The role of standards and guidelines. Are they a substitute for understanding a problem or a protection against the consequences of ignorance?

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Abstract

Two environmental standards, for relative humidity and for light, are discussed in detail as examples of how poor definition of standards and a lack of understanding of the underlying physics leads to irrational, expensive and sometimes damaging distortion of the way museums are built and operated. The relative humidity (RH) standard is so strict that it can only be attained with mechanical air conditioning. A 50% RH standard is high enough to cause condensation damage to buildings in cool climates yet low enough to cause damage to objects that have attained a stress free condition at a high relative humidity in a church or a historic house. The lighting standard defines permitted illumination, which is based on the photosensitivity of the eye, instead of the permitted flux of photons in the spectral energy band which predominantly causes fading. We need, or need to publicise, standards and guidelines for the use of ancient and weak materials, such as lime mortar, which are disregarded by modern industrial craftsmen but are essential for responsible restoration of old artifacts and buildings. The conservation profession must develop rational and attainable environmental and material standards suitable for the whole range of historic relics.

STANDARDS FOR THE MUSEUM ENVIRONMENT

Conservation is now at the same stage as medicine was in the middle of the previous century. We have a few successful treatments for decaying relics but are coming to recognise that the quality of the environment is the overwhelmingly important influence on the preservation of museum collections and historic buildings. The standards and guidelines that we have developed for this purpose are inadequate and some are dangerous. We have specifications for some environmental factors that are so tight that they are expensive and difficult to achieve while other, equally important factors are totally ignored.

We have settled, without any real debate or formal agreement, on standards for museum climate which are now widely used as a legally binding specification in loan contracts for temporary exhibitions and in the design of new museum galleries. Some conservation standards have evolved like industrial standards, after the convening of a committee, the completion of tests and the presentation of a draft standard for discussion. The standards for archives and for storage of photographs are good examples of this deliberate process. Other standards, some of the really important ones, have evolved from pronouncements by respected experts which have fossilised into dogma through repetition in review articles and keynote speeches to conferences.

THE RELATIVE HUMIDITY STANDARD

The relative humidity (RH) in museum galleries holding a variety of materials is usually set at 50 or 55 percent. The reason for this standard is difficult to find because the values have been redefined so many times in the literature. Repetition has enforced a concensus that few now dare to challenge. My view is that there should not be a standard value but rather a sensible method for arriving at a value.

The National Gallery in London holds 58% RH in its exhibition rooms. This value was chosen after measuring the water content of pieces of wood that were exposed in the galleries before air conditioning was installed. This water content was then translated into the corresponding equilibrium RH. This was a simple and ingenious way of arriving at an average value, over a period of time set by the dimensions of the wooden blocks. The air conditioning was thus installed in a spirit of true British conservatism: continue with a value that was already known not to be disastrous. A similar experiment in a museum in Egypt would have led to the equally rational choice of a relative humidity around 30%.

The National Gallery RH is unusually high for a museum. It is fortunate that the building itself is apparently able to endure such a high RH in winter. There are plenty of buildings suffering damage caused by winter humidification even to the 50% standard.

Figure 1 shows a bird's eye view of the Arts and Industries Museum in Washington DC. This building was designed as a museum in the mid nineteenth century, with ingenious use of the towers for ventilation. The advance of technology brought an orthodox air conditioning system with electric boilers for winter humidification.

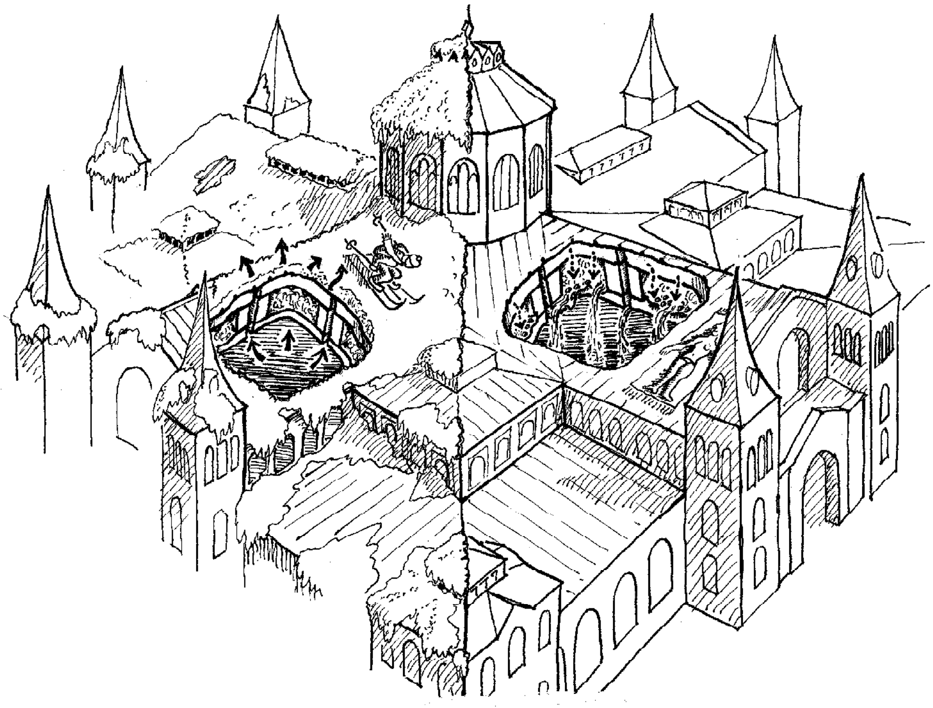

Figure 1. The Arts and Industries Museum of the Smithsonian Institution, Washington D.C. Winter condensation in the roof was succeeded by rainfall in the galleries as the spring sunshine distilled the accumulated water out of the roof panels. This is an example of the unexpected consequences of renovating an old building according to modern standards of fire resistance and thermal insulation and modern standards for museum climate.

The museum's roof was replaced in the late nineteen seventies. The new roof soon showed a magical ability to shower rain down on the interior in bright spring sunshine. The reason for this phenomenon is a fascinating illustration of the problems that arise when the whole apparatus of modern materials, modern standards and modern regulations are applied to ancient things. The old roof was replaced by a box-sandwich construction of two layers of plywood enclosing mineral fibre insulation. The outer surface was of lead-coated copper. The wood was impregnated with a mixture of water soluble salts for fire and rot resistance. A polyester membrane was laid on the bottom plywood as a vapour barrier. In winter, humidified air penetrated through generous cracks in the construction and cooled as it penetrated the porous insulation. Water condensed into the upper plywood, assisted by the hygroscopicity of the salts. When the warm spring sun heated the grey metal roof to 80ºC, the water evaporated from the warmed plywood, diffused through the porous insulation and condensed on the membrane. The hydrophobic polyester sheet held large drops of condensate on its gentle slope. At a crucial instant the drops fused and accelerated, cascading dramatically into the galleries below.

This was a relatively benign example of a widespread phenomenon. The danger to historic buildings and to new museums, from this, often hidden, phenomenon is not always appreciated by architects and engineers. The apparently innocuous 50%RH standard is in fact a very unusual stress on a building's structure. We get a hint about how we should be designing new museums from the fact that old museum buildings made of porous brick or stone, without insulation, seldom suffer condensation damage. Now we run into the difficulty that the rest of the world has moved on. It is normal practice to specify an air barrier in modern construction, and an air barrier is often specified in reconstruction. The unconsidered use of modern materials, techniques and standards is at least as great a threat to old buildings as is neglect.

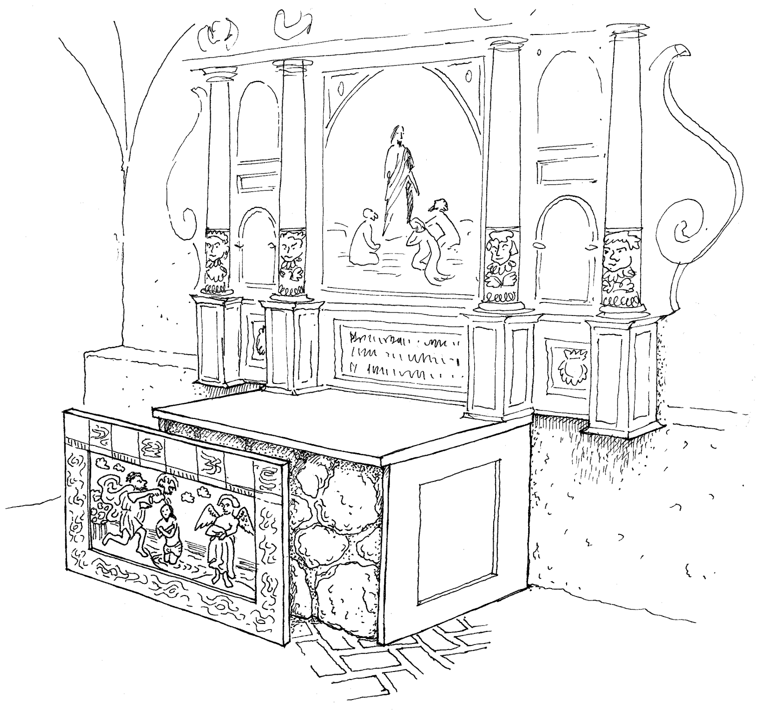

Figure 2. The altar of Gierslev church, Sealand, Denmark. The panel has been moved away to show the structure. The paint has hardened over wood that has always been exposed to a high relative humidity. The paint flaked when the panel was taken for repair to a workshop maintained at 55% RH.

You may think that I am arguing for a lower relative humidity standard for the sake of the museum building, but let me now describe an example where an even higher RH than 58% is necessary and the building does not suffer at all.

Figure 2 shows the altar of the church at Gierslev in Denmark. The altar, which is a rough masonry structure, has a 16th century painted panel of pine wood fixed on its front. The paint was peeling. The bottom of the frame of the painting was glistening wet when it was removed and there was rot on the lower part of the frame and at one place on the back of the panel itself. It was brought to the National Museum, wrapped in polyethylene and put aside to acclimatise slowly to the 55% relative humidity of the workshop. As the panel dried out the paint began to rise in tents above the wood. Clearly the paint had hardened in its youth over wood of high moisture content. We had to repair the painting in a humidified plastic tent in the workshop. We then returned it to the church to hang in a discretely ventilated mounting system that screened it from the damp stone and allowed free air circulation behind the panel. Two visits to the church in the following year showed no further damage to the picture but very few, tiny patches of orange fungus on the modern wood used to mount it. The ambient relative humidity is fairly steady at 75% throughout the year. This seems to be safe if the temperature is kept low. An important weakness in our relative humidity standard is that it assumes a comfortable room temperature and does not allow the possibility of extending the safe zone through manipulation of the temperature. The combined influences on organic growth of RH, temperature, air movement and the nature of the substrate is a vitally important subject that is neglected by conservation scientists.

This 75%RH is surely the highest realtive humidity that we can allow in a building housing historic treasures. But what about Skoklosters castle in Sweden? Here we know that the relative humidity is 100% through the winter because there is a layer of ice on the wallpaper. The ice does no harm: it evaporates in the spring. If the house were warmed a little to reduce the relative humidity, ice might still form and, instead of evaporating, melt, damaging the eighteenth century wall covering.

So now we have examples where 50%RH is too high, 70% is too low and 100% is just right. Am I mocking the standard with strange exceptions? Not at all. I am trying to demonstrate that a fixed RH standard, or a set of fixed points for different materials, is wrong but that an agreed proceedure for arriving at a sensible specification is worth discussing.

LIMITS OF VARIATION OF RELATIVE HUMIDITY

Another troublesome aspect of the climatic standard is the tight limits set for the variation in RH, whatever the average value may be. This can be as tight as ±2%RH and is seldom greater than ±5%. The evidence that this tight control is really necessary is scarce, but not non-existent. In a recent conversation with the custodian of a church with painted walls, I learned that the rate at which paint particles tumbled from the vault to the floor increased markedly when the heating was started up before a service. A glance at the thermohygrograph charts showed that the temperature increased about three degrees and the RH fell about five percent during these events. The flaking of the paint is caused by salt recrystallisation in the porous plaster. We know that salt dissolution and recrystallisation is a subtle process that needs only small cycles of atmospheric RH. On the other hand Stefan Michalski argues, in a forthcoming paper to the Washington meeting of the ICOM Conservation Committee (August 1993), that the ambient RH must wander about forty percentage points away from the RH at which the object attained a stress free condition before physical damage is likely to occur in well constructed objects. A variation of ±20% is unlikely to cause damage. My experience with the poorly adherent paint of the Gierslev altar, recounted earlier, is approximately in agreement with this evaluation of risk. Given the uncertainty about the response of individual objects it is not surprising that conservators involved with specifying a museum climate settle for tight limits. It then becomes the engineer's job to design the equipment.

The result of the prevailing museum environmental standards is a very expensive gallery, filled with the rumble, whirr and hiss of advanced equipment that is intended to hold the relative humidity constant within about 2%. The couriers guarding national treasures, whose travel diaries now resemble those of major opera stars, swing their psychrometers and mutter about unacceptably dangerous conditions, 5% away from the agreed RH. Down below in the engine room, puzzled technicians read computer printout covered in red numbers.

Meanwhile, a rising tide of general irreverence has forced museums to encase all their objects in glass boxes, which are quite capable of holding a perfectly stable RH. The standard for room climate makes no allowance for the far superior stability conferred by enclosure. The concept of the relative humidity buffer, so widely known as a technique for stabilising showcases, can also be used to stabilise rooms, if they are built with hygroscopic walls. Mutual buffering by objects crowded together in store rooms allows very stable relative humidity control, and a slow drift of temperature, with the use of simple equipment and very little energy. Such simple ideas remain unexplored because of our belief that mechanical methods can solve all our environmental problems.

Ideally, the RH standard should be a property of each individual object, not of an empty room awaiting the setting up of an exhibition. According to this way of thinking each object is assigned its ideal environment, and its environmental limits, as far as that can be judged, and then the set of objects destined for a particular exhibition hall or site can be examined for the best compromise climate. This sounds unrealistic, but it is exactly what we do when evaluating a proposal for installing heating in a church, where we demand a high RH for the sake of the painted wood and the wall paintings.

The guidance on humidity that is available to museum managers and architects is, I think, far below the quality that we could achieve by coherently presenting our present knowledge. Poor understanding of humidity fundamentals encourages the imposition of standards that are wrong, or needlessly strict, in the particular circumstances, because people who do not understand the issues tend to shelter behind semi-official standards so that they cannot be blamed if things go wrong. This attitude inhibits the use of cheap, alternative methods of climate control. I do not doubt that the present relative humidity standard has caused unnecessary investment in expensive and complicated equipment.

STANDARDS FOR LIGHTING

Let us now look at the lighting standard. This is usually based on Garry Thomson's recommendation (in *The Museum Environment*), itself in agreement with earlier authorities, of 50-200 lux, according to material. This standard has prompted many an angry memorandum from conservators complaining about 70 lux in the costume collection. If this 70 lux comes from a tungsten lamp it does less damage than 10 lux from a blue sky. Here again the problem lies in the conservator's or architect's acceptance of the standard as a mere number, without understanding the underlying photochemistry.

The lighting standards define the permitted illumination of the surface of the object, defined in lux. The fading of a dye, however, proceeds according to the number of photons absorbed by the material, weighted according to the energy distribution of the photons (with a certain dependence on temperature, relative humidity and oxygen concentration). In general, higher energy photons, such as those that give the eye the impression of blue light, are more effective in causing damage. A lux meter is not much impressed by this blue radiation because the radiation that it detects is weighted according to the sensitivity of the human eye, which peaks quite sharply around 550 nm, corresponding to yellow-green light. Daylight from a blue sky, without direct sunlight, has about twenty times as much blue radiation as incandescent lamplight at the same lux value.

I suggest that radiant energy in the blue part of the spectrum would be a better guide to the aggressiveness of lighting. The fading of many, but not all dyes can be considerably reduced by filtering out some of the blue light. A good deal of blue light can apparently be removed without catastrophic loss of æsthetic appreciation because both daylight and tungsten light are accorded a colour rendering index of 100% in the standard tests.

The lighting standard is illogically based on illumination of the object. The observer responds to the luminance of the object, which is the light coming from it. The lighting standard should ensure that objects can be seen in enough detail to satisfy the viewer. Black writing on white paper can be seen clearly with 20lx of incident light. A fossil leaf on the surface of a lump of coal would be invisible under this light intensity. A practical advantage of a standard based on luminance is that it is easy to measure. The lighting standard was developed with a view to preserving paintings and textiles. The pioneering work on the fading of colours was done on tapestries and watercolours. It is easy to measure the light incident on a painting but much more difficult to measure incident light in other types of exhibition, because most objects are in display cases and guarded by ingenious electronic devices and stiff locks.

The present standard is an intensity. Fading is cumulative: it depends on the light dose, regardless of rate. There are practical difficulties in keeping track of an object's cumulative light dose but there are simple procedures that markedly reduce exposure to light. It is surprising how seldom rooms are completely darkened outside exhibition hours. This simple practice could well be stipulated as a standard for museum exhibitions.

Light is the most powerful unavoidable degrading agent we have in museums, all the more sinister because its action is not dramatically fast. Exhibition designers are fretting at what they regard as the dismally low light levels they are allowed. Art critics praise the boldness of new museums that let in the light and blow away the fusty image of the traditional museum. More exhibitions are being fitted into old houses with lots of windows. Lastly, the prevailing taste for pulling in the public by exhibiting exotic eastern treasures under palm trees photosynthesising under purple spotlights should persuade us that it is time to reassert the importance of museums as repositories, holding the material evidence of the past ready for reinterpretation by the scholars, as well as the entrepreneurs, of the next generation.

STANDARDS FOR MODERN CONSERVATION MATERIALS

When we turn to standards for modern materials used in repair and conservation, there are some encouraging examples of standards developed for the conservation trade. The paper and photographic conservators have developed standards for paper and board for framing and enclosure. Since there are no standards for the quality of artist's paint, and unenforced standards for the amount of chemicals left in photographic prints after their half minute wash, we find ourselves in the amusing position, at least where modern art is concerned, that conservation materials will far outlast the treasures that they enclose.

STANDARDS FOR BUILDING AND DISPLAY MATERIALS

In the less sheltered world of building and exhibition design, the situation is not so encouraging. We borrow half-relevant standards developed by big industries. There is a set limit to the concentration in room air of formaldehyde that can outgas from glued wood products, but we have no standard for the concentration of acetic acid vapour, which outgasses from all wood. The first named chemical damages people, the second damages only museum objects (according to present knowledge). We have not yet done the research necessary to justify setting standards for showcase materials. We resort to empirical testing of materials by locking them up in a damp test tube with bits of copper, lead and silver, thus testing for the risk of a very limited set of corrosion reactions. The lack of standards for exhibition materials is a perpetual irritation to me because the craftsmen and architects who build our exhibitions are used to being ruled by standards and won't take seriously my opinion that they should not use wood, not even wood products that conform to the formaldehyde limit.

STANDARDS FOR OBSOLETE MATERIALS

When I suggest to exhibition architects and painters that they should use methyl cellulose based paint with a chalk filler instead of the ubiquitous, smelly and greasy looking emulsion paint, they tell me they don't know how to use these old fashioned materials, and are not keen to learn.

This brings me to another aspect of conservation standards. Conservation often needs weak materials, but we live in a robust period when industry is still trying to make just about everything stronger. In a society where it takes as many joules to break into food packaging as one gets from eating the contents it is very difficult to convince people that a weak, porous, spottily ochre-coloured lime wash is a better weatherproofing layer for an old house than a plastic paint filled with bits of glass fibre and organo-tin algicide.

CONCLUSION

It seems to me that the fundamental environmental standards for conservation of artefacts are of very uneven quality and only cover part of our needs. Many are poorly formulated and badly explained. Climate standards are biased by the experiences and the resources of conservators who work in rich art museums. There is an urgent need to develop a more coherent, flexible and rational set of environmental standards that apply to a much greater variety of historic structures and collections. If we continue on our anarchic way without our own codes, standards and guidelines, we will continue to be controlled, without realising it, by modern industrial standards.