Presentation of James M. Reilly (Revised May 25, 2009 to reflect changes as delivered)

Using Preservation Metrics to Achieve Sustainable Collection Environments

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One of the most important areas where sustainable practices intersect with preservation of cultural heritage is in the management of collection storage and display conditions. In my presentation this afternoon, I'd like to tell you about new approaches to monitoring and managing preservation environments that have resulted from research over the last few decades, and how those new approaches can be used to enhance sustainability. The basic idea is to regulate the collection environment to achieve an optimal balance of preservation quality, dollar cost, and consumption of fossil fuels. The all-too-common current approach that we might characterize as 'flatlining' is inherently unsustainable. The newer approaches I will describe are inherently sustainable, in that they allow for a continuously adjustable allocation of resources and a means of determining the minimum necessary harm to the global environment.

The place to begin is with the evolution of ideas relating to environmental management in libraries, archives, and museums. A number of received ideas—that environments should be steady and unwavering, that room temperature and 50 % RH are ideal, and that short-term fluctuations matter more than long-term trends—are now regarded by preservation scientists as outmoded and rather counterproductive. Environments are complicated, and such simple notions of the ideal (or the very notion that there is one unique 'ideal' environment) make it more difficult to analyze and manage real-world situations. A particular casualty of these reductive oversimplifications is the ability to make choices that would factor in sustainability and global environmental responsibility. If 'flatlining' is your only method of data analysis, then there are no shades of gray, and no shades of green. Even the greenest of buildings can't make flatlining at 70F, 50 %RH sustainable. The metrics approach, in which there are *a priori* measurements of preservation quality whatever the prevailing conditions, allows for accountability, both in terms of preservation and resources expended.

A close reading of the literature of conservation will reveal that the creators of the unwavering 70 / 50 recommendation regarded their suggestions as provisional pending closer study. The evolution away from such simple ideas and toward a more modern view began with research over the last twenty-five years. Modern thinking holds that all environments are compromises among various agencies of decay. Thanks to research, we know more about the specifics of these agencies. Smithsonian's Museum Conservation Institute has done much to clarify how moisture content affects the mechanical properties of cultural heritage objects.

Their work shows that extremes of dryness and dampness pose the greatest risk of physical damage. And that statement contains one of the most significant differences between old thinking and new thinking. We're now concerned much more with what poses the greatest threat (that is, in identifying the circumstances we need to avoid) than we are with articulating an ideal.

The Library of Congress, among others, and especially we at the Image Permanence Institute have explored and clarified through years of massive accelerated aging projects how materials such as plastics, dyes, paper, leather, and textiles are at risk due to spontaneous chemical change—decay that we might generalize and call 'natural aging.' This kind of deterioration is long-term and depends on the integral over time of temperature (thermal energy) and RH (moisture content of the objects). It is really a form of applied kinetics (the study of reaction rates). The environmental management strategies based on IPI's research have much in common with the way the worldwide pharmaceutical industry ensures that drugs retain their efficacy through changing environmental circumstances during storage and distribution.

The accelerated aging research at IPI and our research on such topics as moisture and temperature equilibration times and the impact of cycling conditions has been largely funded by NEH, who also made possible the development of indispensable algorithms to analyze and model environments, so that collection managers and conservators can quantify for each specific modality of deterioration what the impact of the observed conditions might be for the collections. The algorithms yield numerical estimates of the rate or severity of such problems as natural aging, mold damage, mechanical damage and metal corrosion. They are known as 'preservation metrics' and they represent a radically different approach to environmental management. Crucial to their value in practice is that they are standardized and quantitative, so in fact the quality of environments can be regulated to target the most important decay mechanisms for each type of collection. The metrics have proven their value in practice in such diverse institutions as the Library of Congress, the Museum of Fine Arts, Boston, and the National Museum of Denmark.

NEH, IMLS, and the Andrew W. Mellon Foundation have also funded research at IPI to develop the software and hardware tools to allow collection managers to collect data, organize it, and calculate the preservation metrics. After fifteen years, the simple but profound truth is that sustainable practices in managing the preservation environment must begin with collecting data and being able to manipulate it to extract information. Our focus for the last few years has been on web-based systems for environmental management. We find that web-based systems multiply the value of data by making it much easier to organize and share with allied professionals. In addition, IPI has taken its experience with environmental assessment into the field, working in partnership with the energy management consulting firm Herzog / Wheeler & Associates to explore and develop the all-important cross-disciplinary practice between building engineers, facilities managers, collection staff, and preservation specialists. IPI has found that to be effective, there has to be a process in place whereby the preservation side can know what their environments are and how good or bad they are for collections (that's where the metrics come in), but it doesn't stop there. To make a difference, the process has to build a mutual awareness among the creators and consumers of environmental conditions of why they are the way they are, what range of opportunities exist to modify them, and what the energy implications are of various possible courses of action.

IPI has called this process 'optimization'—meaning that human comfort, energy and fossil fuel consumption, and preservation quality are all measured, brokered and discussed, and ultimately, an optimal combination of all is slowly achieved. This vision can work. Our close working relationship with the Library of Congress over the last ten years has convinced me of that. However, it can't be realized unless the participants in the process have data to analyze, the tools to visualize and organize that data, enough understanding of their local climate, building envelope and mechanical system to determine its capabilities. Yes, environment is complicated and no one discipline can claim domain over all its causes, costs, and impacts. Nobody is master of every aspect, but preservation specialists should be better able than they presently are to analyze and articulate their primary concern, the health of collections. Old ideas and flatlining won't get them there. Learning how temperature, RH and dew point interact, how mechanical systems work and deciding which mechanisms of decay are of prime importance to their collections are the minimum necessary requirements.

A modern view of environmental management understands that most places have a summer and a winter. As the temperature varies throughout the year so does the amount of moisture in the air, which is represented by the dew point. Conservators often don't pay attention to dew point or understand its central role in environmental management. Rising summer temperatures mean that the air holds more moisture. In summer, the air is too warm and has too high a dew point (moisture content). A control scheme that only concerns itself with steady temperature at about 70F will ignore the fact that for months on end the indoor RH will be sky high, risking mold, metal corrosion, mechanical damage and a high rate of natural aging. In winter the opposite happens. The outdoor air is cold and therefore has very little moisture content. Heating that air to 70F when it contains so little moisture (has a very low dew point) will cause a dangerously low indoor RH, leading to mechanical damage for may objects, for example the familiar 'North American' crack pattern for paintings that Marion Mecklenburg et. al. so elegantly described and modeled. Finally, as the natural aging metric tells us, a steady 70F is too warm to prevent a rapid rate of natural aging in many organic materials. Museums that feel that 70F, 50 % RH is ideal must not have any paper, leather, textiles, varnishes, plastics, or dyes in their collections. There may be overwhelming human comfort reasons for 70F, but let's not pretend that everything in the collection is happy.

A more modern general approach to managing environments might be formulated this way: It's the extremes of RH that are most threatening, especially if they are prolonged for the several weeks or few months that most collection objects require to fully feel the effect. The 'spikes' in humidity that really matter are the big dull seasonal hump and trough of summer humidity and winter dryness. Short-term humidity events that many people agonize over are usually, well, meaningless. The more extreme the seasonal averages, the greater the risk. If you have collections of organic materials whose life expectancy at room conditions is fairly short (for example, acidic wood-pulp paper) then you will be mainly concerned with the natural aging rate. That's an easy one to give advice on: keep the temperatures as low as you can without causing the RH to be more than about 55% or 60%. That becomes hard in summer when dew points are high, so the critical parameter in creating a good natural aging rate is to effectively dehumidify in summer. Combine the humidity hump issue with natural aging issue and you have a simple formulation: Provide the lowest temperature you can while maintaining RH between about 20% and 60%.

Finally, what about sustainability? I said earlier that the metrics approach was inherently sustainable because it is not all-or-nothing but rather it allows for incremental improvements, sensible compromises and accountability for decisions made in the name of energy saving. It was no less a genius than Galileo who said, "Measure what is measurable, and make measurable what is not so." A corollary to this thought is that you can't manage what you can't measure. Utility bills are certainly testimony that dollar costs to operate HVAC systems are measurable. We will have to pay more attention to metering mechanical systems separately from other uses, but this seems doable. From the amount of kilowatt-hours of electricity and therms of natural gas that are metered it is possible to estimate the quantity of CO_2 that has been added to the atmosphere. I think that we need to do more research and development on the methodology of how cultural heritage institutions actually implement this vision of balanced stewardship, fiscal responsibility and reduced carbon footprint. IPI already has projects planned to build on its fifteen years of experience. We hope to test aspects of this methodology involving aggressive setbacks and complete shutoffs during unoccupied hours in appropriately chosen spaces. IPI also hopes to expand its program of education and training in these areas. The last thought I would leave you with is that sustainability is far from incompatible with preservation, it is its future.

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