The development of a significance-based lighting framework at the National Museum of Australia

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Abstract
Limiting light-induced colour change of displayed objects to an acceptable degree is an important but difficult task for conservators, who are required to make exposure decisions which have fundamental consequences for access and display, usually without adequate rate data. The National Museum of Australia's early experience with an accelerated fading technique known as microfading, which uniquely allows the relative rates of colour change of actual museum objects to be estimated, is described. The technique is rapid, essentially non-destructive and highly cost-effective, allowing the museum to identify the most vulnerable objects and concentrate its resources on protecting them, rather than applying blanket rules to very broad classes of colourants.

Keywords: exhibition lighting guidelines, fading, significance, risk, microfading

Introduction

In 2000 the National Museum of Australia (NMA) adopted exhibition light exposure guidelines (Tait et al. 2000) developed at the Victoria and Albert Museum (V&A) in the late 1990s (Derbyshire & Ashley-Smith 1999, Ashley-Smith et al. 2002). At the time the NMA saw the V&A approach as a technical and conceptual improvement over earlier flat-rate 50/150 lux rules, while retaining the virtue of being 'practical' and 'simple' to use. The museum recently reviewed those guidelines because, in the words of conservators at the Netherlands National Museum of Ethnography, who had also used the same model, our experience was that '[the] amount of work that such an extensive replacement program would entail… [was]…a major problem' (Reuss et al. 2005).

At an estimated average cost of $1,000 per light-driven changeover, including curatorial time locating and interpreting suitable replacements, registration activities, conservation, de-installation, reinstallation and relighting, the guideline was costing the NMA several hundred thousand dollars a year without a clear commensurate benefit. This led us to ask questions about the price at which practicality and simplicity (for conservators) had been achieved, how and when the burden of those costs fell and on whom, as well as the basis of the science involved, and what other factors besides fading rates and cumulative light exposure might have been overlooked in pursuit of practicality and convenience.

A lux meter isn't all a conservator needs

The V&A scheme rests on a minimum useful coloured lifetime for objects of 500 years, broken up into 50 year blocks during which objects are only allowed one Just Noticeable Fade (JNF), a mainstream colour science estimate of perceptible change. All colour is bleached out after 30 JNFs, and the V&A decided that after 10 such changes an object was, generally speaking, no longer fit for museum display. They placed potentially light-sensitive materials into 'sensitive' and 'durable' categories, corresponding to fading rates equivalent to the ISO Blue Wool (BW) Standards 1–4 and 5–8, respectively. Taking BW2 as the average fading rate for the category, 'sensitive' objects could be displayed for a maximum of two years/decade at 50 lux, while 'durable' objects might stay on display for the duration of an exhibition at 150 lux, with concomitant reductions in time for both categories at higher light levels. Lumping together objects equivalent to ISO BWs 1–4, which span fading rate differences greater than an order of magnitude, acknowledged that for many, if not most, materials there is insufficient fading rate data upon which to make finer distinctions.

The V&A did not represent their approach as anything other than an improved heuristic compromise between the demands of display and preservation, however, explicitly introducing and quantifying an acceptable lifetime and metering exposure according

Table 1. A simplified form of the NMA's 2000 lighting policy

	Zero tolerance	Sensitive	Durable	Permanent
ISO (BW#)	< 1	1–4	5–8	>8
Light level (lux)	0 lux	50 lux	150 lux	250 lux
Length of exposure	dark storage only	2 years/decade	no limit	No limit

to JNFs and cumulative exposures left an impression that it was more rigorous as well as more flexible than previous rules. Like lux measurements however, the apparent objectivity of JNF and cumulative dose calculations reinforced the falsehood that lighting guidelines are, should be or could ever be based solely on objective criteria. The calculations also diverted attention from serious uncertainties in the perceptual data upon which colour change and JNF's are based, and other assumptions and simplifications involved in the exposure calculations based on them.

In fact the seemingly straightforward and useful notion of a quantifiable JNF is fraught with difficulties which will probably never be fully resolved for any particular object because the ability of an observer to notice colour difference is highly dependent on an object's size, texture, patterning, colour, adjacent colours, and lighting, and varies very widely between individuals (Brokerhof et al 2008, Richardson & Saunders 2007, Pretzel 2008). Using one research estimate for the colour change required for an 'average' JNF, if average has any meaning in this context, could easily result in double or half the 'acceptable' exposure predicated on another. A recent paper pessimistically titled 'Colour difference formulas: An unsatisfactory state of affairs' sums up the situation with respect to the colour models on which colour change equations, for example, the various CIELAB formula, are based (Kuenhi Rolf 2008). Much the same is true of other ostensibly objective measurements: the behaviour of Blue Wool Fading Standards, widely used as comparative benchmarks in fading studies, is not necessarily 'standard' (Zhang et al 2008); light measurements themselves are known to vary quite widely (Shaw 2005); and all methods of measuring absolute light-fastness, whether accelerated or in real time are at best uncertain (Feller 1994).

Not least among the assumptions is the question of how long any particular museum might wish their objects to last. For example, while most conservators would baulk at doubling light levels, there appears to be no controversy whatsoever over the V&A's 500 year, as opposed to the Montreal Museum of Fine Arts millennial ambitions (Colby 1992). Furthermore the V&A's projections are based on a constant fading rate and current lighting technology, however, because most objects fade exponentially slower as fading progresses, and new multi-band light sources, including LEDs, promise to deliver as little as half the damaging radiant energy at equivalent lux levels (Druzik & Eshøjment n.d, Cuttle 2000) they are conservative by their own standards. This wouldn't matter if there were little or no cost associated with excess caution, but there is. There is no argument that some kind of framework for exhibition lighting is necessary—especially for fugitive objects which can quickly sustain serious damage under normal museum lighting conditions—but the case for particular cumulative exposure limits, and the strictness with which some conservators apply them, is not as solid as it seems.

While cumulative exposure estimates and fading rates are important, lighting decisions legitimately depend on perceptual, social and institutional criteria, as well as scientific. These include budgets; the importance of a particular object to an exhibition; pressure to display valuable objects while donors or artists are alive; the inevitable decline with age in the ability of people to see objects properly at 50 lux (Michalski 1997) and the museum's aims and audiences generally. They are intrinsic to the museum project and cannot be deplored as departures from an imaginary ideal or ignored altogether. As Michalski wrote long ago, conservators would do better to understand and acknowledge the complexity of lighting decisions and 'drop the role of lighting police' in favour of a more contextual approach (Michalski 1990).

A measurement approach to reducing light-driven object changeovers

After reviewing the NMA's lighting guidelines, the most obvious target for improvement was the order of magnitude range of the 'sensitive' category, for which restrictions are based on a hypothetical BW2 average fading rate. By definition this overexposes materials of most concern according to the 1JNF/50 year criterion, i.e. BW2 equivalent or less, and at the same time imposes unnecessary and costly access restrictions at the BW3–4 end of the spectrum. The logical solution is to separate the fast from slow faders within this category and allow the latter greater exposure. This approach was taken by conservators at the Netherlands National

Museum of Ethnology, who subdivided 'sensitive' into 'sensitive 1' (BW1 or worse), 'sensitive 2' (BW2–3) and 'sensitive 3' (BW3–4), with an additional 'vulnerable' category containing 'sensitive 1' objects which are also pristine (Brokerhof et al. 2008)

In practice, however, permanent exhibitions in museums like the NMA are full of potentially at-risk material for which little or no fading information is available. This is exemplified by the Netherlands museum's decision (Reuss et al. 2005) to put ethnographic objects containing plant fibre on a two-year, 50 lux schedule (equivalent to 'sensitive 2' above) based entirely on the equivocal results of a study of a sample of new unbleached jute by the British Museum, who were not investigating colour change per se, but light-induced cellulose damage (Hallett & Bradley 2003). Where it exists in the literature, data is usually derived from accelerated ageing studies of surrogate samples of mostly European fine art relevance, which are likely to behave quite differently to real objects with their particular histories of production, use and exposure.

To overcome this difficulty, and in particular to identify the most fugitive colourants with more confidence, the NMA acquired a Newport Oriel® Fading Test System (MFT) developed by Paul Whitmore at the Carnegie Mellon University Art Conservation Research Centre (Whitmore et al. 1999). The great strength of this technique, which is the subject of a separate paper at this conference, is that it allows non-destructive fade testing of each colour on real objects in 10 to 15 minutes (Ford & Smith 2011). Of particular relevance to the present discussion is our experience that while a minority of objects are more vulnerable than the BW2 average, and will as a result receive greater protection, the overwhelming majority are more stable and can withstand stand greater cumulative exposure while still remaining within the putative 1JNF/50 year limit.

Using significance assessments to reduce light-driven object replacements

Apart from the lack of fading data, the main factor that emerged in our review as most responsible for the changeover problem, and which could be addressed even without that data, is the assumption that all objects are equally likely to be displayed, and are therefore equally at risk of fading over time. In reality, only a small proportion of the tens of thousands of light-sensitive objects in the NMA's collection are regularly brought out of storage. There is no argument that for this group, exposure needs to be carefully rationed over time, however, it is a waste of money and an unnecessary restriction on access to treat objects which are only rarely on display, or may never feature in an exhibition again, as if they were at the same long-term risk as the museum's treasures.

While the benefit of better fading rate data is obvious, quantifying and relying on an object's probable 'future display history' to set exposure limits might seem a somewhat speculative and even dangerous exercise, however, if one assumes that the exhibition and loan demand for an object (or collection) is related to its significance, the Collection Council of Australia's (CCA) significance assessment methodology (Russell & Winkworth 2009) offers a way forward. Their approach is based on the ICOMOS 'Burra Charter' (ICOMOS 1999), which has been applied to immovable heritage for over 30 years now and is becoming more widely used to prioritise preservation activities in museums and historic houses. The Commonwealth Community Heritage Grant scheme administered by the National Library, for example, bases funding on a formal significance as well as preservation needs assessment (National Library of Australia n.d.). Meul also has written recently about the role of significance assessment as 'a promising alternative to conflicting preventive conservation strategies' for 'ensembles', such as historic houses and their contents (2008).

The CCA publication breaks down significance into four overarching socio-cultural categories—historic, aesthetic, research, and social or spiritual—within which objects or collections are ranked in relation to one another according to provenance, representativeness, rarity, condition and, importantly for a social history museum like the NMA, interpretative potential. Within this framework, the Netherlands National Museum of Ethnography's separate treatment of pristine objects is actually an example of a significance decision based on condition and probably rarity as well, since pristineness is not a common characteristic of historic materials of very low lightfastness. The other criteria may also be relevant because each potentially affects display frequency and loss of particular values.

For Australian conservators, the potential role of significance is acknowledged in the current AICCM Code of Ethics and Practice which states (AICCM 2002):

> *It is recognised that the significance of cultural material may have a bearing on conservation decisions. Accordingly, without breaching the provisions of the AICCM Code of Ethics or Code of Practice, the AICCM member shall ensure that cultural material in her/his care receives levels of conservation appropriate to its significance and available resources.*

Garry Thomson clearly considered significance when he recommended 50 lux 'for all very valuable material[s]…that are especially sensitive to light' (authors' emphasis), although he was probably referring to value as a measure of potential loss rather than display frequency (Thomson 1986). Both of his

qualifications are important and were by and large overlooked by conservators seeking, as Tim Padfield memorably put it, 'to shelter behind semi-official standards [as]...protection against the consequences of ignorance' (Padfield 1994). In a way, we feel we are returning to Thomson's original intent.

Significance is neither an objective nor necessarily stable attribute of an object or collection; on the contrary it is contextual, relational, and shifts over time with academic and popular fashions and historical circumstances, and therefore requires periodic review. Objects within the NMA's National Heritage Collection are there because they are thought to have national significance, however, within the NMA itself there are still distinct levels of significance and therefore of exhibition demand. These differences have always played an important role, not only in acquiring and disposing of objects, but setting in priorities for conservation; for example, Phar Lap's heart is rightly moved with greater care and is infinitely less likely to be loaned than a preserved specimen taken at random from the collection. Conversely one is sometimes struck by a dissonance between the low significance of objects and the time devoted to them in the conservation laboratory. While reluctantly accepting that it is necessary to prioritise, conservators and curators have the uncomfortable feeling that there is something wrong with higher standards of care for more important objects, and the result is that even where they are acknowledged, the inevitable significance decisions affecting conservation activities tend to be informal when they should be explicit, systematic and documented.

Specifically, the proposal currently under discussion with NMA curators is a two tiered light exposure framework, with the most significant objects receiving less cumulative exposure per display period than the rest of the collection (Table 2). The starting point was the 2000 NMA guideline (Table 1), on the pragmatic basis that maintaining something like current exposure allowances - after taking significance into account - and offering better protection for the most significant and/or most fugitive objects in the collection, would provoke the least anxiety. We have not developed a consensus on how long the NMA believes objects should last or which values of JNF to adopt, and it is not clear that it would be worth the effort for the reasons given earlier.

An estimate based on past exhibition lists and an assumption that 5% of the NMA's collection is in regular demand for exhibition (high significance) showed that as much as 80% of changeovers might be avoided without greatly affecting the risk of light damage to the collection as a whole. The numbers are different for each exhibition, and the estimate would vary considerably between museums; for example some museums do not have 'permanent' exhibitions or, conversely, like many community museums and historic properties without storage space, have most of their collection on permanent display.

Systematic significance assessment involves considering the importance of the story (interpretive significance); whether there are duplicates or alternatives (uniqueness or representativeness), or even whether an object is likely to be as important in the future for which we are preserving it as it is now. It might be argued, for example, that while the Azaria Chamberlain dingo story is very important for those who lived through the controversy in the early 1980s, it is likely to become less so for succeeding generations. Lindy Chamberlain Creighton donated material to the NMA and the National Library so her voice could be heard, particularly by those who were convinced at the time of her guilt and participated in her persecution. The same argument could not be made for light-sensitive colonial and pre-colonial era indigenous objects, which can only become more significant with time as the traditional Aboriginal and Torres Strait Islanders' ways of life recede further into the past.

Thinking about significance also led us to question another common assumption: that colour is equally significant—and colour change as detrimental—to all objects. Clearly this is not true. Preserved anatomical specimens, for example, undergo their greatest colour change during the preservation process, and the resultant grayish-brown of the iconic Phar Lap's heart is probably of no particular moment—not even scientific in our case—because the NMA has a huge collection of specimens preserved using the same process at about the same time. On this basis the value to the museum of

Table 2. Example of a simplified significance-based lighting framework

ISO (BW#)	< about BW2	about BW2–3	about BW3–4	> about BW4
	about 50 lux	50–100 lux*	50–150 lux*	100–250 lux*
Exposure of high significance (high use) objects	individually decided	2 years/decade	5 years/decade	life of exhibition
Exposure of average significance (lower use) objects	Individually decided	5 years/decade	life of exhibition max 10 years	life of exhibition max 10 years

**as low as possible consistent with good display*

the proximity sensor that triggers a light in the heart's display case is questionable, and the attention and money might better have been directed towards some other aspect of its preservation or interpretation.

The authors are now working with curators to develop a practical way of assessing significance that recognises its inherent subjectivity, but finally arrives at a point where an object or collection either meets or falls short of a 'likely to be in strong demand for display' threshold over some period, after which the situation would be reviewed as a matter of course. A form of documentation that isn't so involved or so onerous that its use is discouraged is needed, as is a way of incorporating it into Opal, the NMA's collection management database.

In addition to the CCA's criteria, consideration of the NMA specific factors like an object or collection's history of exhibition and loans requests where relevant, and monetary value will be taken into account. There is no desire to rule out a curator's instinct that something is likely to be important in future, or a conservator's unproven hunch that it may contain vulnerable material evidence, so long as they remain the exception and not another way of avoiding prioritisation. The consequences of a wrong decision are not, after all, destruction, but that an object (that has been already screened for instability using micro-fading in the NMA's case) is exposed to still conservative museum lighting conditions for an extra 3–5 years out of its supposed 500- or 1,000-year lifetime.

Until curators and conservators have reached agreement on significance criteria and assessment methodology for the purposes of lighting, the museum is using the framework in Table 2, treating everything as having high significance, and assigning BW equivalents to individual objects according to the results of micro-fade testing. The repeated use of the word 'about' in Table 2 acknowledges the inherent uncertainties associated with accelerated fading in general and micro-fading in particular. Eventually fade testing will be more targeted towards objects of high significance and/or suspected of being particularly vulnerable to light, however in its current role as a general screening tool for objects destined for permanent display the MFT has made significant inroads into changeover rates, not just because more objects turn up in the BW2–4 than the BW2 or worse range, but because testing allows curators an opportunity to substitute works for more stable alternatives prior to an exhibition.

Turn up the lights

Because there is little benefit in damaging a fadeable object by putting it on display if it can't be seen properly, the absolute maximum lux limits have been abandoned in favour of quite broad but still relatively low illumination ranges. This is essentially the position of the Canadian Conservation Institute (CCI) based on the arguments of Michalski (1997) who points out that perceptual data shows 50 lux to be inadequate in many common display situations, not only for older visitors as already mentioned, but anyone trying to closely observe objects with fine detail, low reflectance and low contrast, large size, at long viewing distances and in motion as well as limited viewing time (blockbusters). His argument for tripling 50 lux minimum light levels in most circumstances, (excluding very fugitive materials, and, we would say, very significant objects) is consistent with many people's reaction to 50 lux exhibitions, which if they are pressed to comment, is often negative. Interestingly it does not turn up as a major complaint in NMA visitor satisfaction surveys, however this is probably because older people in particular cheerfully accommodate themselves to unsatisfactory circumstances, and when they have problems seeing or hearing, put it down to their own deficiencies rather than poor exhibition design. In a visual performance assessment carried on 40 well educated older Getty docents, Druzik found that

> *'they either ignore what they can't see—thus it becomes a non-issue—or they work to compensate for it…moving side to side, up and down, and piecing together small tidbits of a larger visual experience. The only person who ever got back to me on visibility complaints was one ex-engineer with whom I'd just had a 30-minute extended conversation with on visibility limitations in gallery display'* (Druzik 2009).

No doubt museum visitors also accept dingy displays as a sign of the importance of the artefacts they have trouble seeing and the care given to them by the museum, and may even feel it adds to the atmosphere. There are reports that photographing iconic objects is more important to some visitors than carefully looking at them, and that the only view of major interest is increasingly the one through the lens of their mobile phones (Kimmelman 2009).

In terms of exhibition design, increased flexibility provides lighting technicians with more options to balance illumination without necessarily dulling down displays or even whole exhibitions to achieve a uniform look, sometimes even reducing ambient levels below the requirements of Australian building codes in the process.

Ditching the Rembrandt rule

There is still a reasonably widespread belief among conservators that a particularly negative interpretation of the 'precautionary principle'—that is, treat everything as if it were a Rembrandt—is the correct fall-back option where, as is often the case, there

is insufficient or unclear evidence upon which to proceed. Anything less is viewed as a more or less undesirable or even unethical compromise. It is not generally understood that risk avoidance itself is a counterproductive and potentially dangerous behaviour precisely because it discourages systematic risk assessment, and in practice delivers rapidly diminishing returns at high marginal cost, diverting attention and resources from competing priorities. It seems increasingly likely that this is also true of air-conditioning 'standards' for museums, where vast sums may well have been squandered maintaining unnecessarily rigid 'universal' conditions and tolerances, and it certainly applies to lighting restrictions based on simplistic interpretations of Thomson's 50/150 lux recommendation and other rules-based guidelines. The alternative is to follow the lead of most other professions when faced with uncertain scenarios, which is to systematically evaluate risks given the best information available. The last decade has seen an increase in interest in formal risk assessment by museums and the adoption of risk management models of collection care by conservators as they struggle to allocate limited funds to the mitigation of incompletely understood deterioration processes (Ashley-Smith 1999, Waller 2003).

Put simply, risk is a product of the magnitude of potential loss of value and the likelihood of it occurring over a defined period (Michalski 2004). In risk management models being developed for conservation, significance is considered to be the cultural heritage equivalent of value, and overall risk a function of loss of significance as a result of the impact of any or all of Michalski's 'nine agents of deterioration' (Canadian Conservation Institute 2009), including fire, water, pests, incorrect temperature and relative humidity, theft, and radiation or light which, to complicate matters further, are rarely independent of each other. The treatment of bark paintings is a particularly good example of how counterproductive a precautionary rules-based approach can be. In the past, like most other coloured objects at the NMA, these paintings were on a two-year changeover schedule in case they contained light-sensitive components, however, the main hazard for bark paintings is not light, but handling and humidity fluctuation (Smith & Roth 2002), and what is often described as 'fading' is actually pigment loss. Over the course of a permanent exhibition, under this regimen, five of the paintings would be subjected to humidity fluctuations, handling, cleaning, pigment consolidation, and transport, instead of just one if it had been left on display for the whole period. Even if bark paintings were sensitive to light, which they aren't in general, regular light-driven changeovers would remain a questionable decision.

Conclusion

Our significance-based lighting framework turns out to be a special case, therefore, of mainstream risk management in which—in addition to being a measure of potential loss—significance is also one of the factors that influence the probability of an adverse event (hazard), in this case, colour change. This is not unusual in museums, and we are therefore treating the development of a new lighting framework as a test case for the more widespread introduction of risk management into the National Museum of Australia's conservation planning. While there is no doubt that the approach will initially be more time consuming and difficult than enforcing rules, the up-front cost will be far outweighed by the long-term benefits to the museum and its public in terms of improved access, better-looking exhibitions, more fulfilling collaboration between curators and conservators, more targeted conservation interventions, and value for money.

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