

CONSERVATION PERSPECTIVES

THE GCI NEWSLETTER

FALL 2018
COLLECTION ENVIRONMENTS



The Getty Conservation Institute

A Note from the Director



Photo: Anna Flavin, GCI

An underlying principle of modern medicine is that it is far better to prevent a problem than to have to treat it.

The same is true in modern conservation practice. To the extent that we can, preventing problems is a safer and more efficient way to care for the vast amount of cultural heritage left to us. This approach, better known as preventive conservation, is most effectively applied to collections as a whole rather than simply to individual objects.

Preventive conservation has long been a strategic interest of the Getty Conservation Institute, and today it is manifested in the GCI's Managing Collection Environments Initiative (MCE), a multiyear undertaking that seeks to address a number of research questions and practical issues related to the control and management of collection environments. In recent years, the conservation field has been debating changes to what—for decades—have been environmental guidelines for collections. Among MCE's objectives, through research and training, is to provide conservation professionals with scientific findings and strategic approaches that balance the preservation needs of collections with the resources available to the institutions responsible for their stewardship.

This edition of *Conservation Perspectives* offers a multiplicity of viewpoints on the current exploration of environmental practices. Leading off is the feature article by Jonathan Ashley-Smith, which takes as its thesis the critical idea that management of collection environments requires a holistic approach that goes well beyond the technical. A museum, as Jonathan notes, is a complex and collective administrative enterprise. To create a collection environment that minimizes degradation within the collections—while not compromising access to them—requires navigating through a variety of human, political, and economic factors, as well as scientific ones.

The first of our shorter articles looks at MCE itself. Foekje Boersma, Joel Taylor, Kathleen Dardes, and Michal Lukomski describe the thinking behind the initiative and its various components, which include scientific research, fieldwork, and educational activities. The second article comes from Roman Kozłowski, head of the Cultural Heritage Research Group at the Jerzy Haber Institute in Kraków, Poland, who writes about evidence-based decision-making, particularly with respect to reducing climate-induced damage to humidity-sensitive materials in museum collections. In the third article, Nigel Blades and Katy Lithgow describe the major effort underway to improve the interior environment of Knole—one of England's largest and most historic houses—which contains an extraordinary collection of furniture and paintings. The edition wraps up with a lively conversation among Julian Bickersteth, Lukasz Bratasz, and Jane Henderson, who delve into the meaning of "sustainability" and discuss the issue of balancing present accessibility to collections with a responsibility to the future.

As noted above, the conservation field is currently engaged in sorting through the scientific, economic, and social implications of environmental management of collections. The array of ideas expressed in the pages that follow will, I hope, contribute to and advance this reassessment that is well underway.

A handwritten signature in black ink, which appears to read "T. Whalen". The signature is fluid and cursive, with a long horizontal stroke at the end.

Timothy P. Whalen
John E. and Louise Bryson Director

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VOLUME 33 • NUMBER 2 • FALL 2018



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The Gallery of Honor in the Rijksmuseum in Amsterdam. Photo: Erik Smits, courtesy of the Rijksmuseum.

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CHALLENGES OF MANAGING COLLECTION ENVIRONMENTS

BY JONATHAN ASHLEY-SMITH

The environments in which collections are kept are affected by the conditions prevailing outdoors and by the will and ability to control the conditions indoors. The aim of environmental management is to minimize the rate of degradation within the collections while not inadvertently compromising access to them. Problems arise from the complex interactions between objects, people, and their environments—problems that can have as much to do with politics and economics as with science and engineering.

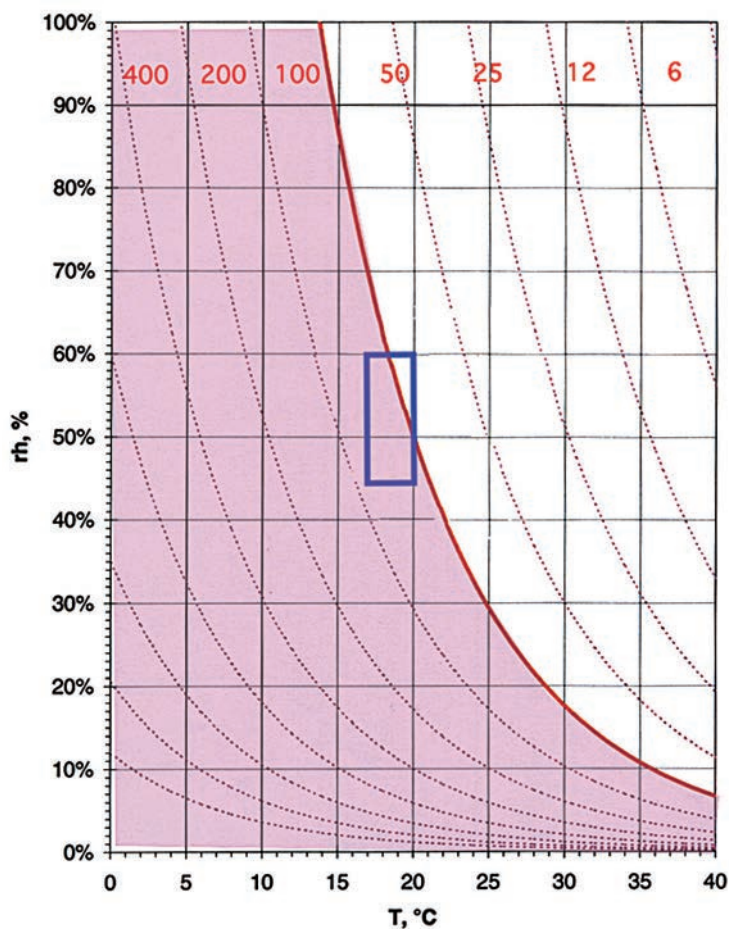
Collection environments are never totally isolated but are part of a larger administrative system. Decisions made both inside and outside the immediate organization affect the management of the collection. While there are routine aspects of environmental management that can be carried out in relative isolation, decisions about planning, specifications, and the collection and communication of data require recognition of the complexity of the decision network and the way it changes through time.

The twentieth-century phrase “the museum environment” reflected a deliberately inward gaze, concentrating on a collection’s immediate environment, and not on the wider environment outside the museum. The scientific methodology of isolating a small part of the system and reducing the number of variables studied enabled great progress in understanding the interaction between objects and their environments. The results of the individual pieces of research were easy to understand and reasonably easy to teach—but they could only be used with caution in decision-making. The work of twentieth-century pioneers who studied the collection environment left the conservation profession with a focus on the objects, concentrating on the proximate causes of change. The concept of the museum as





Polychrome wooden objects on display in the Medieval & Renaissance galleries at the Victoria and Albert Museum in London. The museum's passive environmental approach in these particular galleries exploits the building's massive nature and uses sophisticated control techniques to minimize variations in humidity without relying on refrigeration or humidification machinery. Photo: Jonathan Ashley-Smith.



A typical range of temperature and humidity recommended for storage and display of archive material (paper, parchment, and photographs) as indicated by the central box. The constrained temperature range within the box is dictated by human comfort, whereas the shaded area on the chart shows a much larger range of temperature and humidity where the expected lifetime of the material is as long, if not longer. Graphic: Courtesy of Jonathan Ashley-Smith.

an active enterprise was completely overlooked. This concentration on obvious local cause, rather than on networks of cause-and-effect relationships, persists in some current environmental recommendations and in collection risk assessment methodologies.

Focus on individual agents can lead to neglect of important synergies between potential hazards—for instance, light, pollution, and humidity. It can inadvertently lead to prioritizing one agent of deterioration over another of equal importance. Arguments about humidity tend to overshadow the effects of temperature, while a focus on proximate physical causes diverts attention from opportunities to address the involvement of people and their effects on the environment.

THE MUSEUM SYSTEM

In mid-twentieth-century discussions, the word “museum” usually referred to a large museum or gallery with nationally or internationally important collections. The word will be used here as a term for any building, of whatever size, housing a collection of objects that some believe have lasting significance.

The different professions that work in museums have ambitions and approaches formed by their specialized learning and practical experience. But despite different backgrounds and development paths that create distinct mind-sets, these separate

museum tribes must collaborate to achieve common goals. The necessary communication can be made easier by a shared appreciation of the whole museum system. Broader understanding of the competing ambitions and complex interconnections can make the inevitable compromises more palatable.

The museum is a dynamic system that includes people and objects. Each object is part of a network that connects the collection, the building, visitors, staff, directors, funders, and politicians. The museum system interfaces with a world of constantly changing political and meteorological climates. The atmosphere surrounding the building alters daily and seasonally, varying over longer periods with the shifting patterns of pollution and the effects of climate change. The cities that house museums can grow rapidly or decline because of economic recession, natural disaster, or war. It is not possible to manage the collection environment without considering at least some part of this greater interconnected and dynamic system.

Some elements of the system have been understood for a long time—for instance, the role played by human beings in influencing decisions about museum environments. Humans have senses that can detect, and to some extent quantify, temperature and light. We seek comfortable temperatures that may be quite different from those outside the buildings we inhabit, and we value light because it enables us to carry out certain tasks. A great deal of technological innovation during the nineteenth and twentieth centuries was directed toward developing indoor environments with adequate temperature control and sufficient light for work and leisure activities. Temperature and lighting levels in museums are determined with human preferences in mind; this results in limits to how much they can be modified to favor the longevity of collections on display.

Humans complain when they are uncomfortable or inconvenienced. It is not likely that a scientific argument would succeed in convincing museum visitors that they really aren’t that cold or that the lights really are bright enough. Even though it means consuming more energy and decreasing the lifetimes of collections, winter temperatures inside museums have been allowed to increase to satisfy visitor comfort. The early lighting recommendation of a 50-lux maximum for the display of sensitive objects has become a 50-lux minimum. No museum wants dissatisfied customers. During the 1980s, one large UK museum successfully ended visitor complaints by discreetly doubling the lighting level of its sensitive displays. They avoided criticism for flouting the prevailing strict guidelines by keeping this information to themselves until changes in conservation attitudes made it safe to divulge.

People are more sensitive to temperature than to humidity. In historic houses in northern Europe, it has become common to raise the ambient temperature to control the high humidity levels that might increase mold risk. This procedure may be difficult to maintain during the summer months as visitors complain about the heat (and the apparent waste of energy). Visitor comments have led to a reappraisal of target humidity levels rather than suggestions that the visitors just tolerate the discomfort for the sake of the collections.

MORE THAN MATERIALS SCIENCE

The science of materials is essential to understanding the interactions between objects and environmental factors such as light, pollution, temperature, and relative humidity. Environmental management is a part of preventive conservation, which relies on the prediction that a proposed action will decrease the risk of damage. Notions of prediction and risk introduce the concept of uncertainty. Uncertainty in the area of scientific interpretation refers to the variability of measurements. This variation can be treated mathematically, as the observations are recorded using numbers. The uncertainty that many decision makers face is not so easily quantified. Uncertainty may be due to lack of knowledge or ambiguity of language, or simply to the inability to see a clear difference between options that present mixtures of good and bad points. Defining damage is notoriously difficult. Definitions that rely solely on the scientific measurement of change are of limited use. The human appreciation of damage inevitably involves subjective estimation of changes in value and significance.

Conservation is about preserving items of cultural heritage so they can continue to be used for education and enjoyment, as reliable evidence of the past, and as a resource for future study.

That is, they must be preserved for future generations without prejudicing the needs of those who want to enjoy them right now. The appropriate balance between present and future audiences can be informed by scientific understanding, but the final decision on distribution of benefit is one of ethics.

Take, for example, lighting policy. The debate on the rationing of light for display of sensitive objects has reached a quite civil level. The arguments can be couched in terms that reflect a scientific understanding of rates of fading and the limits of visual perception. Policies for rationing light-dose based on this understanding were published at the end of the twentieth century. However, at present these policies have been overtaken by approaches that include an assessment of the significance of the collection. Objective science has been supplemented by a subjective assessment of values.

The current lack of vocal disagreement on ways to ration light masks unresolved problems of variability and uncertainty. One approach to uncertainty is precautionary behavior—just play it safe. But you will not be thanked by current audiences if your present light levels or rationing protocols do not allow the appreciation of the objects today. You will not be thanked by future audiences if, when the box is ceremoniously opened in a hundred years, thermal decay has reduced the



The lack of barriers between an air-conditioned gallery and open museum spaces means that tight environmental specifications cannot be met. Whether or not tight environmental specifications are necessary for all collections is a subject of current research, but decision-making in the museum context is complex, and considerations extend beyond the results of research. Photo: Jonathan Ashley-Smith.



The Victoria and Albert Museum uses environmental specifications that offer maximum flexibility for implementing energy-efficient, sustainability-driven approaches. The new furniture gallery is an example of this approach, where climates are specified as a combination of an untypically broad range of acceptable RH and pragmatic limits to allowable changes to objects over time. Photo: Jonathan Ashley-Smith.

silk dress to tattered ribbons. More research might decrease the scientific uncertainty, but the predictions that would be necessary to argue for funding for this research or for improved storage rely on the continuation of the museum system in a stable and recognizable form.

A CHANGING WORLD

Management of the collection environment depends on decisions in other parts of the museum organization and on events outside the museum. In general, these factors are difficult to predict and are beyond the control of those in charge of collections. Thus they are often conveniently neglected. For short-term day-to-day decisions, this is not a problem. Over the long term, the impact of outside factors cannot be ignored.

Fashions in museum management can alter demands for environmental control as well as the will to finance it. The centrality of collections to the purpose of museums has been a topic of discussion in the professional literature. If collections are considered less important than the museum's immediate social or political role, why spend money on systems to extend their lifetime? A new museum director, for instance, hailed as a heroic leader, may want to sweep away all intellectual and physical barriers between the visitor and the exhibits, reflecting the attitude that constant change is the only way museums can remain sustainable.

On a national scale, ill will between states or factions affects foreign investment, international loans, and tourist numbers, all of which impact income streams needed by museums. On a global scale there are issues of climate change. Although the causes and extent of climate change can be disputed, it is difficult to deny that temperatures are increasing in parts of the world. In Europe there will be a decrease in the energy needed for heating in northern latitudes and an increase in energy needed for cooling farther south. The change in external environment will eventually mean that new hardware is required, as climate change affects energy consumption in museums. Shouldn't someone be planning for that need right now?

In the last half of the twentieth century, the major drive in

environmental management was to install systems that tightly controlled climatic conditions throughout the building. The plant used energy in a way that was, at the time, both affordable and acceptable. However, within *this* century some museums have faced the choice of paying their energy bills or paying their staff. As green arguments gain popularity, there is more pressure on museums to justify using nonrenewable energy to preserve a few selected historic artifacts. Some museums have claimed exemption on the basis of their responsibility for unique collections of priceless heritage. In a political climate where "elite" has become a dirty word, they risk losing public sympathy.

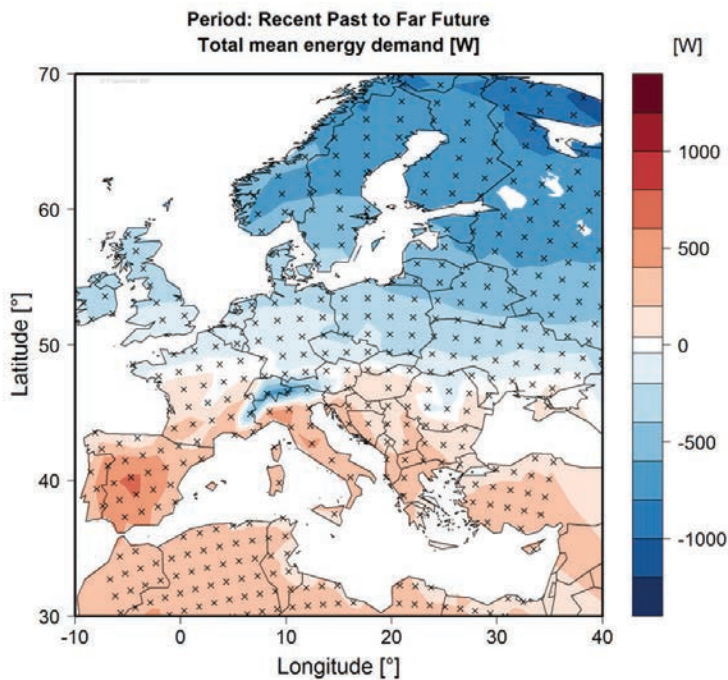
The pressures of energy cost and sustainability are driving research. As a short-term measure, museums and archives are experimenting with turning off environmental systems for increasingly long periods and monitoring the changes. Other low-energy solutions to storage and display are being tried. Continuing debates about tolerable ranges of temperature and humidity have stimulated research into object vulnerability. The results will be welcomed if they show that currently recommended ranges can be broadened, especially if that leads to decreased energy demand.

THE KNOWN UNKNOWN

There remain many things we don't know about object-environment interactions. If you look at the dates of publications on hazards such as indoor and outdoor pollution, insect pests, vibration, particulates, light, temperature, and humidity, you can observe time-related clusters that suggest a beginning, followed by dedicated research, and then a final conclusion for each topic. However, the fact that a subject has been previously studied, but is not being studied now, doesn't mean that knowledge in that area is complete. Clustering is often just an indication of insufficient data. There are limited numbers of research centers, all chasing limited funding. It is inevitable that fashion and the lure of novelty play a part in what is thought interesting, fundable, and publishable. While there is probably not going to be a revolutionary breakthrough that alters preventive conservation forever, there is a great deal of detail to be filled in. There is a need to determine the full extent of material susceptibilities and to understand mechanisms of change. And, of course, there is a need to relate this information to human perception and values.

One great advance would involve conservators, scientists, registrars, and curators agreeing on something like the allowable range of relative humidity for hygroscopic materials. There are several hurdles to overcome. One is that personal experience will always override scientific explanation. It's no use declaring that a set of circumstances is unlikely to cause damage if an individual is convinced that they have observed damage caused by those circumstances. The difficulty is that despite huge amounts of environmental data and assessments of object condition collected over the last few decades, there has been little success in correlating the two. Another hurdle is the immense variability in the material and structure of historic artifacts that share a common description, such as paintings or furniture.

The problem is having to construct a general rule from a finite number of observations and then to use this general rule to predict



The predicted difference resulting from climate change in the energy needed to maintain a tightly specified environment within a historic building. This is for a period extending from the recent past up to the end of the 21st century. The “W” stands for watt as a measurement of energy consumption. Graphic: Courtesy of climateforculture.eu.

the behavior of individual items. That leads to the difficulty of dealing with exceptions to the rule. A well-devised series of experiments or a thorough epidemiological study can only provide results that have to be interpreted probabilistically. It is bound to be exhausting and expensive to guard against all possible events, rather than just the most probable. But ignoring the improbable tails of the probability curve means accepting the possibility of damage.

COMMUNICATING PROGRESS

It is surprising in an age of instant global communication how slow and patchy the spread of new knowledge can be. One difficulty has been deciding how to frame the results of research and then find acceptable vehicles for dissemination. During the 1990s, researchers at the Smithsonian were criticized for publishing in materials science and engineering journals rather than in the mainstream conservation literature. Discussions have been less about what is the right thing to say and more about who has the right to say it. The furor over the recommendations of the Bizot Group early in this decade was a sign that many museum staff felt that their directors had no right to say anything about the preservation of objects in their own institutions.

Traditional means of communication, such as journals and conferences, are aimed at specialist audiences. Conference presentations are getting shorter, and journals are focused on novel results; there are rarely slots for historical perspectives or considered reviews of current thought. Outside the museum, the various tribes that need to work together do not go to the same conferences or read the same journals—this at a time when they should be learning a common language and sharing knowledge, which will involve finding ways to overcome concerns about losing specialist authority.

So where can the skills be learned? What are the options for successful dissemination of progress?

Courses taught at universities or online have to provide up-

to-date information as well as tools for thinking. Textbooks are time-consuming to write and expensive to buy. Usually published in a single language, a heavy book may not be the ideal dissemination vehicle. Textbooks rarely deal with all aspects of the museum environment in one volume. They favor either mechanisms of decay or methodologies for decision-making, but rarely both. An exception is *Managing Indoor Climate Risks in Museums* by Bart Ankersmit and Marc Stappers,¹ which deals with most of the component parts of the problem: the collection, its significance, the building, the hardware, and the visiting public. It accepts the elements of politics and economics and even gives a voice to the engineer.

Striking a balance between making a convincing argument and stressing the inevitability of uncertainty is difficult. Simple catchphrases such as “stable is safe” may be thought to convey an important concept, but they are dangerous if not followed by discussions on the great flexibility of the words used. It is necessary to explain the vagueness of the calculations used to promote concepts. It is important to learn that a precise-looking number often hides a range of probabilities. A straight-line graph is often shorthand for a diffuse cloud of data points. A better catchphrase might be “it’s never that simple.” A major shift is needed in the way preventive conservation is taught, allowing students to acknowledge complexity and uncertainty while learning when it is appropriate to use generalizations and when it is permissible to construct an individual solution that is relevant to a specific local case.

Jonathan Ashley-Smith was head of conservation at the Victoria and Albert Museum for twenty-five years and is currently a teacher, researcher, and consultant based in Cambridge, United Kingdom. He is the author of Risk Assessment for Object Conservation (1999) and served as secretary-general of the International Institute for Conservation (2003–6).

1. Bart Ankersmit and Marc H. L. Stappers, *Managing Indoor Climate Risks in Museums* (Switzerland: Springer, 2017).



Freedom from barriers leaves objects at physical risk. Uncased objects will slowly become soiled and eventually be at risk from cleaning, even in galleries with filtered air. There are always hidden slow-acting risks, even when HVAC systems are in use. Photo: Jonathan Ashley-Smith.

THE MANAGING COLLECTION ENVIRONMENTS INITIATIVE

A Holistic Approach

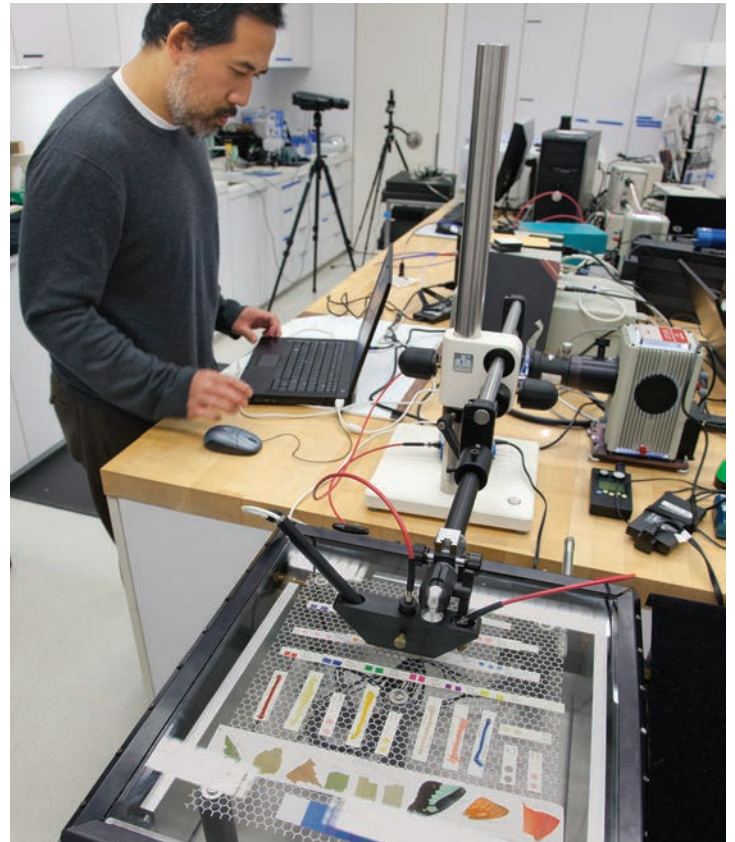
BY FOEKJE BOERSMA, JOEL TAYLOR, KATHLEEN DARDES,
AND MICHAL LUKOMSKI

IN HIS ICONIC PUBLICATION *THE MUSEUM ENVIRONMENT*, Garry Thomson stated that the museum world's practices relating to international loans could potentially steer institutions toward a specific temperature and relative humidity (RH) range, regardless of the climate in which an institution might be located, the type of collection it preserved, or the environmental conditions to which the collection had historically been exposed. Thomson's prescience would be borne out. The convenience of a simple set of numbers that might be universally applied and somehow universally appropriate was too tempting to resist. Over recent decades, museums specified climatic conditions within a "safe" narrow range, not only for loans but also for permanent exhibition and storage spaces. This specificity resulted in large capital investments in mechanical systems and escalating operating costs, as the energy needed to fuel such systems became increasingly expensive.

There was, however, a recognition—slow to form but persistent once it did—that a "one size fits all" approach to environmental specifications for collections in general was often unattainable, not based on evidence, and quite possibly unnecessary. Calls were made by Jonathan Ashley-Smith, then head of conservation at the Victoria and Albert Museum, and by others for a more honest look at environmental parameters since the experience of borrowing and lending institutions indicated that some objects might be more robust than otherwise thought.¹

Nonetheless, museum practice with respect to environmental conditions for collections had remained largely unchanged by the time a group of museum directors openly questioned long-standing protocols relating to loan requirements. In 2008 directors associated with the International Group of Organizers of Large-scale Exhibitions, also known as the Bizot Group, expressed concern about the sustainability of long-established practices for loans—and by extension for collection conditions more generally—sparking a debate throughout the conservation community over the necessity of tight, prescriptive environmental specifications.

Museum environmental research and experience over recent decades has strongly suggested that some collection materials may be able to withstand a wider range of temperature and RH conditions without risk of damage. Yet there remains some dispute and uncertainty within the conservation field about the potential longer-term impacts a more liberal approach to environments would have on collections.



Vincent Beltran, assistant scientist, in the lighting research lab using a fadeometer to determine light sensitivity. Microfadeometry, which uses a tiny spot of very intense light to measure color changes in light-sensitive objects, is a technique that has been used in GCI research for a number of years. Photo: Scott S. Warren, for the GCI.

MANAGING COLLECTION ENVIRONMENTS INITIATIVE

In 2013 the GCI launched the Managing Collection Environments initiative (MCE) to explore some of the issues relating to collection environments with which the field is wrestling. Building on the GCI's previous experience in preventive conservation, MCE functions as an integrated program of research, education, field activities, and information dissemination.

Through its various activities, the initiative addresses a range of research, policies, and practices pertaining to the field's current understanding of the museum environment and to the actions generally taken to manage climate conditions for collections in a safe and sustainable manner. MCE is targeting a number of factors that are seen as contributing to lingering uncertainty within some corners of the field, including gaps in research (specifically a lack of data and quality of evidence); limited collaboration and practical examples or case studies; policies that are not being revised at the institutional level; and the difficulty of decision-making where a high degree of uncertainty can exist.

Research: Quality of Evidence

Given the lack of data to support climate strategies based on

evidence of damage in historic objects caused by fluctuations in temperature and RH (often referred to in conservation as climate-induced damage), MCE has undertaken research that can provide a better understanding of the behavior of the material. There are two significant knowledge gaps in understanding the impact of environmental conditions on historic materials sensitive to moisture: the variation in mechanical properties across a typical collection and the way aging affects the mechanical properties of different materials. Research into material change has often used mock-ups with new materials, but recommendations for environmental conditions based on such samples have been controversial, since artificial aging of new materials does not reflect the complexity of compounded physical and chemical processes occurring over centuries.

To narrow this knowledge gap, MCE is applying small-scale engineering techniques such as micro- and nano-indentation to historic materials. These methods offer a means of material characterization that enables examination of submillimeter samples in various microclimatic conditions. Because micro- and nano-indentation are virtually nondestructive—cross-sectional samples of historic material are not chemically altered during measurement, and tests leave only minimal physical markings—subsequent examination of these samples is possible. These studies have enabled systematic examination of mechanical properties of historic paints for the first time and provide opportunities for nano-indentation data to contribute to predictive models of material behavior.

However, connecting laboratory research with practical field studies remains the biggest challenge. This problem is addressed by MCE through an experimental program on a small collection of historic (nonmuseum) wooden objects exposed to a set of predefined climate fluctuations. The aim of the program is to explore the potential for accurately and quantitatively tracing the response of wood to climatic changes, combining a suite of monitoring techniques: acoustic emission, physical measurements, photography, and high-resolution 3-D scanning.

This ongoing research offers insight into responses of naturally aged objects to climate variations, including indications of relationships between response and specific climate history. Through this research, it is possible to analyze the sensitivity of this suite of methods to fracturing, cracking, and deformation, and also to better understand the quality of data gathered with these techniques. Once a suitable monitoring protocol is established, this research can be used to answer pertinent questions that have eluded the field, such as the role of existing damage in object response.

These developments will inform best practice for monitoring change and should help improve the quality of data gathered in research projects and field studies. Understanding critical conditions leading to damage for mixed museum collections is equally important. While research remains in progress, collected data already show that objects having acclimatized to their climate history is an important consideration when recommending fluctuation levels.

Practice: Collaboration and Dealing with Uncertainty

Although MCE's research will increase understanding of the behavior of materials and thereby contribute to our knowledge of what may



Several participants and an instructor in the MCE June 2017 Philadelphia workshop, part of the project's Preserving Collections in the Age of Sustainability course. Photo: Foekje Boersma, GCI.

constitute a “safe” environment, it is also clear that science alone cannot entirely remove professional reservations regarding changes to a collection's environment. The many variables in material, construction, and other factors mean that scientific experiments cannot cover every possible situation. Of more importance is that what constitutes “damage” is subjective and varies with context. Therefore, MCE also addresses decision-making in the face of uncertainty, which requires collaboration among several of the professions involved in the operation of a cultural heritage institution. Making decisions based purely on the needs of the collection is not feasible—human comfort, the building's capabilities, and organizational resources are also key factors. Decision-making should take into account all these factors and involve different stakeholders with varied levels of engagement and decision-making powers. These colleagues often bring knowledge about specific parts of the process, as well as different perspectives, to the table. While scientific research can inform practical strategies, ultimately collection, building, and human needs have to be balanced with an institution's mission and capacity, external challenges such as extreme climates, and constrained resources.

To specifically address decision-making in the context of the practical business of collections care, MCE has created a professional development program that will include a variety of workshops, meetings, and longer courses. The centerpiece of this program is the Preserving Collections in the Age of Sustainability course, which is intended for decision makers involved in collection preservation, including conservators, facilities staff, registrars, and collection managers. The initial nine-month course, held in 2017, consisted of three phases, beginning with a ten-week online component of readings and assignments that ensured participants would be prepared for discussion and reflection. The second phase consisted of a two-week intensive workshop at the Pennsylvania Academy of the Fine Arts in Philadelphia, which featured lectures and discussions encouraging the diverse group of participants to draw out the complexities of featured case studies. The third phase, a distance mentoring phase directly following the workshop, assisted participants in implementing ideas from their action plans (drawn up during previous phases of the course) within their own institutions, working with their colleagues.

The course considered a range of topics pertinent to the environmental management of collections. By aligning presentations of up-to-date research with discussions of case studies and their individual situations, course participants had an opportunity to reflect on



The MCE project's pilot study on climate-induced change to objects. Left: Michal Lukomski, senior scientist, assembles components for phase one of the study in the Getty Museum's conservation labs. The study included the use of acoustic emission to monitor the response of wood to climatic changes. Right: Joel Taylor, senior project specialist, discusses with Lukomski phase two of the pilot study, which was carried out on specially created mock-ups to better understand the extent to which different kinds of change could be measured. Photos: (left) Foekje Boersma, GCI, and (right) Andrzej Liguz, for the GCI.

their current practices and lay a foundation for lasting institutional change. The course's emphasis on both technical information and interpersonal skills such as communication, negotiation, and leadership underscored the need to move away from prescriptive solutions and quick fixes and toward a comprehensive analysis of the present situation, collaborative decision-making, and long-term goals tailored to the specifics of a given museum—its building, its location, the nature of the collection, its programming, and its resources.

The course curriculum was designed to be flexible and adaptable to different locations, cultural contexts, and climate zones. The MCE team plans to offer the course at approximate two-year intervals with various partners both within the United States and internationally.

To increase the number of examples that reflect this kind of decision-making, MCE has begun to develop field activities with partner institutions to produce real-life examples of the decision-making process as it relates to different types of museums, collections, climates, and challenges. These will lead to case studies that will be incorporated into future courses and published as technical reports.

Policy: Influencing the Debate

Existing policy and practice can always be an obstacle to change, even when there is a better understanding of the risks of climate-induced change to collections. As Garry Thomson predicted, international loan agreements too often stipulate climate requirements for objects around a moderate RH set point, regardless of the climate in which an institution is located or the type of collection it preserves. It has been up to the borrowing institution to accommodate these requirements. Adhering to tight parameters in loans prevents institutions from moving toward more sustainable approaches. It is therefore important for the field to openly discuss the impact on international loans of evidence-based approaches for individual institutions that employ risk management methods instead of default ranges, and to consider how the negotiation and enablement of loans can be facilitated.

Reference points, such as standards and guidelines, also need updating so they can be more helpful in various decision-making processes. To this end, members of the MCE team have joined with professional colleagues in efforts designed to influence environmental management policies. One of these is participation in the revision

of the *2015 ASHRAE Handbook—HVAC Applications: Chapter 23, Museums, Galleries, Archives, and Libraries* (the handbook for the American Society for Heating, Refrigerating and Air-Conditioning Engineers), alongside other international experts in the cultural heritage field, including conservation scientists, conservators, preservation architects, and engineers. One of the proposed revisions is the reinforcement of a starting point for climate control specifications that is no longer the historically perceived optimum of 50% RH and 70°F/21°C but is instead the historical climate average to which a certain collection and building have been acclimatized (with broad limits to avoid universal problems like mold). The guidance therefore accounts for acclimatization of objects to different environments and institutions located in different climate zones. It also separates the guidance for permanent collections from loans that may have come from environments with different climatic ranges. These changes should result in environmental strategies that could be easier to achieve with nonmechanical controls (such as building envelope improvements) and limited mechanical intervention at a more affordable cost to the institution, without endangering collections by placing them at risk of climate-induced damage.

A HOLISTIC APPROACH

What makes MCE unique in its approach is that it addresses the challenge of rethinking collection care environments from a variety of angles. Designing environmental strategies for collections requires new technical data and new decision-making processes that involve the input of different stakeholders. Environmental management for museum collections is not the sole responsibility of conservators and conservation scientists. As the field advances in this area, the holistic approach has the advantage of advocating for conditions that not only are safe for collections but also are more economically and environmentally sustainable.

Foekje Boersma is a former GCI senior project specialist and project manager of MCE (2013 to early 2018). Joel Taylor is a GCI senior project specialist. Kathleen Dardes is head of the GCI Collections department. Michal Lukomski is a GCI senior scientist.

1. Jonathan Ashley-Smith, Nick Umney, and David Ford, "Let's Be Honest—Realistic Environmental Parameters for Loaned Objects," in *Preventive Conservation: Practice, Theory and Research—Preprints of the Contributions to the Ottawa Conference, 12–16 September 1994* (London: IIC, 1994), 28–31.

COLLECTION ENVIRONMENTS AND EVIDENCE-BASED DECISION-MAKING

BY ROMAN KOZLOWSKI

IN 2014 THE INTERNATIONAL INSTITUTE FOR CONSERVATION OF Historic and Artistic Works (IIC) and the International Council of Museums—Committee for Conservation (ICOM-CC) issued a joint declaration on environmental guidelines for museums, generally perceived as a fundamental milestone in advancing the debate on appropriate environmental specifications for collections.¹ The declaration stated that “the issue of collection and material environmental requirements is complex, and conservators/conservation scientists should actively seek to explain and unpack these complexities.” It called for a more customized approach to setting the environment for collections and historic interiors, taking into consideration the different requirements needed for objects on display, in storage, or in transit, as well as any individual sensitivities to certain conditions and the degree to which objects may have become acclimatized to their local environment.

Moving to variable specifications requires evidence-based decision-making. This entails establishing clear communication between research and heritage managers, and an effective transition from basic research to application. A crucial research focus is climate-induced change on humidity-sensitive materials, an area the Jerzy Haber Institute in Kraków has been active in for a number of years.

CLIMATE-INDUCED DAMAGE

Climate-induced damage to humidity-sensitive materials is an important risk in most museum collections and historical interiors, as such materials undergo physical change when they lose or gain moisture. The constraint from free movement, due to rigid construction or connection to materials that respond differently, induces stresses in the objects. These stresses can cause deformation, cracking, and delamination. Heritage science and conservation practice have developed two general approaches to providing evidence necessary to inform climate specifications: (1) analyses of the historic climates to which the objects have “acclimatized,” and (2) analysis of the physical response of materials and objects to relative humidity (RH) and temperature fluctuations.

Awareness of object acclimatization to a particular indoor environment has been long reflected in the requirement by some that climate conditions be retained as fully as possible when vulnerable objects are moved from their usual location for restoration or exhibition. Stefan Michalski coined the term “proofed fluctuation,” defined as the largest RH or temperature fluctuation to which the object previously has been exposed. He assumed that the risk of further physical damage from fluctuations smaller than the proofed



values is low if the object and environment are not altered. If the past fluctuation was enough to cause fracture, the object has fractured, and the cracks reduce the stress that would otherwise develop in the undamaged material. The acclimatization concept has been convincingly confirmed by two new research tactics. The first is precise direct tracing of damage in objects using acoustic emission (AE). The second is collecting observations from a large group of well-defined objects (exemplified by the Rijksmuseum study on the effects of humidity fluctuations on decorated wooden panels in the museum’s collection).

The AE method—based on monitoring the energy released as sound waves during fracture processes in materials—was successfully used in over a year of monitoring crack propagation in wooden elements of two pieces of furniture, in the National Museum in Kraków and the Victoria and Albert Museum in London, selected by conservators as particularly vulnerable to damage potentially induced even by the con-



The Mazarin Chest, circa 1640, an exquisite piece of Japanese export lacquer displayed in the Victoria and Albert Museum. Assemblies of cross-grained wooden elements in the Mazarin Chest lid have led to climate-induced cracks in the wood and lacquer layer, evident at the corners. Photos: © Victoria and Albert Museum, London.

trolled environmental conditions in the galleries.² The crack propagation determined was below 1 mm per year in each piece of furniture—a minute change for any practical assessment of damage, which could be recorded only owing to the amazing sensitivity of the AE sensors.

In the Rijksmuseum study, construction, material properties, and condition of more than 370 decorated oak panels (cabinet doors and panel paintings that had been in the same location for about 100 years) were examined.³ Shrinkage cracks and failing joints were the common types of damage and were generally formed before the objects entered the museum collection. The uniform damage pattern reflected early “acclimatization” of similar wooden constructions to probable large RH variations in the uncontrolled environments in which the objects were historically kept.

The acclimatization concept was explicitly expressed in standards on control of the indoor environmental conditions. Among them, the European Standard 15757:2010—*Conservation of Cultural Property – Specifications for Temperature and Relative Humidity to Limit Climate-Induced Mechanical Damage in Organic Hygroscopic Materials*—is widely referred to by museums and research institutions. For example, out of nineteen presentations at the Climate for Collections: Standards and Uncertainties conference organized by the Doerner Institute in Munich in November 2012, eleven quoted the standard as a reference. The standard provides a methodology of processing accumulated past climate records to establish more quantitatively targeted microclimates, specifying average levels of climatic parameters and their seasonal drift, as well as bands of

tolerable short-term fluctuations. The standard stresses that the harmlessness of the existing climatic conditions has been a key assumption in the acclimatization approach, which has to be carefully checked in each case.

Obviously, environmental specifications cannot be based on the acclimatization approach when:

1. new damage continues to accumulate in an object;
2. an object has to be moved to a different climatic environment; or
3. conservation treatments may alter the safety margins of objects achieved by their acclimatization to the past conditions.

In these instances, decision-making requires analysis of moisture and mechanical response of materials and their assemblies to address how much variation in RH is actually safe for a specific object made of hygroscopic materials.

A particularly effective way to analyze the response of materials is computer modeling, which simulates “real-time” moisture movement and the resulting strain and stress fields across objects of varying shape, thickness, or water vapor permeability in response to RH variations. The modeling has been based on existing and developing information on material properties such as adsorption or desorption of water vapor, moisture-related swelling and shrinkage, water vapor diffusion and surface emission coefficients, and tensile properties. The modeling provides a quantitative assessment of the climate-induced risk based on the analysis of moisture-related dimensional response of objects. By offering a direct rather than indirect measure of the hazard, significant progress in the practice of evaluating climate parameters by themselves can be made.

A new online environmental data analysis tool, HERIE, is being developed collaboratively by several institutions including the Getty Conservation Institute (GCI), to overcome a barrier to exploiting advantages of modeling of object moisture response in conservation practice.⁴ The user provides basic characterization of objects in the specific collection and uploads RH data, recorded in a gallery or simulated for various climate-control scenarios. The software processes the data, using the precalculated database, into strain versus time history experienced by the object. The risk of damage is then assessed by comparing strain against a critical level selected by the user—the damage criterion.

NEW INITIATIVES

Recent years have brought promising new initiatives that address the major deficiency in the modeling—the lack of material properties and failure criteria (e.g., the point at which movement in wood or paint layer exceeds their elastic limits). These are derived directly from investigations and observations of actual objects aged and adapted over decades or centuries to indoor environments in which they have been preserved. Such adaptation might have involved an unknown level of permanent change, like deformation or fracturing, making historical materials different from new materials, also with respect to their vulnerability to damage processes.

The new initiatives range from mechanical characterization of aged materials by monitoring deformation of historical painted panels (also in laboratory tests developed by GESAAF [Dipartimento di Gestione dei Sistemi Agrari, Alimentari e Forestali] of the University

of Florence), to using micro- and nano-indentation methods on sub-millimeter samples of aged paint layers, glues, or gessoes, developed by the GCI within its Managing Collection Environments Initiative to better estimate and, ultimately, improve accuracy of numerical modeling predictions. The micro-indentation technique, which permits multiple measurements of a single sample, will be used by the GCI to determine moisture-related mechanical properties of historical materials contained in glue paint decorations of known origins and detailed aging histories in Norwegian stave churches. This research is part of the newly initiated SyMBoL project (Sustainable Management of Heritage Buildings in a Long-Term Perspective), coordinated by the Norwegian University of Science and Technology in Trondheim.

Another equally important area for future conservation efforts is refining damage criteria to base them on the observation and monitoring of actual objects displayed in real-world conditions in museums and historic buildings. Again, no matter how much evidence is obtained from laboratory work with replicas simulating original objects, decision makers will remain skeptical of the evidence obtained. Well-documented damage development on freshly treated or consolidated objects would be of interest, as such objects may be particularly vulnerable to RH variations.

Finally, an acute gap in the conservation literature is the general absence of thoroughly documented reports on the effect of climate control failures on actual objects. These reports could cover collection observations in which damage to objects could be related to unusual recorded humidity variations resulting from power failures or poor

maintenance of air-conditioning equipment, insufficient response of the systems to sudden spells of extreme weather outdoors, or incidents of water intrusion into display or storage areas. Hannah Singer's detailed report on the effect of dramatically increased RH levels on the paper collection in Vienna's Albertina Museum due to rainwater infiltration remains, unfortunately, an exception.⁵

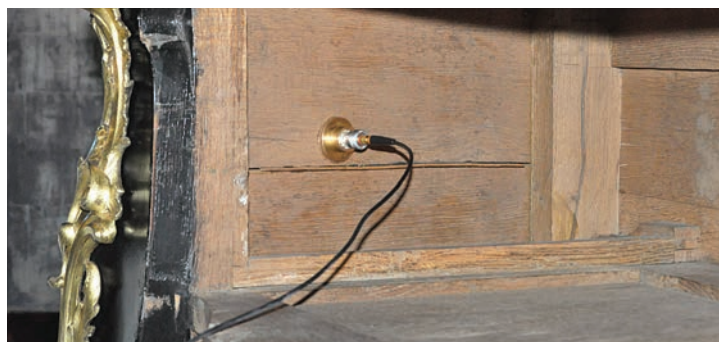
The emerging methodology linking collection analysis and numerical and experimental studies to better understand climate-induced damage of specific objects has so far focused on objects of fine and decorative art—and, predominantly, decorated wood. An obvious next step will be evidence-based climate specifications for library and archival collections that contain almost exclusively hygroscopic materials: paper, board, parchment, leather, and wood. The model of moisture and mechanical response would need to address broader patterns of damage, including not only physical failure such as cracks or tears but also three-dimensional deformation like curls or cockles. The gap in solid information on the issues is evident in the most up-to-date ISO standard 11799:2015—*Information and Documentation – Document Storage Requirements for Archive and Library Materials*—which does not specify any recommended range of RH variations.

Coupling chemical degradation of modern artistic materials like plastics to risk of mechanical damage is another emerging field of research.

THE NEED FOR COLLABORATION

The IIC/ICOM-CC guidelines called upon conservators and conservation scientists to take a more active role in developing evidence-based environmental specifications. The latest developments offer diverse approaches in which observations and data increasingly gathered from measurements of historic materials can supply input into algorithms modeling risk of climate-induced damage and provide a frame of reference for conservation and museum professionals. We are also witnessing a decrease in the obstacles to research feeding back into conservation practice: fundamental science has become more accessible through evidence-based standards and software tools, advanced techniques of object monitoring now are more widely used for routine work, and research projects lead more often to general outcomes. However, to build on these trends, developments should be supported that aim to bring together in-depth, object-based information and experimental and modeling studies, and that enable full engagement of all actors interested in effective management of collection environments to reduce energy use while maintaining high standards of collection care.

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An eighteenth-century French commode displayed in the collection of the Victoria and Albert Museum. Photo: ©Victoria and Albert Museum, London. To monitor climate-induced fracturing of wood inside the commode, an acoustic emission sensor was mounted close to the tip of an existing crack. Photo: Marcin Strojcecki, the Jerzy Haber Institute.

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A HISTORIC CHANGE AT A HISTORIC HOUSE

Climate Management at Knole



BY NIGEL BLADES AND KATY LITHGOW

DATING BACK TO THE FIFTEENTH CENTURY, THE KNOLE ESTATE, situated in west Kent, includes one of England's largest and most historic houses. Simultaneously a medieval archbishop's palace, a Jacobean Renaissance courtier's house, a repository of royal Stuart furniture, a grand eighteenth-century ducal residence—home to Earls and Dukes of Dorset and Lords Sackville—childhood home to Vita Sackville-West, and inspiration for Virginia Woolf's *Orlando*, Knole and its increasingly fragile antiquarian charms have drawn visitors in the thousands since the late eighteenth century.

By 1874 Reginald Mortimer, the First Lord Sackville, found that “people strayed away from their parties, broke into our rooms, tore the fringe off the chairs and couches, and did all manner of things, whereupon I felt obliged to shut up the place.” Although visiting resumed at reduced levels on his death in 1888,¹ and the collections were repaired, the massive costs of maintenance and taxes in the twentieth century led to the house being transferred to the National Trust for England, Wales, and Northern Ireland in 1946, with subsequent gifts of some contents in lieu of taxes.

A PROBLEMATIC ENVIRONMENT

In 1946 James Lees-Milne of the National Trust found the building and contents in poor condition, describing “piles of dust under the chairs from worm borings. The gesso furniture too is in a terrible state. All the picture labels want renewing; the silver furniture clean-

ing; the window mullions mending.”² Government-aided building repair tackled high-priority work in the latter half of the twentieth century but did not fully address the poor buffering of the internal environment. Knole also lacked modern heating, and electric lighting and power were minimal. Thus collections at Knole had become accustomed to a relative humidity (RH) of typically 60–90 percent—much higher than found in most English country houses.

Housekeeping was reintroduced to control light and dust, reflecting the Trust's emphasis on preventive conservation, which prioritizes dealing with cause over effects.³ A 2002–5 Leverhulme-funded research project demonstrated that the high RH bound dust to Knole's textiles, while condition surveys (most recently 2008–12) disclosed environment-related damage. For example, at least 80 of 310 paintings were affected by mold, insects, and condensation. However, conservation was limited to emergency and “little and often” treatments to maintain the status quo, as there was little point in treating objects only to return them to a poor environment.

The most recent phase of emergency building repairs began in 2012 as Phase 1 of the £20 million “Inspired by Knole” project.⁴ Phases 2 and 3—addressing showrooms and contents, and supported by £7.75 million from the Heritage Lottery Fund—began in 2013. Building repair provided the opportunity to improve the environment through humidity-controlled conservation heating. This technique is used successfully in most of the Trust's historic houses to stabilize RH for the care of collections.⁵ However, there were concerns about how objects would respond to the lower RH

environment of the Trust's 40–65 percent RH control specification, to address mold and insect pests.

IMPLEMENTING CLIMATE CONTROL

The feasibility of introducing conservation heating was studied from the early 2000s and then tested in Knole's Reynolds Room in 2011. Insulation to enhance the building's thermal performance and reduce energy consumed by conservation heating was considered.

To assess the impact on the Knole collections of changing the environment from the uncontrolled 60–90 percent RH to a controlled 40–65 percent RH display environment, acoustic emission (AE) monitoring was undertaken from 2016, as a research collaboration with the Polish Academy of Sciences Jerzy Haber Institute of Catalysis and Surface Chemistry, which has expertise in using AE to measure the response of historic furniture and wooden sculpture to changing RH and temperature. Because AE monitoring is labor intensive, only two sets of "canary objects" were studied. Examples of the most sensitive and significant items were chosen—a torchère and table from a rare 1671 Parisian suite of furniture by Pierre Gole, and a torchère and table from a set of japanned furniture by Gerritt Jensen, dated 1691. AE monitoring showed that both suites were physically very stable in the uncontrolled high RH environment at Knole, and that the AE response did not increase significantly as the furniture was moved to the controlled environments with an RH upper limit of 65 percent (although woodworm activity was recorded). In the future, the set point will be reduced to 60 percent so the annual display climate will be broadly within 40–65 percent RH.

The type of heating needed careful consideration to avoid detracting from the showrooms' sense of history. Although not as environmentally sustainable as hot water heating systems using renewable energy, fixed and portable electric heaters were selected. The infrastructure for electric heating is far less invasive than the pipes, radiators, and valves needed for "wet" heating. Where there was wall space, fixed traditional pattern sectional radiators were installed. However, in most rooms heating is from black-painted oil-filled radiators powered from a dedicated conservation heating circuit. In addition, Knole's Ballroom has an electric heat mat under the carpet, which can deliver low-level radiant heat across the main floor area of the room. (This technology is not yet sufficiently



The Knole ballroom with an electric heating mat under the carpet. A portable electric heater is visible at the far end of the room. Photo: ©National Trust Images/Nigel Blades.

resilient to footfall to withstand wider installation.) Insulation was installed chiefly in ceiling spaces and in some areas of the walls to reduce heat loss from the showrooms, and in turn to reduce heating power needed to maintain conservation conditions. Its use was constrained by the desire to limit disturbance to the historic fabric.

THE RESULT

The first-phase showrooms opened in March 2017 with a building management system operating a conservation heating control strategy with an upper RH limit of 65 percent. AE monitoring continued until summer 2018. This technique has proved extremely useful in demonstrating that the environmental changes brought about by the introduction of heating have been safe for the house and collections. Keeping the collections at around 60 percent will prevent mold growth and wood-boring insect attack, while avoiding damage to furniture and paintings from drying and desiccation. The project is nearing the end of its final phase, with full completion in spring 2019.

As the highest-priority conservation project in the Trust concerning a building, interiors, and a collection of preeminent significance and fragility, great emphasis has been laid on research to minimize the risk of unintended consequences in the introduction of well-intentioned improvements. A clear understanding of the condition of the collection to identify causes of deterioration and rationalize the selection of control measures, real-time testing of novel as well as more familiar solutions, and research to assess the risks and benefits of changing environments and object response have been essential to strengthen confidence in conservation decision-making at Knole.

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The Gole Suite in the Cartoon Gallery at Knole with acoustic emission monitoring equipment. Photo: ©National Trust/Nigel Blades.

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SUSTAINABILITY, ACCESS, AND PROCESS

A Discussion about Collection Environments

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LUKASZ BRATASZ is head of the Sustainable Conservation Laboratory at Yale's Institute for the Preservation of Cultural Heritage and a research fellow at the Jerzy Haber Institute of Catalysis and Surface Chemistry in Kraków. Earlier in his career, he was a head of the Laboratory of Analysis and Non-Destructive Testing of Artefacts in the National Museum in Kraków.

JANE HENDERSON is a reader in conservation at Cardiff University's School of History, Archaeology and Religion. She serves on the editorial panel of the *Journal of the Institute of Conservation* and on the ICOM-CC preventive conservation working group, and was coeditor of the *Journal of the American Institute for Conservation* special edition on collection care.

They spoke with **JOEL TAYLOR**, a senior project specialist with the GCI Collections department, and **JEFFREY LEVIN**, editor of *Conservation Perspectives*, *The GCI Newsletter*.

JEFFREY LEVIN The 2014 joint declaration of the IIC and ICOM-CC addressed sustainability in the context of collection environments. What does the term “sustainability” mean to each of you?

JULIAN BICKERSTETH I have always liked the Brundtland² definition as meeting the needs of the present without compromising the ability of future generations to meet their own needs. I say that because we have to think globally before we think locally. I was born into a world where there were 2.9 billion people, and now there are 7.6 billion. In the 1960s there was a famous book by Paul Ehrlich called *The Population Bomb*, which said by the 1970s we'd have widespread famine because we can't feed this number

of people. Well, here we are with well over twice that. So, I remain optimistic that we will achieve a sustainable future in some way.

JANE HENDERSON I tend to work with the social, economic, and environmental definition of sustainability, which says you have to think of all three issues together. And I consider culture to be part of the social. My optimism lies on the environmental side of the sustainability bottom line. My pessimism lies in the economic and social sides of it—economic from external forces and the social in conservation. We don't really address that in a convincing way.

LUKASZ BRATASZ I don't think sustainability is a solution or even a goal. Rather it's the process of negotiating and renegotiating activities with problematic consequences. It's this negotiating and balancing between our actions and their consequences that is the heart of sustainability at all levels—economic or environmental. Speaking about heritage, our actions in preservation can have negative consequences, and we need to identify and balance different needs.

LEVIN It's been about four years since the 2014 declaration. What obstacles remain to developing more sustainable practices?

HENDERSON In my experience, the obstacles are always economic. We are in the grip of massive public sector funding cuts, so the ability to implement professional practice has been limited by job losses and restrictions in opportunity. While some positive things can be done in terms of being able to describe a green dividend in the implementation of informed conservation practice, there are great challenges in the loss of professionalism, expertise, and institutional knowledge.

BICKERSTETH The 2014 declaration was a watershed and occurred in part because the IIC and ICOM-CC conferences were back-to-back in roughly the same part of the world. It was a great moment to seize. But it was also a watershed because in the previous seven or eight years the parameters we'd been living with since Garry Thomson's work and the energy required to achieve those parameters were suddenly butting up against each



What you really need to train these passionate conservators to do is to interface with the other players in this debate, particularly around environmental parameters. We need to be able to talk the language of facilities managers and directors, and at the same time understand the impact of their decisions on the collections we look after.

JULIAN BICKERSTETH

other. The profession had to decide how to respond. The 2014 declaration was not wholly agreed to by the profession, but since then there's been considerable maturing of the debate. It moved us forward in a way that previously had not been achieved, and there's been a massive amount of new science that's come out. Yesterday I was actually looking at the papers for the IIC Preventive Conservation conference in Turin, and they show a high level of work on implementation and a wider understanding of the science behind what happens with environmental change.

BRATASZ I'm from Poland, which is now among developed countries but for many years was a developing country, and I look at the 2014 declaration as a very powerful document without which I couldn't communicate with decision makers. Not every country is like Britain, where the level of expertise is high. In many museums, you don't have basic expertise and an understanding of sustainability. Given the risk aversion of decision makers such as museum directors, it can be difficult to communicate when you start to speak about parameters. I look at the declaration as a signal to everyone that we need to relax and rethink climate control. For me as a specialist in climate-induced risk, the declaration was a political document—very powerful and very needed.

BICKERSTETH The word “powerful” is a strong one. Jane, from your perspective, was it a powerful document in the UK?

HENDERSON It has had an effect that you can see through work done in the European standards groups. A couple of new standards came out in 2018—one dealing with specifications for rooms intended for storage or use of collections, and the other dealing with indoor climate.³ What's important about these standards is that they emphasize the concept of this being a decision-making process with criteria. What was powerful about the 2014 declaration was that it outlined the things that really matter in making those decisions—and sustainability is one of the very important factors. With these new standards we'll start to see a greater ability of people to go to decision makers and managers, as Lukasz said, and argue, “Look, these are recognized ways of operating.”

JOEL TAYLOR Do any of you see an acknowledgment of the declaration outside conservation?

HENDERSON If it's been acknowledged in Wales, it would probably be because I was raising it. We've been working on devising conservation principles for movable collections in Wales, and it's come up in those discussions. But more to what Lukasz is saying, a lot of museums don't have people who have time to be specialists—it's a trickle down in terms of documents and standards coming out. It's definitely conservators leading it, but there are not many of us in Wales, and certainly not many of us who get to go to conferences. I don't think it's unheard or unwelcome, but conservators do struggle to speak in other forums. We have ICOM-CC, but how many of the CCs go to the main ICOM meeting?

BRATASZ I, too, think there's a problem spreading this concept of sustainability in the museum field. Conservators or conservation scientists are leading the discussion, maybe because they tend to think long term. I'm currently at Yale, and the natural history museum here is well prepared to discuss sustainability because it's so deeply in their mission of conserving biodiversity. The libraries, too. But the fine art museums much less so. It's risk aversion. Many museums, here at Yale or in the United States, lead the nation in contacts with donors and asking them to donate. They look at the relaxation of climate controls as a potential risk that can undermine their claims that they preserve their collection at the highest possible level. But there also are some incentives. In Poland, the main incentive to go for a sustainable solution is as a selling point in grant applications for building new museum storage. It was so powerful that museums started to speak about green museums—not because of political pressure from the top, but to have something to distinguish themselves from competitors. However, I tried to suggest to the ministry in Poland that all applications should include evaluation of energy consumption and sustainable solutions, and the ministry wasn't convinced. I think that they perceive low energy consumption as a solution for poor countries, not rich countries. We have a lot of work to do in this respect.

BICKERSTETH I've seen evidence of the declaration's influence in all

sorts of unlikely places. I've been working on historic huts in Antarctica, where it's a document they've used in terms of the uncontrolled environment in the huts. I was in Papua New Guinea two weeks ago, and there it was at the National Museum. They've got a fantastic HVAC system but don't have money to run it, so they were saying, "What can we achieve within these types of parameters?" In those places, it's been accessible and used. I'd also say that I've seen conservators use it to create fantastic relationships with facility managers. In a couple of instances, museum directors have leapt in and said, "We're really on board with this." At other levels—generally more the art gallery scene—it's been a harder process. In sum, where the leaders are on board, great strides have been made. In other instances, there have been political reasons why it's not been used.

HENDERSON Within the UK museum sector, the imperative of sustainability is extremely well established, but I don't know if those making the changes would necessarily link it to the 2014 declaration. That's not to say that they're not linked, but I don't know if it's seen as the cause.

TAYLOR Much debate surrounding this international issue has involved anglophone countries. Has that influenced this discussion?

BICKERSTETH It's very interesting that some of the papers being submitted on this to the IIC 2018 Congress on Preventive Conservation are from Egypt, India, Japan, and Mexico. They're high-quality papers, and very honest. Frankly, there's been a lack of honesty about what's really happening in a lot of institutions. As the science moves forward, there is an ever-greater need for transparency. That's where, in a sense, our non-anglophone colleagues are leading the way.

HENDERSON One thing I wanted to get into this discussion was the assumption that it's all about turning down the air-conditioning and consuming less energy. Actually, it's about improving infrastructure, fixing roofs, doors, building maintenance, and things like that. It's not about lowering air-conditioning, but rather dialing up preventive maintenance—something that's easier to get. A lot of the dishonesty arises because people claim they are aiming for this or that standard, but they really just want to be in the top tier or have Number One next to their name rather than any absolute need. Those people who feel less burdened by that need are able to be more honest about what is required to achieve sensible environmental conditions.

BRATASZ There are a number of very good publications dealing with sustainable energy consumption, but this is more an academic interest. In practice, I don't see statistical change. One obstacle is that there is no publicly available data on energy consumption normalized to the volume or the surface area, so decision makers don't know how much they can save and so on. This information is missing from the equation. There are some simulations, but they are far from the real-world situations. A second obstacle relates to the way we evaluate risk connected to climate variation. We generally have three approaches. One is based on analysis of the mechanical behavior of objects, a second is the acclimatization concept, and the third is the use of non-

invasive models for tracing damage development. In one model, the mechanical behavior is so oriented toward the risks that they define the worst-case scenario. Museum directors seeing that focus on the risk increase. Conservation science is not really clear why some objects survive remarkably well in uncontrolled environments, such as historic houses and churches. The information is not consistent, and this is an obstacle that needs to be addressed by future research.

BICKERSTETH I believe museums have a wonderful opportunity to be modelers and advocates for sustainability. I know of two or three institutions in Australia who have reduced their energy consumption by 25 to 40 percent. Interestingly, they've mostly done that by HVAC tweaking, not by relaxing parameters. There's much more efficiency that's possible given new knowledge. But the unit cost of energy is rising so fast that energy bills are often increasing despite what they're doing. That's disheartening, but at least they can say they would be rising a lot more if they weren't making these changes.

HENDERSON When you look at social, economic, and environmental factors, conservators are clearly confident in their influence on the environmental issues. We have great enthusiasm for doing that. I would note that there is a huge amount of enthusiasm in this new Sustainability in Conservation group, which is driven by students and emerging conservators.⁴ I think the museum sector as a whole is very confident about engaging in social and economic programs, but I'm not sure to what extent conservators are engaging in discussions about cohesive communities, sustainable societies, and sustainable growth. I'd like to see our ambition extend into that terrain.

BICKERSTETH Jane, among your students is there increasing optimism around sustainable futures and conservation, or is there pessimism?

HENDERSON I wouldn't say it was optimism or pessimism. I'd say it's passion. The students are passionate about environmental sustainability. We do what's called green impact every year in our labs, and we go for the gold award every time. They're so passionate, thinking much more about green solvents, minimizing use of materials, and stopping running water—just everything. They know they are the generation that has to pull it together.

BRATASZ I agree that among the younger generation and the students there is great enthusiasm. I'm supervising several students at Yale who analyze consumption for generally sustainable solutions, like water consumption or lighting. I even have a group of international students who were asked to speak with our museum directors, and they talked to them about environmental standards and asked difficult questions. The younger generation is definitely with us. Something is changing.

TAYLOR Lukasz, your definition of sustainability was the inclusion of a process and negotiation. Do you see this debate on change across the sector as a cause for optimism?



I don't think sustainability is a solution or even a goal. Rather it's the process of negotiating and renegotiating activities with problematic consequences.

LUKASZ BRATASZ

BRATASZ Absolutely. Sustainability is a process. It's not a green solution or low energy consumption or an HVAC system. It's a process. This is relatively simple when you try to reduce energy consumption in a museum—you change something in your HVAC system. But we need to discuss which part of the society we are valuing—the current generation or future generations? For example, for objects that are photosensitive, what is the social discount rate for showing the object to a person today or in twenty or two hundred years? This discussion is much broader and more interesting. Changing one HVAC system to another is important because of its economic impact, but from an intellectual standpoint the discussion of sustainability opens up so many more doors.

LEVIN You raise the important point of balancing present accessibility with future accessibility. How is that addressed in discussions within the profession and the larger museum community?

HENDERSON In Wales we have a Well-being of Future Generations Act.⁵ All museum grant funding has to show how it addresses that act. There's also money to spend now for energy efficiency measures. So the concept of future generations and the social context is well established in the UK.

BRATASZ But what about loss of the value of the collection due, for example, to deterioration processes? I understand the social discount rate in terms of economic value, but I haven't seen much work on the loss of the artistic value or the authenticity or the color of the object.

HENDERSON There have been quite a few papers, particularly in Australia and Amsterdam, about calculating loss of value. Doing calculations is kind of a two-year process, and it's not something organizations with smaller resources do. It doesn't mean that they don't have the concept of sustainability for future generations—they just lack the resources to do the calculation.

BICKERSTETH Going back to students for a moment, one of the challenges for all educational organizations must be the limited number of teaching modules. What you really need to train these passionate conservators to do is to interface with the other players

in this debate, particularly around environmental parameters. We need to be able to talk the language of facilities managers and directors, and at the same time understand the impact of their decisions on the collections we look after. Getting that mix right amongst our passionate young trainee conservators is the challenge.

TAYLOR That's something we've experienced in our Managing Collection Environments initiative, as well as in the training courses we've been doing with midcareer professionals. When we ask them what obstacles they encounter in implementing their activities, it's very rarely understanding the technical information—it's this issue of getting to the table and then being able to communicate the information that they have.

HENDERSON The ability to influence is a key conservation skill. If you're not able to carry the argument, then you can't be an effective preventive conservator. As a young conservator, I was very uninfluential. My technique was shouting and shouting again, and I discovered how uninfluential that was. Influence technique is something I now slip into any course I'm doing on preventive conservation and environmental management. Certainly we should teach communication and influence skills—without a doubt—but courses are two to four years. Careers are thirty to forty years. As a sector, we have to make communication and influence a priority so that throughout their careers, at different levels, conservators can pitch their ideas appropriately.

LEVIN Has there been an increase in collaboration between disciplines? Have conservators been interacting more effectively with museum colleagues?

BICKERSTETH We've definitely advanced. Relationships with directors and facility managers vary a lot, but we're no longer a back-of-house operation. We're seen as a critical part of the operation.

HENDERSON We're out of the closet, and we're in the galleries. We don't stay behind the scenes. Conservation is now front of house.

BRATASZ I also think there is collaboration among the various fields, with different specialists speaking to each other. But the nature of our work has also changed. We are no longer in the situation



There's an unspoken but underlying assumption in preventive conservation that our role is to make things last as long as possible. I'm not sure we should consider ourselves in charge of how long things last. We should be in charge of interpreting, explaining, and managing the life expectancy and longevity of objects.

JANE HENDERSON

where there is some preventive conservation rule we can simply apply without looking at the consequences of our measures, which go beyond particular institution, region, or country. We look at the consequences of various options and then negotiate. To do that, we need to interact with many disciplines. This didn't exist before, but it has developed. How we work has changed.

HENDERSON I'd like to pick up on risk-based management and risk analysis. There's an inherent conservatism in the conservation field stemming from our concern with "damage," and if we constantly talk in terms of what can go wrong, we feed that. There's an unspoken but underlying assumption in preventive conservation that our role is to make things last as long as possible. I'm not sure we should consider ourselves in charge of how long things last. We should be in charge of interpreting, explaining, and managing the life expectancy and longevity of objects. If you engage people in a discussion about what benefits you can gain from an activity—not just the risks—you shift the discussion. We talk about how a collection might be damaged but rarely talk about who might benefit from its use. That leads us to a kind of colonialist position that the people with the most resources, skills, and familiarity with the collections are the ones who do the least damage in the sense of accelerated change. Those people will always be privileged, whereas if we talk about who has been excluded from cultural heritage—who would gain most socially and economically from access to cultural heritage—it may be communities of people who don't know how to handle objects or don't have the air-conditioning. We talk about risk-based but we don't talk about reward-based. We set up the activity as potentially risky and therefore risk aversion is fed, whereas if people who have traditionally been excluded suddenly have a chance to have a tangible relationship with something concrete from their past, the reward might be establishing their social place in society, and a closing of the cultural divide.

BRATASZ I absolutely agree with you. With sustainable development, there is this path that goes from present to future. We should look at that, but at the same time include those other members of society in the present. I think we can extend the term sustainable not only to time but to different parts of society.

TAYLOR I personally see no particular reason why a privileged

few in future generations should be given access to something that less privileged people in the present generation do not have access to. To a certain extent that speaks to the social sustainability that we all agree is a part of this. It's really negotiating these different kinds of access socially and temporally.

BRATASZ I'm a physicist. I need numbers. For example, if we have to decide how long you can show the object before you damage it, you have to define how you compare and weight the value to various social groups now and in the future. And if we don't have a number that compares one view of an object today with someone seeing it in five hundred years, we cannot answer the question of what and for whom we preserve our heritage.

HENDERSON We need the quantitative data to underpin the discussion. And conservators should be the ones coming into the discussion of the quantitative data. But that is also a discussion about the value of access—and I'm not sure that we, as a profession, are very good at that. There are different forms of access and benefit that I don't hear discussed or well described in the conservation community, and I don't know how well we are able then to build that into Lukasz's model. We need to expand our conceptions in these areas.

BICKERSTETH It's a space that our colleagues in built heritage are better at. The concept of significance assessments is tied to a discussion of values. Certainly, conservators have far more to say about the significance of what we're working on in terms of its social, cultural, artistic, and historic values, etc., and overlaying that into decision-making processes. Our built heritage conservator friends tend to be brought up with that discussion and that training. I'm not sure we're so good at it.

HENDERSON All of our students have to do significance assessments, in which you have to negotiate with owners at different levels of complexity, so I think the concept of significance is certainly coming through with the new generation.

BICKERSTETH It's a new-generation thing. I think the mid-generation people struggle with it.

TAYLOR An area where a lot of decision-making goes on—not always with transparency—is international loans. How would each of you relate decision-making to the issue of environmental standards for international loans?

HENDERSON The big art museums and well-funded institutions feel they have to be seen as the best or A-plus. Their decision-making may have nothing to do with the needs of the collection and more to do with the ambitions of the institution. There's nothing necessarily wrong about that as long as you know that's why you're doing it—that you're not pretending to do it for the collection when it doesn't actually need it. Because if you're doing it to get more funding, great—knock yourself out. As long as you spend some of it on conservation. In terms of the 2014 declaration, we can move away from standards about numbers and move towards standards as well as procedures, because then we might get somewhere. What I like about these declarations is that there are factors you take into consideration. If we start by saying, "We'll take these particular factors into consideration," that's how we'll be honest about it. Then we can begin to do more accountable decision-making. The declaration speaks to that by stopping numbers being the story and making the story those things that matter to us—sustainability, access, use, and enjoyment.

BRATASZ I imagine in coming years a change of environmental guidelines from indicating the numbers, to showing the process of how we made a decision and how we measure success in preservation—because 40 to 60 percent relative humidity doesn't guarantee success at all. Our field needs to develop metrics for measuring success in terms of use of the collection—which can be considered a social benefit—as well as its preservation.

BICKERSTETH It's worth remembering the lead-up to the 2014 declaration—the National Museum Directors' Council statement, the Bizot Group statement, and the strong view articulated by our German colleagues that this move was driven by big art museums to make loaning easier and cheaper. It also was affected by an effort to reduce the number of couriers accompanying the art loans. We saw decoupling that from the decision-making about permanent collections as critical to what the declaration was seeking to identify. Has that moved in the last four years? The pressure on loans is as great as ever. I hear fewer complaints about ridiculous parameters being set by loaning institutions, but I'm sure it still goes on. Inevitably what happens is that if A is lending to B, A will provide strict guidelines to ensure that B will look after the loans as well as they possibly can. Then B says, "You're not achieving that back at A, so why should we do that when we borrow from you?" And that discussion goes round and round. Loaning is such a critical part of the art world. There's no doubt it creates greater access. But the damage to objects is something rarely talked about in the process of loaning. It must be happening given the nature of things being moved around the world, but we hear very little about it. There is a whole other discussion around where the loan world exists in this environmental space.

LEVIN Looking ahead ten years, where do each of you think we might be in this larger reevaluation process?

BICKERSTETH We still have an enormous amount to learn about what climatic variations do to objects. But scientific data will continue to grow, and the technology to analyze that data will get smarter. This will continue to amplify our knowledge. For us as conservators, that will enhance our ability to engage with our museum colleagues. We're only going to become more important, and our role will be one of increasing relevance.

BRATASZ The main barriers in implementing sustainable solutions are not related to how well we understand the environmental impact on the objects. The real issue is building a dialogue and engaging in a process that is transparent, and in which we clearly identify our aims. Most of the damage is related to temperature, which we set for human comfort—not for the good and preservation of an object. So we need an integration of comprehensive risk assessments with an understanding of where values are concentrated and how they relate to the society. This is the more important issue in my mind.

HENDERSON As Julian says, we'll continue to grow the data. But we have to be more honest about the things we don't know. We are dealing with every kind of material and every kind of environment in many multiple combinations. How are we going to make good decisions where we don't have all the data? That ties into Lukasz's comments about transparency, openness, and honesty. If we are more open and honest about what we do and don't know—and involve more people—then we can make decisions where we accept an inherent leap into the dark on the grounds that we believe the benefits are enough. This goes back to reward-based activity. It's always going to be less risky to lend something to the National Gallery in London than to a small museum in South Wales or in southern India. In those situations, there will be fewer resources. But that doesn't necessarily mean you should oppose lending simply because the measurable change would be greater in those museums. The measurable change has to be offset by the measurable benefit for people who are going to gain access to those collections.

1. www.icom-cc.org/332/-icom-cc-documents/declaration-on-environmental-guidelines/#.WOP8r34nZeg

2. World Commission on Environment and Development, *Report of the World Commission on Environment and Development: Our Common Future*, colloquially known as "The Brundtland Report" (1987), www.un-documents.net/our-common-future.pdf

3. British Standards Institution, *Conservation of Cultural Heritage—Specifications for Location, Construction and Modification of Buildings or Rooms Intended for the Storage or Use of Heritage Collections* (BS EN 16893:2018); and British Standards Institution, *Conservation of Cultural Heritage: Indoor Climate—Ventilation Management for the Protection of Cultural Heritage Buildings and Collections* (BS EN 15759-2:2018).

4. www.sustainabilityinconservation.com

5. gov.wales/topics/people-and-communities/people/future-generations-act/?lang=en

RESOURCES COLLECTION ENVIRONMENTS

For links to the resources listed below that are available online, please visit http://bit.ly/resources_33_2

POLICIES & DECLARATIONS

Bizot Green Protocol by the Bizot Group, in “Environmental Sustainability: Reducing Museums’ Carbon Footprint” (2015), London: National Museum Directors’ Council.

Environmental Guidelines—ICOM—CC and IIC Declaration by the International Council of Museums—Committee for Conservation, and International Institute for Conservation of Historic and Artistic Works (2014).

STANDARDS & GUIDANCE

Conservation of Cultural Property—Specifications for Temperature and Relative Humidity to Limit Climate-Induced Mechanical Damage in Organic Hygroscopic Materials (2010), European Standard BS EN 15757:2010.

“*Museums, Galleries, Archives, and Libraries,*” in *ASHRAE Handbook: Heating, Ventilating, and Air-Conditioning Applications* by the American Society of Heating, Refrigerating and Air Conditioning Engineers (2015), Atlanta, GA: ASHRAE, 23.1–23.22 (handbook is currently being revised for publication in 2019).

Specification for Managing Environmental Conditions for Cultural Collections (2012), London: British Standards Institution PAS 198:2012.

BOOKS, JOURNALS & CONFERENCE PROCEEDINGS

“Acoustic Emission Monitoring of Micro-Damage in Wooden Art Objects to Assess Climate Management Strategies” by M. Lukomski, M. Strojcecki, B. Pretzel, N. Blades, V. L. Beltran, and A. Freeman, in *Insight* 59, no. 5 (May 2017), 256–64.

Climate for Collections: Standards and Uncertainties by Jonathan Ashley-Smith, Andreas Burmester, and Melanie Bauernfeind (2013), London: Archetype Publications in association with Doerner Institut, Munich.



GCI Science staff Michal Lukomski and Ashley Freeman using the nano-indenter in a long-term study to better understand the response of hygroscopic materials to climatic fluctuations. Photo: Evan Guston, for the GCI.

Environmental Management for Collections: Alternative Conservation Strategies for Hot and Humid Climates by Shin Maekawa, Vincent L. Beltran, and Michael Henry (2015), Los Angeles: Getty Conservation Institute.

Environmental Sustainability at Historic Sites and Museums by Sarah Sutton (2015), London: Rowman & Littlefield.

Epidemiology: Basic Ideas Applied to Museum Collections: A Report from an Experts Meeting Organized by the Getty Conservation Institute, June 15–16, 2015 by Jim Druzik and Foekje Boersma (2017), Los Angeles: Getty Conservation Institute.

“Intergenerational Justice: A Useful Perspective for Heritage Conservation” by Joel Taylor, in *CeROArt* (2013).

Issues in Contemporary Oil Paint, edited by Klaas Jan van den Berg, Aviva Burnstock, Matthijs de Keijzer, Jay Krueger, Tom Learner, Alberto de Tagle, and Gunnar Heydenreich (2014), Switzerland: Springer.

Managing Indoor Climate Risks in Museums by Bart Ankersmit and Marc H. L. Stappers (2017), Switzerland: Springer.

Modern Paints Uncovered: Proceedings from the Modern Paints Uncovered Symposium, May 16–19, 2006, Tate Modern, London, edited by Thomas J. S. Learner, Patricia Smithen, Jay W. Krueger, and Michael R. Schilling (2008), Los Angeles: Getty Publications.

The Plus/Minus Dilemma: A Way Forward in Environmental Guidelines (2010), IIC.

“Precaution, Proof, and Pragmatism: Evolving Perspectives on the Museum Environment” by Foekje Boersma, Kathleen Dardes, and James Druzik, in *Conservation Perspectives, The GCI Newsletter* 29.2 (Fall 2014), 4–9.

Proceedings of the Smithsonian Institution Summit on the Museum Preservation Environment, edited by Sarah Stauderman and William G. Tompkins (2016).

“Quantifying the Mechanical Properties of Artists’ Paints with Nanoindentation” by M. Wright, M. Hudson, M. Kokkori, K. Muir, F. Casadio, K. Faber, and K. R. Shull, in *Proceedings of the 2014 Annual Meeting of the Adhesion Society* (2014), Red Hook, NY: Curran Associates, 285–7.

“The Role of Micromechanics in the Epidemiology of Climate-Induced Damage” by Michal Lukomski, James Druzik, Vincent Beltran, Ashley Freeman, Foekje Boersma, and Joel Taylor, paper presented at the Mechanics of Art Materials and Its Future in Heritage Science: A Seminar and Symposium 24–25 October 2016 (2017), Suitland, Maryland: Smithsonian Museum Conservation Institute.

“Tensile Properties of Latex Paint Films with TiO₂ Pigment” by Eric Hagan, Maria Charalambides, Christina Young, Tom Learner, and Stephen Hackney, in *Mechanics of Time-Dependent Materials* 13, no. 2 (2009), 149–61.

ONLINE RESOURCES, ORGANIZATIONS & NETWORKS

HERIE: Quantitative Assessment of Risk of Physical Damage of Cultural Objects Due to Climate Variations. herie.mnk.pl

For more information on issues related to collection environments, search AATA Online at aata.getty.edu/home/

GCI News

Project Updates

MOSAIKON INITIATIVE UPDATES

Conservation and Management of Archaeological Sites with Mosaics

This training course—the third in a series of regional courses given as part of the MOSAIKON initiative—concluded in May 2018 with a weeklong workshop in Rome. Including nearly twenty participants from Algeria, Cyprus, Lebanon, Mali, Morocco, and Tunisia, this yearlong course, taught in French, began in May 2017 with a three-week workshop at the World Heritage Site of Volubilis, Morocco. A long-distance mentoring period followed, during which the participants developed practical projects at their home sites, guided by course instructors.

The course concluded with a follow-up meeting in Rome that enabled participants to see other examples of site conservation and management, including those in an urban context; there were site visits within and outside of the city. The meeting also provided an opportunity to meet Italian colleagues grappling with similar issues. Participants engaged in structured site exercises and presented their individual mentored projects. Their colleagues, the course instructors, and Italian heritage professionals provided feedback on their work.

Technician Training Course

In April–May 2018 the third module of the two-year mosaic conservation technician training course at Volubilis was carried out over five weeks, in collaboration with Direction du Patrimoine Culturel. This module focused on maintenance of mosaics detached and relaid in situ on concrete, as well as on stabilization of walls and wall plasters. The planning of conservation projects for an entire building at the site, the Maison d'Orphée, was also part of the program, as was the condition assessment and recording of medieval ceramic tile decoration (*zellij*) at a historic monument in the nearby World Heritage city of Meknes.

The fourth and final module of the course will occur over six weeks in October–November 2018 and will include selected technician trainees from other North African countries



The follow-up workshop for the Third Regional Course on the Conservation and Management of Archaeological Sites with Mosaics, held in Rome, May 2018. Photo: Araldo De Luca, for the GCI.

who participated in the previous GCI regional course. The subjects of this specialized training are the relaying in situ on lime mortar beddings of mosaics previously relaid in situ on reinforced concrete panels, and the conservation and storage of mosaics previously detached and left without support panels. This module addresses the need for trained personnel in Morocco and other countries in the MOSAIKON region to handle these two common conservation problems facing previously detached mosaics.

Paphos Conservation and Management Plan

The GCI is working with the Department of Antiquities of Cyprus (DoA) on a collaborative project at the World Heritage Site of Nea Paphos and its Necropolis, known as the Tombs of the Kings, located on the southwest coast of Cyprus. The site contains Hellenistic, Roman, Byzantine, Frankish, and Ottoman architectural remains, and, most notably, outstanding Roman mosaics.

In June 2018 the GCI team traveled to Cyprus for the second field season of this project. A priority activity of this campaign was to begin mapping the site and recording the mosaics through drone photography, photogrammetry, and laser scanning, to produce a comprehensive site plan. The Carleton Immersive Media Studio of Carleton University in Ottawa is conducting the recording and documentation, with involvement of DoA staff, and it will be developing a Geographic Information System

(GIS) for the long-term management of the site. The GCI team began a rapid survey of the site's mosaics, looking at the state of conservation, significance, and risk, building on an existing DoA inventory of all the site's mosaics. An inventory and naming system for the buildings, rooms, and selected features on the site was developed for use in the GIS and mosaic survey and for future site documentation.

As part of the conservation and management plan, which serves as the framework for the project, assessments of the site's significance, management structure, and visitor management were begun by the GCI and DoA. In addition, the GCI and DoA teams discussed project planning and the development of a small workshop on archaeological shelters for Paphos to define criteria for protective shelters for the site's mosaics that may serve as the model for the design of future shelters at the site.

PRINCIPLES FOR ANCIENT BUDDHIST GROTTOS IN GANSU

The GCI and China's Dunhuang Academy (DA) have collaborated on regional planning since 2016, when the DA took on the new challenge of managing additional grotto sites in Gansu Province associated with the Silk Road.

In 2017 the GCI and DA, along with China ICOMOS, conducted a five-day training course on the China Principles for senior staff from national-level heritage sites in Gansu Province. A course outcome was the recognition that the large number of ancient Buddhist grotto sites in the province, among the most numerous in the country, would benefit from a more coherent approach to their management and conservation. The official inventory lists twenty-three grotto sites at national-level significance (three of which are part of the World Heritage Silk Road nomination), nine at the provincial level, and forty-six at county or city levels, as well as countless others without designation. These sites are diverse in style, location, and size. Many are located in the desert regions of western Gansu, where the Mogao Grottoes with its hundreds of caves decorated with extraordinary wall paintings is recognized as the pinnacle of grotto achievement. Many more are situated along the Hexi corridor, and still others were created in forested eastern Gansu; among these the largest and best known is Maijishan Grottoes, renowned for its sculptural decoration and imposing setting.

Despite their diversity, grotto sites share many attributes that lend themselves to a uniform approach to their conservation and management. Recognizing this opportunity to



Yunya Temple, Gansu Province, China. Photo: Lori Wong, GCI.

provide guidance to managers of these sites—many of which lack adequate staffing, expertise, and exposure to national standards—the DA and GCI are developing a set of principles consistent with the China Principles but focused on the needs of grotto sites. In spring 2018 the DA and GCI team visited grotto sites in eastern Gansu to familiarize themselves with these lesser-known sites and begin drafting the grotto principles.

CONSERVATION OF LOUISE NEVELSON'S CITY ON THE HIGH MOUNTAIN

Louise Nevelson's *City on the High Mountain* (1983)—a complex, large-scale assemblage of found metal pieces painted black, in the collection of the Storm King Art Center in New Windsor, New York—is the first case study resulting from a six-year partnership between

the GCI and the US Army Research Lab (ARL) to develop a new generation of outdoor coatings with enhanced performance suitable for outdoor sculpture. This case study is part of the GCI's Outdoor Sculpture project.

Low-gloss, or matte, coatings have been extensively used by artists since the 1960s. For outdoor painted sculpture, however, matte coatings are problematic in terms of durability. Unavoidably overloaded with pigments and flattening agents, they contain a minimal amount of resin, resulting rapidly in degradation phenomena such as fading, streaking, marbling, and overall disfiguration. Because the US Army also has a strong interest in developing durable matte black coatings for use on military assets, the GCI has been collaborating with the ARL, working with a range of artists' estates and foundations to tailor ARL's latest coating

formulation to their aesthetic requirements.

The Louise Nevelson Foundation was the first to approve the paint to replicate Nevelson's signature black matte paint. *City on the High Mountain*, which had exhibited signs of paint coatings failure, was selected for the case study after a series of application tests. In November 2017 *City on the High Mountain* was deinstalled from Storm King and taken to American Stripping Company (ASCo), a paint application facility in Virginia. The treatment included stripping the previous coats of paints, surface preparation, and repainting. At each step of the treatment, the team—which included a private conservator, a paint applicator from ASCo, the paint formulator from ARL, and GCI and Storm King staff—deliberated on the best treatment options and methods. The team is pleased with the aesthetic appeal of the new paint and optimistic about its performance and durability. The sculpture was reinstalled at Storm King in early fall 2018, and its performance will be monitored over the next few years. The project's long-term goal is to expand the color and gloss palette available to fit the requirements of other artists.

HERCULANEUM PROJECT

In May and June 2018 the GCI Herculaneum Project team carried out a field campaign in the tablinum of the House of the Bicentenary with two main objectives: cleaning the wall paintings in the tablinum of the house, and planning the Phase II environmental monitoring and climate improvement strategies. The project, funded in part by the GCI Council, is a collaboration with the Archaeological Park of Herculaneum (Pa-Erco) and the Herculaneum Conservation Project (HCP).

GCI team members have been working with Italian conservators from the CBC Conservazione Beni Culturali to develop innovative cleaning methods and materials to reduce an accumulation of atmospheric pollutants, coatings, paraffin, and degraded beeswax applied in previous maintenance interventions, which have contributed to deterioration of the wall paintings. The team has developed a system using rigid solvent gels to reduce the wax and remove the surface accumulation.

Planning for the environmental monitoring and climate improvement strategies was carried out in collaboration with staff from the HCP, Pa-Erco, and external Italian consultants to assess the viability of the existing monitoring system and discuss modifications to the system to aid in the development of appropriate strategies for stabilizing the tablinum's environment. Currently, the HCP and Pa-Erco are conducting



Mark Gittins and Leslie Rainer, members of the Herculeum conservation team, at work in the tablinum of the House of the Bicentenary, Herculeum. Photo: Araldo De Luca, for the GCI.

stabilization operations in other parts of the house, including roof repairs and modifications, stabilization of walls, and stabilization of wall paintings and mosaic pavement. The combined efforts of the GCI, HCP, and Pa-Erco aim to address conservation issues in the house, developing methods and materials for treatment and monitoring to ensure the long-term preservation of the house with a view to reopening it to the public following conservation.

Recent Events

ARCADE LAUNCHED FOR CITY OF LINCOLN, UK

On May 17, 2018, at a ceremony held at the Guildhall in Lincoln, United Kingdom, the City of Lincoln Council and the GCI launched ARCADE (Access Resource for Conservation and Archaeology in a Development Environment), a powerful and publicly accessible system to inventory, map, describe, and help protect the rich cultural heritage of the City of Lincoln, which has stood from Roman times to the present. The system was built using Arches,¹ a web-based open source data-management platform developed by the GCI in partnership with World Monuments Fund.

A collaboration between the Lincoln Council and the GCI, ARCADE² currently contains eighteen thousand records, including records of archaeological sites and finds, historic buildings, excavations and surveys, and related books, reports, maps, and photographs. Many entries show relationships between different types of cultural heritage data, such as a historic

building and its architect, or an archaeological site and artifacts found at that site that may now reside in a museum. ARCADE is being used by planners and developers to better understand the development constraints in areas with cultural heritage assets, and it can help them determine how best to balance development and heritage preservation.

“Our colleagues at City of Lincoln have been enthusiastic collaborators as we have worked together to adapt Arches as the underlying platform of ARCADE,” said Tim Whalen, John E. and Louise Bryson Director of the GCI. “The importance of historical data maintained by City of Lincoln offers an opportunity for us to demonstrate the significant advantages of Arches to the international conservation community and the benefits it provides to those in need of a modern and comprehensive cultural heritage management system.”



Steep Hill Street, Lincoln, United Kingdom, which has the highest concentration of historic buildings anywhere in the city. Photo: Alastair MacIntosh, City of Lincoln Council.

The GCI is also partnering with Historic England to deploy Arches as the platform for the new Greater London Historic Environment Record, anticipated to be launched at the end of 2019.

1. www.archesproject.org
2. arcade.lincoln.gov.uk

EXPERTS MEETING ON THE CLEANING OF WOODEN GILDED SURFACES

In March 2018 the GCI convened a three-day experts meeting at the Getty Center to discuss issues related to the cleaning of wooden gilded surfaces, with twelve invited participants from Australia, Brazil, France, Spain, the United Kingdom, and the United States joining GCI and Getty Museum staff. Participants represented a variety of professional backgrounds in the field of wooden gilded surfaces conservation and cleaning, as well as various international perspectives. The meeting was part of the first phase of a new GCI project on cleaning wooden gilded surfaces. Currently there is a lack of consensus and formal training in the cleaning of these highly sensitive surfaces, potentially damaged by inappropriate restoration campaigns.

At the meeting's first day, participants shared their professional backgrounds and experience, and the cleaning practices in their country. Curators from the Getty Museum joined the second day to discuss ethical considerations and the dialogue among different stakeholders involved in the decision-making regarding a treatment; this was followed by a discussion on specific methods available to clean gilded surfaces. The final day included presentations by conservation scientists and discussions on scientific methods used to study these surfaces and control the effects of clean-

ing systems. The meeting concluded with conversations about next steps, including strategies to answer identified training needs in the form of a course, as well as didactic materials. Participants agreed to exchange ideas and documents in the wake of the meeting. A report summarizing the meeting will be available in 2019.

The new GCI project draws on research conducted by the Institute and partners on cleaning other types of surfaces, such as acrylic painted surfaces, which, although different in nature, are also sensitive to water-based cleaning systems. Cleaning materials and strategies used successfully for these surfaces will be tested on gilded wood, with the aim of developing cleaning protocols that can be shared with the field through workshops and didactic materials.

MICROFADE TESTING EXPERTS MEETING

In March 2018 the GCI organized an experts meeting to examine issues related to advancing microfade testing (MFT) practice in the conservation community. Participants included scientists and conservators from Australia, Canada, France, Hong Kong, Poland, Sweden, the United Kingdom, and the United States.

Introduced by Paul Whitmore in the mid-1990s, and used at the GCI since the early 2000s, MFT provides a means of directly assessing the light sensitivity of artworks. The technique exposes a small spot (less than 0.5 mm) to an intense light source and monitors the resulting color change. MFT data is commonly compared to the fading rates of Blue Wool standards, allowing the prediction of an object's fugitivity before exhibition and the

development of object-specific light exposure guidelines. MFT has become generally accepted as a preventive conservation tool, but there remain obstacles to its widespread use, including the presence of multiple iterations of the instrument; issues in the acquisition, setup, operation, and maintenance of a non-turnkey instrument; and uncertainty regarding the interpretation of MFT data and how it is used to guide lighting policy.

The first day of the experts meeting was a public seminar and instrument demonstration. Subsequent days focused on technical aspects of MFT and various dissemination strategies, resulting in the identification of several possible action items, including creating a website for didactic information and the development of training courses and guidelines. With colleagues at allied institutions, the GCI will look to lead a collaborative effort to broaden MFT use as fundamental instrumentation for preventive conservation. A report on the meeting is anticipated to be available by early 2019.

MODERN ARCHITECTURE COURSE HELD

In early May 2018 the Conserving Modern Architecture Initiative held its first short training course, Introduction to Conserving Modern Architecture, at the Getty Center. Attended by twenty-five people from around the world and taught by instructors in private practice and GCI staff, the course—a combination of lectures, case studies, and labs—covered a range of subjects, beginning with an overview of the ways accepted preservation practice and heritage listing are applied to modern buildings.



Participants in the GCI's 2018 Introduction to Conserving Modern Architecture course visiting the Eames House in Los Angeles. Chandler McCoy, GCI senior project specialist, addresses the group. Photo: Evan Guston, for the GCI.

Participants were introduced to a conservation methodology, and several case studies were used to demonstrate how this methodology has been used with respect to modern buildings. There were technical sessions on material and system deterioration and repair, focusing on the diagnosis and conservation of reinforced concrete, glass, metal windows, and curtain wall assemblies, and on the treatment and replacement of modern finish materials. There were also demonstrations of analytical equipment and laboratory techniques focusing on concrete, sealants, and paint analysis. An on-site session was held at the Eames House, at which participants learned about the scientific studies and analysis the GCI has conducted as part of the Eames House Conservation Project. The GCI hopes to repeat this course at the Getty Center in 2019.

ART ON THE ROCKS COLLOQUIUM

Beginning June 24, 2018, the GCI held a nine-day colloquium with twenty-four rock art scholars, site managers, conservators, and filmmakers at the Getty Center, entitled Art on the Rocks: Developing Action Plans for Public and Professional Networking. The colloquium included discussions and presentations, as well as visits to rock art sites to discuss their management, preservation, research activities, and community issues. Participants visited the complex at Little Lake Ranch and Painted Rock, both in California, and the Lower Pecos River region in Texas.

In 2015 the GCI published *Rock Art: A Cultural Treasure at Risk*, which arose from the GCI's Southern African Rock Art Project and its exchange program among rock art specialists, managers, and custodian communities from southern Africa and Australia. *Rock Art* outlined a vision for rock art preservation and public involvement and has been the cornerstone for discussions since. Following its publication, the GCI organized a 2017 international colloquium, Art on the



Jacob Thomas of the University of Gothenburg demonstrating a retro-reflective MFT during the public seminar portion of the March 2018 MFT experts meeting. Photo: Ashley Freeman, GCI.



Participants in the 2018 GCI rock art symposium visiting the White Shaman Mural in the Lower Pecos River region of Texas. Photo: Charles Koenig, for the GCI.

Rocks: A Global Heritage, in Namibia. The June 2018 colloquium was a follow-up to that event.

At the June 2018 colloquium, participants addressed two key directives established at the 2017 Namibia colloquium. The first was acknowledgment that to generate awareness for this endangered global heritage, rock art professionals must reach a broader audience. To this end, attendees committed to making greater use of media and to developing content for distribution to a range of audiences. With greater public enthusiasm for rock art preservation, policy and decision makers who are in positions to enact change will be motivated to do so. The second key directive addressed was the establishment of an informal network through which an exchange of information and intellectual resources can be made among allied professionals. By making connections between those responsible for site management, improved communication can elevate conservation and management practice. Participants committed to formulating tangible action plans to advance the agenda of this informal network.

Upcoming Events

SCHOLAR APPLICATIONS NOW BEING ACCEPTED

The Conservation Guest Scholar program provides an opportunity for conservation leaders to pursue research that advances conservation practice and contributes new ideas to the field. Successful candidates are in residence at the Getty Center for periods of three, six, or nine months and are chosen by a professional committee through a competitive process.

Instructions, application forms, and additional information are available online in the “How to Apply” section of the Getty Foundation website. The 2019–20 Conservation Guest Scholar program application deadline is November 1, 2018.

2018–19 CONSERVATION GUEST SCHOLARS

Olga Gago Muñiz
Santiago Cathedral Foundation, Spain

“The Great Challenge at Worship Sites: Conserving Their Material Dimension While Also Preserving Their Intangible Heritage”
September–December 2018

Darius A. Arya
American Institute for Roman Culture, Italy
“The Role of New Media for Heritage Preservation and Promotion: Successful Storytelling, Best Practices, and Tools for Tangible Results”
October–December 2018

Jonathan Ashley-Smith
Independent Scholar, United Kingdom
“The Communication of Uncertainty in Cultural Heritage Management”
January–March 2019

Giancarlo Buzzanca
Ministry of Cultural Heritage and Activities and Tourism, Rome
“CA GraDoCo—Computer Aided Graphic Documentation for Conservation: Bibliographic Review and Analysis of Best Practices, Standards and Customization (1997/2007/2017)”
January–March 2019

Mario Eduardo Santana Quintero

Carleton University, Ottawa

“Ethical Principles for the Application of Digital Workflows in Heritage Conservation”
January–March 2019

Nancy J. Bell

The National Archives, Kew, and Visiting Researcher, Northumbria University, United Kingdom

“Building Better Bridges: Translating Heritage Science Research”
April–June 2019

Stephen J. Farneth

Architectural Resources Group, San Francisco

“Earthquake Disaster Recovery in Heritage Towns: Comparative Survey of Past Experience and Observations for an Improved Conservation-Focused Recovery Process”
April–June 2019

Stavroula Golfomitou

University of Gothenburg, Sweden

“Perceptions of Cleaning in Museums”
April–June 2019

POSTDOCTORAL FELLOWSHIP IN CONSERVATION SCIENCE

The Getty Conservation Institute’s Postdoctoral Fellowship in Conservation Science is a two-year program designed to provide recent PhDs in chemistry and other physical or material sciences with experience in conservation science. The 2019–21 Postdoctoral Fellow will be an integral part of GCI Science’s Preventive Conservation and Modern and Contemporary Art research initiatives. The fellowship runs from September 2019 to August 2021. In addition to an annual stipend, the fellow will be provided an annual study trip allowance and generous benefits including travel to and housing in Los Angeles, and full health benefits.

Completed application materials must be received on or before November 1, 2018. Apply via the Getty website’s “Work with Us” page.

GRADUATE INTERNSHIP PROGRAM

Applications are being accepted for the 2019–20 Getty Graduate Internship program. These internships are full-time positions for students who intend to pursue careers in fields related to the visual arts. Programs and departments throughout the Getty provide training and work experience in areas including curatorship, education, conservation, research, information management, public programs, and grant making. The GCI pursues a range of activities dedicated to

advancing conservation practice, to enhance the preservation, understanding, and interpretation of the visual arts. Twelve-month internships are available in the GCI’s Collections, Buildings and Sites, and Science departments.

Instructions, application forms, and additional information are available online in the “How to Apply” section of the Getty Foundation website. For further information, contact the Getty Foundation at gradinterns@getty.edu. The application deadline is November 1, 2018.

2018–19 GRADUATE INTERNS

Veronica Biolcati

University of Bologna, Italy

Building Capacity in Scientific Imaging for Technical Studies Research

Cindy Calbimonte

Universidade do Minho, Braga, Portugal

Earthen Architecture Initiative and Seismic Retrofitting Project

Megan DiNoia

Institute of Fine Arts, New York University

GCI Publications

Gina Eichmueller

Hochschule für Technik und Wirtschaft Berlin, Germany

Managing Collection Environments Initiative

Debora Gobbo

University of Bologna, Italy

Preservation of Plastics, Modern, and Contemporary Art

Kristen Munchheimer

Anhalt University of Applied Sciences, Germany

Conserving Modern Architecture Initiative

Jorge Otero

Sheffield Hallam University, United Kingdom

Built Heritage Research Initiative

Tribute

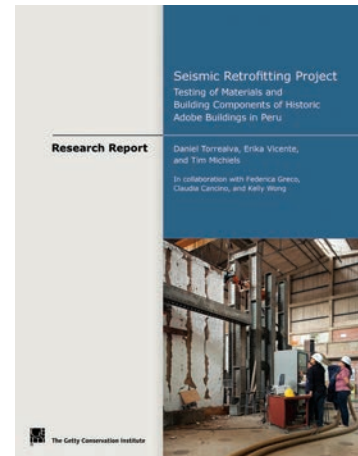
BRUNO POULIOT

Bruno Pouliot, a field editor for *AATA Online* for fourteen years, passed away in May 2018. He advised *AATA Online* staff and reviewed abstracts in many areas of conservation, including education and training, plant and animal materials, resins and lacquers, and plastics.

Bruno was senior conservator of objects at Winterthur Museum, Garden & Library and an affiliated professor at Winterthur/University of Delaware Program in Art Conservation. He

was a 2018 recipient of the American Institute for Conservation’s Robert L. Feller Lifetime Achievement Award, given for exceptional contributions to the conservation profession over the course of one’s career. His expertise and devotion to the field will be truly missed.

Online Publications



Seismic Retrofitting Project: Testing of Materials and Building Components of Historic Adobe Buildings in Peru

Daniel Torrealva, Erika Vicente, and Tim Michiels in collaboration with Federica Greco, Claudia Cancino, and Kelly Wong



Proyecto de Estabilización Sismorresistente: Informe sobre el análisis de condiciones, diagnóstico y pruebas de protección para las pinturas murales—Templo Santiago Apóstol de Kuñotambo

Clemencia Vernaza, Claudia Cancino y Leslie Rainer en colaboración con Rotney Abrill Ugarte, Humberto Gutiérrez Palomino, Hugo Germán Rivera Rossell y Luis Villacorta Santamato

The J. Paul Getty Trust

James Cuno, *President and Chief Executive Officer*

The Getty Conservation Institute

Timothy P. Whalen, *John E. and Louise Bryson Director*

Jeanne Marie Teutonico, *Associate Director, Programs*

Kathleen Gaines, *Associate Director, Administration*

Kathleen Dardes, *Head of Collections*

Tom Learner, *Head of Science*

Susan Macdonald, *Head of Buildings and Sites*

Conservation Perspectives, The GCI Newsletter

Jeffrey Levin, *Editor*

Angela Escobar, *Assistant Editor*

Carol Hahn, *Production Assistant*

Picnic Design, *Design*

Graphic Visions, *Lithography*

Conservation Perspectives, The GCI Newsletter is distributed free of charge twice a year to professionals in conservation and related fields and to members of the public concerned about conservation. Back issues of the newsletter, as well as additional information regarding the activities of the GCI, can be found in the Conservation section of the Getty's website, www.getty.edu/conservation.

The Getty Conservation Institute (GCI) works internationally to advance conservation practice in the visual arts—broadly interpreted to include objects, collections, architecture, and sites. The Institute serves the conservation community through scientific research, education and training, field projects, and the dissemination of information. In all its endeavors, the GCI creates and delivers knowledge that contributes to the conservation of the world's cultural heritage.

The GCI is a program of the J. Paul Getty Trust, a cultural and philanthropic institution dedicated to the presentation, conservation, and interpretation of the world's artistic legacy.



AMERICAN FORESTS

This publication was printed on Forest Stewardship Council® (FSC®)—certified recycled paper with vegetable-based inks. A donation to the American Forests ReLeaf program has been made on behalf of the GCI for its use of FSC®-certified paper.



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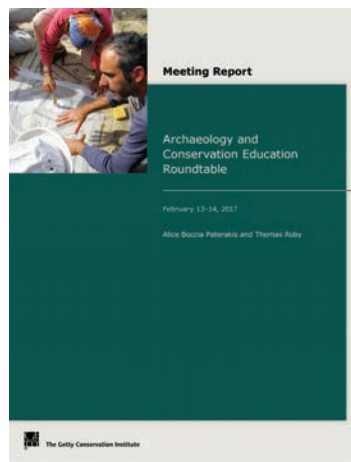


**Seismic Retrofitting Project
Recommendations for Advanced Modeling
of Historic Earthen Sites**

Paulo B. Lourenço and João M. Pereira
in collaboration with Giorgos Karanikoloudis,
Federica Greco, and Claudia Cancino

For millennia, communities around the world have used earth to construct an array of impressive structures. Despite their prevalence, earthen buildings are highly susceptible to damage from seismic events. Since the 1990s, the GCI has worked to advance conservation of earthen heritage through its Getty Seismic Adobe Project and more recently with its Seismic Retrofitting Project (SRP), which aims to combine traditional construction techniques with leading methodologies to improve the structural performance of earthen buildings.

The above publications are from the dissemination phase of SRP. *Testing of Materials and Building Components* describes the material characteristics of adobe, brick masonry, and timber used in historic buildings while presenting a set of extensive tests on *quincha* panels and traditional timber joints found in churches on the Peruvian coast. *Informe sobre el análisis de condiciones, diagnóstico y pruebas de protección para las pinturas murales* establishes a methodology for the stabilization of the wall paintings using the church of Kuñotambo as a case study on consolidating its finishes prior to the seismic retrofitting of the site. *Recommendations for Advanced Modeling* outlines instructions for the application of numerical modeling in projects involving historic earthen structures and specific analyses required for their evaluation.



**Archaeology and Conservation
Education Roundtable
Meeting Report, February 13–14, 2017**

Alice Boccia Paterakis and Thomas Roby

Archaeology and Conservation Education Roundtable summarizes a two-day meeting of educators in conservation and archaeology from five universities in the United States and the United Kingdom at which both fields are taught. Representatives of US professional organizations of archaeologists and conservators were also present at the meeting convened by the Getty Conservation Institute in February 2017. This publication reports on the ways participants identified to improve practice in both fields and to better integrate their activities through curriculum reform and training. Summary recommendations were also put forward.

Online publications are available free at
www.getty.edu/conservation.



CONSERVATION PERSPECTIVES

THE GCI NEWSLETTER



The exhibition *Muslims' Worlds (Welten der Muslime)* at the Ethnological Museum in Berlin-Dahlem, Germany, November 2011. Photo: Robert Schlesinger.

