RISK MANAGEMENT APPLIED TO PREVENTIVE CONSERVATION

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Introduction

A risk management approach can provide a decision-making method for preventive conservation of a museum collection or group of collections. Risk is the chance of an undesirable change occurring. Risk assessment is the analysis of the magnitude of each and all risks affecting some entity. Risk management is the application of available resources in a way that minimizes overall risk (Crouch and Wilson, 1982; Moore, 1983; Suokas and Rouhiainen, 1993).

We make dozens, if not hundreds, of risk assessments and risk management decisions each day. Examples of risk management decisions that many of us make daily before we even start work include deciding whether an extra five minutes of sleep will result in being late for work, determining when a hot cup of coffee has cooled enough to be sipped safely, and judging whether the time saved by exceeding the speed limit while driving to work is worth the risk of an accident or fine.

Assuming that we get up and arrive at work safely, we continue to make risk assessment and management decisions as we work with collections. Many decisions are exceedingly simple. An example is deciding whether to re-close the cap on a jar of fluid preservative after a specimen has been removed for a brief examination, or to leave it open. A somewhat more complex decision is judging how many small specimens can be carried safely at one time. Occasionally, major decisions must be made. An example is deciding if a humidification system should be installed in a temporary storage facility that has existed for several years without humidification. Finally, at least once each year, anyone involved with budget allocation must decide how limited resources can be distributed to best reduce risk to collections.

Some of these decisions are so simple and repetitive that they can become a procedure. For instance, a standard procedure could be to re-close a container of fluid preservative before one minute has elapsed. Other decisions are less repetitive and will always require some judgment. For example, twenty small specimens might be carried safely on a tray if each specimen weighs only a few grams, while it could be dangerous to carry more than a single specimen if each specimen weighs a few kilograms. Other decisions, such as the installation of a humidification system in a temporary storage area, are complex. A wise decision requires consideration of both immediate and long-term risks associated with the *status quo,* the proposed action, and alternative methods of mitigating the problem, such as humidity control by enclosure and buffering.

Finally, determining how to use limited resources to obtain the greatest possible reduction in total risk to collections is a very complex decision. It requires the assessment of so many types of risk and possible means of mitigation that it cannot be made properly without an organized method of evaluating the relative costs and benefits of alternative strategies.

A risk management approach can be used, not only to organize thoughts on any decision affecting the preventive conservation of collections, but also to provide a method for considering the most difficult decision we face - how limited resources can best be applied to the protection of collections.

A Risk Management Approach

A risk management approach to collection preservation issues involves four basic steps:

1) identifying all risks to collections,
2) assessing the magnitude of each risk,
3) identifying possible mitigation strategies, and
4) evaluating the costs and benefits associated with each strategy.

These steps are discussed in a general way to make them applicable to all types of collections.

IDENTIFYING ALL RISKS TO COLLECTIONS

The application of risk management to preventive conservation has been made possible by the development of a comprehensive classification of the agents of deterioration (Michalski. 1987, 1990b). Nine agents of physical deterioration, and one agent of non-physical deterioration (custodial neglect), are listed in column 1 of Table 1.

Table 1. Specific examples of types of risk and the relative importance of implementing means of control at each possible level for control. Type of risk: 1 = catastrophic, 2 = severe, and 3 = mild/gradual (see text explanation for type of risk).

Agent of Deterioration	Type of Risk	Example of Risk	Levels for Control: location	site	building	room	cabinet	specimen	policy	procedure
Physical forces	1	earthquake								
	2	mishandling								
	3	poor support								
Fire	1									
Water	1	flood								
	2	roof leaks								
	3	rising damp								
Criminals	1	major theft								
	2	isolated vandalism								
	3	embezzlement by staff								
Pests	2	infestation								
Pollutants	1	from nearby disaster								
	2	corrosive cleaner used								
	3	wooden storage materials								
Light and radiation	3	exposure to light								
Incorrect temperature	2	thermal shock								
	3	higher than ideal								
Incorrect relative humidity	2	HVAC malfunction								
	3	higher (or lower) than ideal								
Custodial neglect	1	collection abandonment								
	2	loss of specimen data								
	3	lack of legal title								

least important — most important

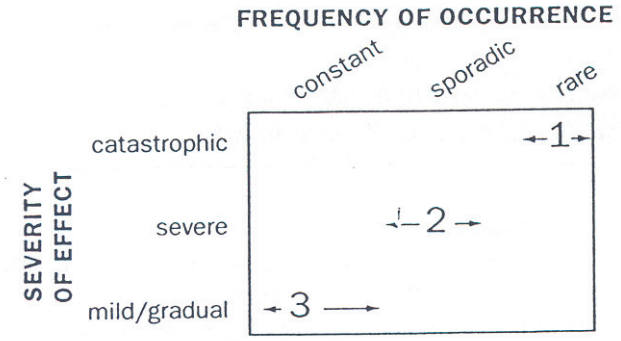

Figure I. The ranges of frequency and severity of the types of risk(1, 2, and 3).

Each agent of deterioration can be manifested as one or more of three different types of risk, characterized by the frequency of occurrence and the severity of effect on collections. This is shown schematically in Figure 1. Risks that belong in the lower right section of this diagram, those tending to be rare in occurrence and gradual in effect, are so insignificant that they are of little concern. The risk of damage due to exposure to incorrect temperature in a collection of diamonds is an example. Risks that belong in the upper left section of the diagram, those tending to be constant in occurrence and catastrophic in effect, are so severe that collections subject to them are unlikely to exist. A snowball collection in a hot room is an example. Three types of risk remain to be considered:

1) rare and catastrophic,
2) sporadic and severe, and
3) constant and mild/gradual.

The indicated limits in frequency and severity for each type of risk are arbitrary and may vary among individual collections. An example of a Type 1 risk is fire, which occurs only rarely but has a catastrophic effect. At the other end of the spectrum, an example of Type 3 risk is damage caused by low levels of pollutants in collection areas. It occurs at a nearly constant rate and is mild and gradual in effect. Examples of different types of risks associated with agents of deterioration are given in column 3 of Table 1.

ASSESSING THE MAGNITUDE OF EACH RISK

The purpose of a risk assessment is to make commensurable the risks to collections that accrue from various threats, ranging from earthquakes at one extreme to slightly warmer than optimal temperatures at the other. The basis for this commensurability is the combination of probability and severity factors. All risks, regardless of type, have a magnitude that is the product of probability and severity (see Table 2). In practice, for most risks that are not Type 1 (rare and catastrophic in nature), extent is considered instead of probability. Severity is interpreted to be the product of the fraction of the collection susceptible to the threat and the potential loss in value to the collection (Waller, 1994).

Frequently, a range of probabilities can be used to describe the severity of a possible occurrence; making precise calculation of the risk more complex. For example, a range of probabilities describes the chance of a fire that could result in complete, partial, or minimal damage to a collection. While progress is being made in dealing with these complexities (see, for example, Harmathy et al; 1989) approximations that can be obtained by considering extremely simplified models are useful as starting estimates (Waller, 1994).

Similarly, the total risk to a collection from all agents of deterioration can be calculated as the combination of all individual risks. However, the total risk is not the simple sum of the individual risks. A complete description of the combinative analysis required to determine a numeric value for the total risk to a collection is beyond the scope of this chapter. Further, at present, this exact calculation is probably of little value considering the uncertainties in our knowledge of the magnitudes of individual risks.

Nevertheless, a semiquantitative understanding and application of this risk management procedure will lead to better decisions on preventive conservation issues. In addition, by attempting to estimate the magnitude of individual risks, we can identify the risks for which reasonable estimates of probability or severity cannot be made. This procedure, therefore, also identifies the factors affecting collection preservation that are most in need of study.

Taking all of these factors into consideration, it is still possible and advantageous to attempt to estimate the magnitude and the bounds of uncertainty of the estimate for each identified risk to a collection. The classification of risks into three types is helpful in establishing these estimates because sources of information on the probability and severity associated with each risk depend on its type.

As a rule, information on Type 1 risks (infrequent disasters) must be obtained from central

Table 2. Calculation of magnitude of risk and severity.

Magnitude of Risk	=	*Probability (or extent)*	x *Severity*
			(Severity = Fraction susceptible x Loss in value)
Magnitude of Risk	=	*Probability (or extent)*	x *Fraction susceptible x Loss in value*

agencies such as geological surveys, flood prediction authoritie, and insurance data bureaus. The agency best equipped to provide this information will depend on the political jurisdiction and geographic area in which the collection resides. Museums administered under a parent organization may have access to a risk management expert employed by the organization. If so, the risk management expert could assist in interpreting information on Type 1 risks.

Information on Type 2 risks (intermediate frequency), such as damage from mishandling, must come from conservation documentation. The magnitude of Type 2 risks can be determined precisely only through analysis of condition data over time. This fact further supports the need for collection and specimen condition reports and suggests some of the information that these reports must record.

The magnitude of Type 3 risks (constant) should come from conservation science studies coupled with monitoring of environmental conditions in collections. A model of our ability to predict these rates is exemplified in the photo degradation studies of many materials (Michalski, 1990a). Further studies of the rates of deterioration of materials exposed to specific ranges of environmental conditions are needed to increase the number of deterioration processes for which we can predict rates. Until sufficient information is available from such studies, conservation documentation can provide some idea of the magnitude of these risks for a particular collection.

IDENTIFYING POSSIBLE MITIGATION STRATEGIES

Means of Control

After all risks to a collection have been identified and their magnitude quantified, or at least estimated. risk mitigation strategies can be explored. There are three basic means for mitigating a risk:

1) eliminate the source of the risk,
2) establish a barrier, and
3) act on the agent responsible for the risk,

Often all three means can be used to reduce a risk. but one may prove to be most effective.

Eliminate source

The risk of collection damage from an incorrect (too high) relative humidity level in a basement storage area can serve as an example of how each strategy could be applied to the same problem. If the problem is caused by infiltrating damp, resulting from poor drainage around the building, then eliminating the risk might involve installing gutters along eaves and installing drainpipes running to dry wells at a distance; grading the ground level away from the building; installing weeping tile drains around the foundation; or some combination of these. Alternatively, if the problem is a result of the basement remaining cooler than humid outside air, then heating the basement area could eliminate the risk from incorrect relative humidity. In most cases, eliminating the threat is the preferred means of control. However, in the example above, heating the basement area may create or increase other threats to the collections, such as thermal degradation, or fire, and hence may be inadvisable.

Establish barrier

Establishing a barrier is usually the next preferred means of control. In the example above, where infiltrating damp was the source of the problem, applying waterproof coatings to the foundation may adequately reduce the relative humidity and eliminate the risk. If the problem results from low temperatures in the basement, then the problem may be a seasonal one. Assuming that the annual average relative humidity is appropriate for the collection, the best barrier might be created by using well- sealed, water-vapor-impermeable cabinets for the collection. If this option were adopted, the procedures for working with the collection might have to be modified to ensure that specimens would nor be removed from cabinets for an extended time during periods of high relative humidity.

Act on agent

Acting on the agent responsible for the risk is usually done when the other means of control have failed to reduce the risk sufficiently. For the above

example, installation of a dehumidifier would be considered acting on the agent. It is worth noting that while this direct approach is the one that often would be considered first. depending on the source and extent of the problem, it could prove to be the worst choice when all long-term costs and risks are considered. In this case, the presence of a dehumidifier could increase the risks of fire and of local flooding, particularly if maintenance and servicing requirements could not be met.

All possible means of control should be considered for mitigating each significant risk to collections. Frequently, one of the methods will be most appropriate and provide the best cost/benefit. In other cases, effective control of the risk might require the use of all three methods together.

Levels for Control

Each of the three basic means of control described above can and should be considered at each of the eight possible levels for control: location, site, building, room, cabinet, specimen, policy, and procedure.

Location

The location of collections often cannot be controlled. If, however, location is a matter of choice, then all possible care should be taken to ensure that it minimizes exposure to both natural and human-made risks.

Site

Many risks to collections can be significantly affected by modification to the building site. As noted above, the risk from an incorrectly high relative humidity might be reduced by site modifications to improve drainage.

Building

Buildings and building-wide systems traditionally constitute the level on which museums rely most heavily for control of risks to collections. This is certainly an important level for controlling risks from most agents of deterioration. However, estimation of risks for which building-wide systems are a major means of mitigation must consider that such systems will probably fail to operate or may malfunction over a projected period.

Room

Means of control applied at the level of individual rooms are also important for control of risks associated with most of the agents of deterioration. One such example is to install light switches for each collection storage room or, better still, for discrete areas within a room in order to reduce light-induced deterioration in collections.

Cabinet

The importance of cabinets in reducing risks to collections cannot be overemphasized. Cabinets can provide effective barriers to many agents of deterioration, especially pests, light, and relative humidity fluctuations. Although initial cost for high-quality cabinets is significant. maintenance costs are very low and useful life is long. Therefore, cabinets become very cost effective over time.

Specimen

The specimen level of risk mitigation is of primary importance to the preservation of fluid-preserved specimens. The quality of the seal on each specimen container is critical for reducing oxidation, which increases acidity, and evaporation. which results in dilution of alcohol strength. For other types of collections, specimen-level means of control include adequate physical support, dust covers, and additional protective measures.

Policy

The policy level of risk mitigation is especially important for reducing risks from custodial neglect. For example, needless damage to specimens from inappropriate use can be eliminated by establishing and enforcing a policy that defines appropriate uses.

Procedure

Finally, proper and well-established procedures are essential to an effective overall risk management strategy. In many cases such procedures will, by themselves, provide the most cost-effective manner of reducing a risk.

EVALUATING COSTS AND BENEFITS ASSOCIATED WITH EACH STRATEGY

After all risks to collections have been identified and quantified, at least by rank, and all possible means of control applicable at any level have been identified, an assessment is made of the cost and benefits associated with each strategy. This assessment should be guided by the considerations discussed below.

Effect of a Proposed Strategy on Each and All Agents of Deterioration

Commonly, a strategy to reduce the risk from one agent of deterioration will influence the risk from another agent. For example, spray humidifiers

installed without adequate water treatment may pose more problems than the low humidity levels that they solve because of particulate pollutant accumulation on collections (Rogers and Costain, 1980). More optimistically, strategies such as the use of quality cabinets may reduce many risks from a range of agents of deterioration, including criminals, light, contaminants, and incorrect relative humidity.

Cost/Benefit Associated with Both Implementation and Maintenance Stages

Most people have a tendency to carefully consider the costs associated with implementation or installation but not those associated with maintenance. Numerous examples can be cited where climate control systems failed to function according to specifications because there was inadequate support for required maintenance.

Conversely, most people have a tendency to think about the future benefits of a risk reduction strategy and neglect to consider, or underestimate, the risks to which collections may be exposed while the strategy is being implemented. This is especially important when the strategy is expected to reduce risks for a relatively limited period. An example is modifications to temporary facilities. In this case, increased risks involving physical forces, fire, criminal acts, and pollutants (for example, dust) during renovation may exceed the anticipated reduction in risk over the time the collection is in the temporary facility.

Effect of a Proposed Strategy on Risks Other Than Those to Collections

Throughout this chapter, the focus has been on risks to collections and the evaluation of the effect of mitigation strategies on those risks alone. However, before a strategy is implemented, it is essential to consider the effect of the strategy on risks other than those to collections. One must consider, for example, the effect of the strategy on the health and safety of staff, visitors, and users of the collection. As a more complex instance, the risk to the local and global environment introduced by installation of an energy-intensive air-handling system should be considered.

SUMMARY

A method for evaluating risk to collections and determining which risk mitigation strategies would provide the best cost/benefit ratio in reducing total risk to collections has been outlined. At present, the precision with which this method can be applied is limited by a lack of derailed information on the magnitude of many of the risks affecting collections. It is evident, however, that order of magnitude estimates for individual risks can provide improved understanding of the size and nature of risks to collections. Further, the sources that need to be developed and exploited to provide more accurate information have been identified for each type of risk. This information helps to establish goals in both conservation documentation and conservation science.

The risk management approach to conservation planning and decision making offers several other advantages. The approach is holistic in nature. All sources of risk are considered, and the scope of the assessment can be made broad enough to include the impact of proposed actions on the global environment. The solutions developed through this method are necessarily pragmatic because they will provide the greatest reduction in risk to collections for any given amount of resources available for preventive conservation. Finally, by providing a clear basis for requesting resources to mitigate risks, this approach will improve the credibility of the request and, consequently, increase the probability of acquiring the resources.

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