they warn us that we may have a potential problem. Understanding mechanisms of decay enables us to think of methods to slow down the process or even prevent it from happening. Sometimes someone has the courage to compile the available literature, work out dose-effect relationships, and formulate 'safe levels' or set 'limits of exposure'. The ultimate use of our research results seems to be the definition of guidelines or even standards.

And then the brain goes numb. As soon as we have distinguished 'safe' numbers we cling to them and tend to forget where they came from or what they mean. Technology takes over when it comes to solving conservation problems. We have climate control equipment that can dry even museums in the tropics to the mythical value of 50% RH. We can dim the lights to less than 50 lux. But why did we want to do that?

This paper is written to reflect on the research that has been carried out in the area of museum collections and indoor climate. Which types of research have we been focussing on? What do we know by now and how do we apply our knowledge? Then it investigates how else we can use the results of valuable research in the context of Collection Risk Management, where, in combination with observations in practice, we try to explain the past, assess the present and predict the future. We can apply our knowledge to rank risks for our collections. But do we know enough? Does our research provide the 'right', applicable, data? Or do we have to re-focus our efforts? Hopefully, this paper stimulates debate on how to get the most value out of our research.

TYPES OF CLIMATE RESEARCH

Looking at the area of museum climate, air quality and light, I can distinguish four types of research (fig. 1).

1. MECHANISMS OF DECAY

Most research related to conservation problems starts with a study of the mechanisms of decay, to understand the phenomena that we observe; the 'what', 'why' and 'how'. For relative humidity (RH) and temperature (T) we have distinguished three situations that are 'wrong': too low, too high and too large fluctuation. The interaction between materials and an incorrect climate can be chemical (hydrolysis,

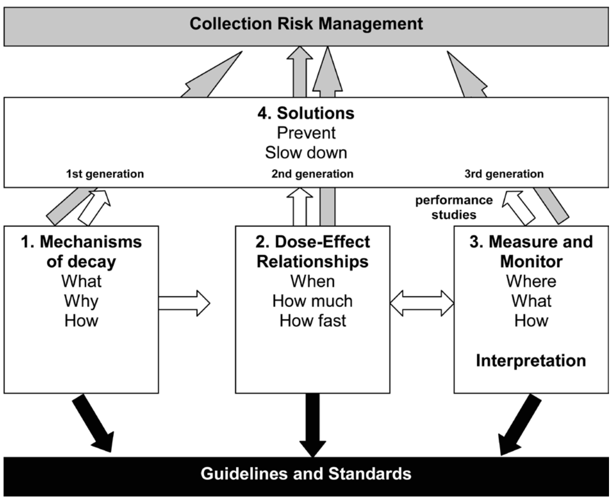

Figure 1. Types of research in the field of museum (micro) climates.

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oxidation), mechano-physical (stress, melting) or biological (mould). With this understanding we were able to develop what I call the first generation solutions to conservation problems – try to keep a constant RH (which became 'the smaller the fluctuations, the better'), make sure RH is not too high and not too low. This type of research can provide us with useful information on rate of decay, enabling us to estimate 'expected life time', 'mean time to failure' and to draw 'isoperms' [1, 2]. But it usually does not tell us how low is too low or which fluctuations are really too large.

2. Dose-effect relationships

Therefore, a next step is to look at the dose-effect relationships. The influence of other parameters can be included here and synergistic effects can be studied. This provides a better understanding of what happens so that second generation solutions can be developed. Formation of lead acetate corrosion can be stopped by removing the source of acetic acid, but it can also be slowed down to an acceptable level by lowering the acetic acid air concentration to a safe level (ventilation) and by reducing the relative humidity. Now we have a choice of options to solve the problem and flexibility in our approach. Key papers are the studies into the effects of RH fluctuations on wood by Erhardt et al. [3] and Bratasz et al. [4], the effects of T and RH on ageing of paper by Graminski et al. [5] and Zou et al. [6], and on acetate film by Reilly [7].

3. Measure and monitor

Once we understand dose-effect relationships, but also to increase understanding of these relationships, we need to measure and monitor the environment. RH, temperature, light and indoor air pollutants are good examples of agents of deterioration that have been measured extensively. We can measure numbers and link them to effects, like % RH, or we can determine the effect directly with dosimeters, like the blue wool standards and more recently developed air quality dosimeters [8, 9] and light dosimeter [10], or surrogate materials and early warming systems.

We also use measuring studies to determine the performance of our remedies. Here it strikes me that the interpretation of measurements is often less detailed than the measuring itself. For an explanation of how the inside climate relates to the outside climate, the role of absolute humidity and vapour pressure, evaluation of the performance of a solution, we can turn to the work of for example Padfield [11] and Maekawa [12]. Proper measuring and interpretation can lead to further improved, third generation solutions of conservation problems.

4. Standards and guidelines

And now it becomes interesting. The combination of understanding mechanisms, dose-effect relationships and monitoring can lead to the definition of 'safe levels of exposure', guidelines and even standards (here I focus on collections although most climate standards are a compromise between collection needs, human comfort and technical feasibility in buildings). Based on a selection of publications that are within our reach, grasp, and language skills, we can define safe levels, no observable adverse effect levels (NOAEL) or lowest observable adverse effect dose (LOAED) [13]. The 'observable effect' is determined by the available technology with which we observe, while the 'adversity' is determined by our acceptance of change, where not all change is necessarily adverse. If a book derives its main value from the information the text gives, a slight yellowing of the paper does not affect that informational value and may be acceptable. This is important to realise, because this means that our guidelines and standards are prone to adjustment in time. What we find acceptable now, may be unacceptable in the future, which means we have to redefine our standard (as is often being done in environmental and health safety). It can also go the other way. We may become more relaxed and realise that a generally accepted standard is based on extreme caution. We agree that fluctuations in RH are worse than a stable environment. But which fluctuations are really bad for our collections? Erhardt [3] and Bratasz [4] provide us with theoretical studies and practical experiments, but still we cannot agree on where the limits are for wood, let alone for the large variety of not yet studied materials.

Process standards that describe, for example, that light levels should be measured, how to do that, and how to interpret the results, provide guidance towards good working practice. Numerical standards on the other hand are restrictive, leaving little room for flexibility. The numerical '50 lux standard', suggests that 49 lux is safe and 51 lux is detrimental. Based on detailed and nuanced knowledge about light and light sensitivity, a rigid level has been defined that enables the non-nuanced mind to transfer responsibility to the standard. That is really a waste of knowledge because a good understanding of dose-effect relationships provides the opportunity to develop a flexible approach to exposures. For example light: a higher illuminance can be acceptable as long as the duration of exposure is reduced so that the dose of lux multiplied by hours of exposure remains in the acceptable range. Ideally, our knowledge should lead to guidelines which describe these dose-effect relationships and leave flexibility for intelligent interpretation. After all, we all like to take our own responsibility when it comes to crossing the street, ignoring the red traffic light when there is no immediate risk, even though the standard says 'red = do not cross'. We gladly turn that particular standard into a guideline.

Fortunately ASHRAE [14] and the new lighting guidelines [15] are based on that flexible approach. It is most interesting to experience that conservators and collection managers, who have to specify their requirements to the designers and engineers, call on advisers to ask for numbers, because the guidelines are too difficult and not useful. Do they not want to take responsibility for their own decisions and specifications or should we put more effort in embedding the guidelines in museum practice, in teaching how to use them, and in providing tools to apply the guidelines with confidence?

Risk, collection risk assessment and collection risk management

For me numerical standards lead to a dead end and ultimately to a loss of intelligence. So, which other way could we go? Instead of defining standards we can develop a working method to rank and prioritise our conservation needs and mitigate the most relevant in a cost-effective manner: collection risk management. In my opinion this is where our knowledge can be applied much more effectively. Before discussing how, I will provide some background on risk, risk assessment, and risk management.

Risk

The goal of collection management can be defined as 'delivering the collection to some point in the future with as much value as possible' [16]. It involves making well informed decisions to prioritise and allocate resources to optimize the value of our collections, be that through increasing the value (development) or through minimizing the losses (preservation), while one needs access to and use of collections to justify one's reason for existence or to generate revenues to be able to invest anything at all [17, 18]. One of the means to minimize loss of value, or to maintain value, is (preventive) conservation. To prioritise our actions and spending we need to determine what are the biggest or most urgent risks to our collections.

Risk is defined as the 'possibility of loss'. Risk is usually looked at as the product of the likelihood or probability that a harmful event or process will happen, and the consequence, impact or effect of that event or process: Risk = Probability x Consequence. The likelihood or probability refers to the chance that a particular event may take place, to the frequency with which incidents happen or to the rate at which degradation processes take place when given the chance. The consequence can be expressed by considering how much of a collection could be affected and 'how bad' the impact will be. This is expressed as 'loss of value', where value is not just monetary value: it can be anything from cultural, historical, educational to emotional. Thus risk becomes the 'possibility of loss of value' or the 'expected loss of value' in a certain period of time [17, 18].

Collection risk management

After establishing the context for risk management, the first part of risk management is an assessment of all risk, which consists of several steps (fig. 2) [19, 20]. It starts with identifying a diversity of risks that will include all plausible risks. That means not just the obvious ones and those that have proven to be risks in the past, but also the invisible and not yet experienced risk. Consequently, analysing the risks involves developing scenarios which describe the chain of events from cause to effect. Then the specific risks can be evaluated and compared. The Australian-New Zealand Standard for Risk Management [20] (N.B. an example of a useful

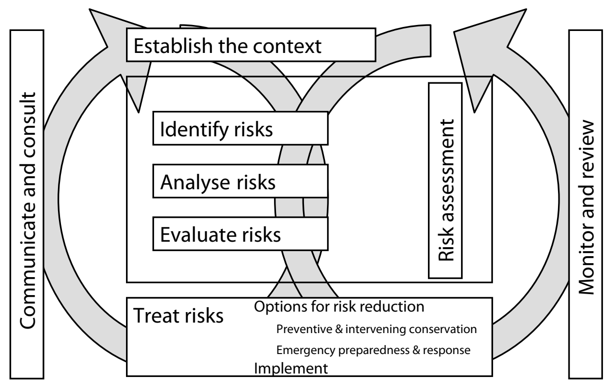

Figure 2. Schematic representation of Risk Assessment and Risk Management (after: Australian/New Zealand Standard, AS/NZS 4360:2004).

process standard) provides examples of various ways to evaluate risks, varying from quantitative, through semi-quantitative to qualitative. In practice the choice of a particular method will depend on the quality and certainty of the available data for likelihood and impact. In the field of cultural heritage, Waller has developed the Cultural Property Risk Analysis Model which uses quantitative fractional numbers [18]. Several organizations have already applied his model in practice [21-23]. Michalski has proposed a semi-quantitative set of simple scales [24]. Currently, CCI, ICCROM and ICN have a partnership in which they, together with Waller, develop tools and resources for risk assessment. Within this partnership CCI has taken the lead to develop a user-friendly model for risk assessment. Whichever system for risk assessment and evaluation is used, the result is a more or less rational ranking of risks based on their expected magnitude. This allows setting priorities in treating or reducing the risks. If conducted properly the outcome of a risk assessment provides an organization with credible and convincing results that enable well considered decision-making.

The second part of risk management is treating or mitigating the relevant risks. We think about the most cost-effective way to reduce the risk to an acceptable level. This is where the studies into the development and performance of solutions become relevant. We may understand the effectiveness of mitigation options but the cost aspects are often vague. How much does it cost to narrow RH fluctuations from a bandwidth of 15% to 10%? Is the preservation benefit of a narrow range worth the extra cost? Management decisions will often be made on the basis of economic arguments. Here we should also keep in mind the trend towards sustainable solutions, a field in which Cassar and her team are important players [25].

Risk scenarios and scenario pool

Doing a risk assessment involves developing scenarios for the identified risks. A scenario describes a specific risk so that it can be assessed. It tells the story about what is expected to happen in a given context, location or situation, from the beginning (the hazard or source) to the end (the loss of value), taking into account all mitigating and magnifying factors. To quantify the risk, we use the current knowledge about probabilities, rates and impact. Thus the scenario requires mining the huge source of scientific data that is scattered around the world, contains examples of which data is available, where to find it, and how to use it.

Experience in applying and teaching risk assessment of heritage collections demonstrates that an important resource for assessors is a pool of scenarios made by experts in real situations. As a spin-off from the CCI-ICCROM-ICN courses 'Preventive Conservation – Reducing Risks to Collections' (2003-2007) ICN has taken the lead in developing a set of reference scenarios, the 'Scenario Pool'. The 'Scenario Pool' started in 2006 as an exercise in writing unambiguous scenarios and in developing a consistent working practice for the course teaching staff. The scenarios, template and guidelines for scenario writing that resulted from that exercise are now used as teaching material. Meanwhile the scenario pool has the potential to become a tool for compiling data on specific risks. As the scenarios are discussed and peer reviewed they offer a basis for growing and expanding knowledge. For users who find themselves in slightly different circumstances, the reference provides directions for how and where to find applicable data. Since scenario writing focuses the author on available data, it confronts one also with the lack thereof. Thus the scenario pool could help define areas for future research for the participating institutions.

Available data for risk assessment

What has our experience been so far with the availability of applicable data from climate research for scenario writing? Somehow we have to predict material change over the next decades; both the likelihood and the consequence. The second step is to translate that material change into a change in value, where a change in material may not always prove to be a loss of value. Our main sources for data on both likelihood and consequence are: incident reports, statistics, and conservation science. Our starting point to identify risks is the collection itself. It tells us about risks that have already manifested themselves. We can look for damage and deduce its cause. This is information provided by our condition surveys in combination with our experience of interpreting 'what the collection tells us'. That interpretation is fed by the results of our studies into mechanisms of decay and dose-effect relationships, guided in the right direction by the results of our monitoring. We seem to have become quite good at this, but we actually make many mistakes if we are not aware of our own biases in observation and interpretation. Looking closely at the procedures and working processes within an institution, usually by conducting staff interviews, can give us data on the frequency at which incidents occur. Practice shows that there are actually very few institutions that systematically record their incidents, let alone their near-incidents. Hence, there is uncertainty in the data to predict incidents at an institutional level in the future. For example, how often do water pipes burst?

When incident data from within the institution is lacking, we may resort to using data derived from a more general level. Thus, our second source for data consists of regional, national or even international statistics. This source is especially relevant for catastrophes such as flood, fire and theft. They do not happen frequently enough to generate reliable data within a single institution. But even on a national level, it is not easy to find good sources for this type of information. Recently Tétreault has generated very useful data on fire in Canadian museums from a risk management perspective [26].

For the continuous processes that cause mild but accumulating change, we have a third source of data: the results of our scientific research. We are interested especially in the studies that provide information on the rate of degradation, either from studying the mechanism of decay or the dose-effect relationships. But we also need insight into the actual consequence. How many sheets of paper in an acid box turn yellow due to acid hydrolysis? Despite the huge body of literature, there actually seems to be only a limited number of useful and applicable publications. They are even used to predict changes in materials that were not included in the original study.

In addition to this 'objective' data about probabilities, frequencies, rates and material properties, the 'subjective' side of risk assessment, translating material change into loss of value, is an area where there is definitely a lot of work to be done [27, 28]. Developing frameworks for valuation and determining loss of value goes beyond the scope of this paper, but it is in my opinion the most interesting part of the discussions between all those involved in collection risk management.

Conclusion

All the different types of climate research we have conducted through the years have provided us with a reasonably good insight and understanding of mechanisms, dose-effect relationships, techniques to measure and monitor, and solutions for our conservation problems. The ultimate application of the outcome of those studies is the definition of guidelines and standards. Although hard numbers are needed in, for example, building contracts specifications, these should be derived from intelligent use of insight and understanding instead of transferring responsibility for the consequences of one's decision to an anonymous number from a numerical standard.

In the systematic approach of collection risk management, we use the results to predict material change in the future. We translate this material change into a loss of value. This enables us to rank the various identified risks according to their potential loss of value. We can then decide what are the biggest risks, the risks with the highest uncertainty or the risks with a common cause, and develop cost-effective options to reduce those risks. We use our collective knowledge to make well-argued proposals to mitigate the risks that really matter. It allows us to develop tailor made solutions for a particular problem rather than applying somebody else's best practice. This means we can reach the optimum result at minimum cost.

Writing scenarios to enable us to qualify or quantify risks, confronts us with a lack of data about the probability and frequency of events - incident reports, (inter)national statistics - together with a lack of knowledge about the actual consequence of any particular event. How much of our collections get wet in case of flooding and how much damage does that cause? We also still lack data on rates and consequences of decay processes for various materials. Another relevant topic is the cost-benefit analysis of (sustainable) solutions for climate problems. Does collection risk management tell us that we, as a research community, should focus our efforts on even more relevant topics than we have done so far? I leave that question open for discussion.

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London). These are also the people that currently form the 'scenario pool team'. Once the start-up problems have been solved, the entire network of former course participants and others involved in risk assessment should be involved in creating a large, open pool where knowledge can be shared so that the risk management community can profit from each other's experience.

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