CONSERVATION PERSPECTIVES

THE GCI NEWSLETTER

FALL 2014

COLLECTION ENVIRONMENTS

The Getty Conservation Institute

A Note from the Director

Photo: Anna Flavin, GCI

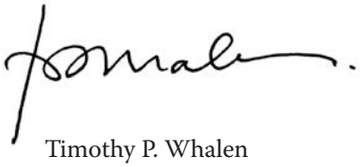
In this world, nothing is set in stone. Change is a constant in every aspect of life, and the conservation field is, of course, subject to that unavoidable truth. This has been particularly evident in recent discussions and debates within the field regarding standards for collection environments. For the better part of the second half of the twentieth century, collecting institutions and conservation professionals considered the standards for the collection environment to be a somewhat settled matter. But, for a variety of reasons, that has not proven to be the case. Energy costs have risen, and with that rise has come a gnawing sense that certain specifications are no longer sustainable. Also being questioned is whether a single environmental standard for all collections and all places is appropriate and applicable. In addition, new pressures related to the loan of objects have led some to call for more flexible standards for environments in borrowing institutions. Finally, as many have pointed out, detailed and comprehensive scientific evidence about how a variety of objects actually respond to change or variation in their immediate environment has been lacking. All these issues have prompted many in the conservation field and collecting institutions to begin to question adherence to the environmental specifications they have relied on for so long.

In order to address some of the continuing questions and concerns regarding environmental strategies for collections, the Getty Conservation Institute began an initiative called Managing Collection Environments. This edition of *Conservation Perspectives* examines a number of issues related to the collection environment, beginning with our feature article, authored by GCI staff working on that initiative—Foekje Boersma, Kathleen Dardes, and James Druzik. Their article offers a succinct exploration of the evolving understanding of what composes an appropriate and safe environment for cultural heritage collections.

These changing perceptions have been prompted in part by recent scientific work. In his article, scientist Stefan Michalski of the Canadian Conservation Institute provides a crisp and concise review of research in conservation science that has established, in some areas, clearer parameters for collection environments; at the same time, he articulates a collaborative approach for future research. Paul van Duin, head of Furniture Conservation at the Rijksmuseum, emphasizes in his article the need for systematic study of large groups of real objects, and he describes how one such effort, the Climate4Wood research project, is bringing helpful insight into the museum environment issue.

The current striving for sustainability in the building or renovating of museums most definitely has implications for the museum environment. In their article, conservator Rachael Perkins Arenstein and architect Scott Raphael Schiamberg provide a primer for conservators on how they can make themselves part of the building process to ensure that preservation concerns are integrated into construction design. And in our roundtable discussion, conservators Anna Bülow, Martijn de Ruijter, and Merv Richard weigh risk against pragmatism as they grapple with questions about what constitutes appropriate environments for diverse collections in diverse places and how these questions might be resolved in the context of museum loans.

Without a doubt, our understanding of the environmental needs of collections is deepening and becoming more nuanced. With the GCI's new initiative—and with the ideas presented here—we seek to advance conservation thought and practice in collection environments as part of the larger review and rethinking under way among our colleagues around the world.



Timothy P. Whalen

Contents

COLLECTION ENVIRONMENTS

4 **FEATURE ARTICLE**
PRECAUTION, PROOF, AND PRAGMATISM
Evolving Perspectives on the Museum Environment
By Foekje Boersma, Kathleen Dardes, and James Druzik

10
CONSERVATION RESEARCH INTO THE MUSEUM CLIMATE
The Current Landscape
By Stefan Michalski

13
CLIMATE EFFECTS ON MUSEUM OBJECTS
The Need for Monitoring and Analysis
By Paul van Duin

16
GREEN MUSEUMS
A LEED Primer for Preservation Professionals
By Rachael Perkins Arenstein and Scott Raphael Schiamberg

18
PRAGMATISM AND RISK
A Discussion about Collection Environments

24 **KEY RESOURCES**
A list of key resources related to collection environments

25 **GCI NEWS**
Projects, events, and publications

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ON THE COVER
A portion of a cabinet attributed to Jan van Mekeren, Amsterdam, ca. 1695, now in the Rijksmuseum. The vertical crack—caused by shrinkage in the oak construction—was subject to conservation after this photograph was taken in 1995. Photo: ©Rijksmuseum.

www.getty.edu/conservation

PRECAUTION, PROOF, *and* PRAGMATISM

Evolving Perspectives on the Museum Environment

Striving for more sustainable climate management, museums are rethinking their environmental policies. A gallery setting with a variety of objects on display from lending institutions in climate zones other than that of the exhibiting museum poses the challenge of weighing preservation against access. A view of the 2011 exhibition *Paris: Life & Luxury* at the J. Paul Getty Museum. Photo: Courtesy of the J. Paul Getty Museum.

BY FOEKJE BOERSMA, KATHLEEN DARDES, AND JAMES DRUZIK

No one can dispute that the physical and ambient environments in which cultural heritage collections reside have a significant impact on their long-term preservation. Throughout the twentieth century, the emerging conservation science and conservation/restoration professions tried to establish what exactly constitutes a safe environment.

Scientific research, together with observations in the field, increased understanding of the agents of deterioration and their workings, and these findings led to the specification of environmental parameters in guidelines and standards. As these became universally accepted and implemented, they also became more rigid over time, resulting in a one-size-fits-all approach.

With the current need to adapt to global climate change and to deal with the impact of the serious budgetary pressures faced by collecting institutions, such an approach has been found to be unsustainable. In recent years, the international conservation field has been challenged to review and revise these long-held positions. To understand how the field is currently responding to changing times—and why and how experience, perceptions, and uncertainty appear to influence positions—it is important to appreciate how the concept of the museum environment has developed since the late nineteenth century, and how several milestones of technical research and experience informed the environmental guidelines of the late twentieth century.

MUSEUM ENVIRONMENT MILESTONES

The control of the indoor climate of museums has a long history, but it was not until the early twentieth century that museums attempted yearlong humidity control. In 1908, the Boston Museum of Fine Arts was the first US museum to try this, settling upon a relative humidity (RH) of 55%–60%, based on trials conducted over two years. Then in 1915, the Cleveland Museum of Art installed a humidification and heating system set to maintain 50%–55% RH, also experimentally determined to be optimum. Although these experiments were not published in detail, they seem to be the earliest instances of humidity specifications for the museum climate.[1]

As air-conditioning systems were adopted by museums, discussions followed about the suitable range of control for the museum environment. The first International Conference for the Study of Scientific Methods for the Examination and Preservation of Works of Art in 1930 resulted, ten years later, in the publication of the *Manual on the Conservation of Paintings*, authored by a panel of international experts, including Harold Plenderleith and George Stout. Even with a better understanding of the environmental agents of deterioration, the experts suggested a pragmatic approach. The panel wrote: "We have no adequate information at present to enable us to fix an absolute standard. The reason for choosing 60 to 65% as the figure for relative humidity for practical purposes is that in many climates it is the nearest approach to the conditions in which a degree of stability may be easily obtained. […] In a temperate climate, 60% of relative humidity is the easiest standard to keep up. At normal temperatures, this represents comfortable

conditions for the human organism. […] It may thus be assumed that atmospheric conditions at present considered normal for the majority of objects in museums will also be acceptable to visitors."[2]

An increased understanding of the effects of indoor climate on vulnerable materials was the result of efforts to evacuate and protect the collections of Europe's great national museums during both world wars. Stable conditions—such as those created in temporary storage in adapted mines in the United Kingdom—were found to reduce the time spent on maintaining the artworks. Those conditions were around 17°C/63°F with RH around 58% for Manod[3] and 15.5°C–23.8°C/60°F–75°F with 60%–65% RH for Westwood Quarry.[4]

After World War II, science established its place in the museum world, and as deterioration mechanisms were better understood, interest grew in what we now call preventive conservation. In 1949 at the American Association of Museums conference in Chicago, George Stout advocated "long-range conservation." The care of museum objects, he said, is "as much concerned with things which are evidently in a good state as with things which are conspicuously in a bad state." He went on to say that, "It would be impossible to figure the cost of neglect against the cost of constant care and protection, but it does not take much imagination to see that consistent care will save money as well as the integrity of objects. […] There may be those who think that the care of a collection is only a matter of occasional repair. […] Conservation is merely the business of trying to prevent undue deterioration. This effort requires the best available knowledge of the true state of the thing that is subject to deterioration. It requires further that every attempt be made to keep that state as it is."[5]

In 1960, Harold Plenderleith and Paul Philippot published the results of a 1955 international ICOM survey on the effects of climate on the conservation of museum objects. Their report, "Climatology and Conservation in Museums," provided a fairly wide "zone of safety," as the authors called it, placing the RH range as 50%–65% but noting that RH should not undergo abrupt changes. They also stated that object safety depends on its past history, its structure, and the conditions to which it has become acclimatized. The authors acknowledged that "even the best museum conditions can be dangerous for a painted panel that has been normally housed in a cold damp country house." The report also mentioned, possibly for the first time, risk as a factor in determining an environment for a collection: "A rational system of conservation will, then, be based first of all on a thorough assessment or diagnosis of the risks inherent in the milieu in which objects are placed."[6]

In 1967, the International Institute for Conservation (IIC) organized in London the first conference on museum climatology. In the preface to the conference publication, N. S. Brommelle, IIC's secretary-general, described preventive conservation: "The study of how the environment in a museum affects its contents, and of how to ensure that their inevitable ageing processes are slowed to a minimum has become to be called Museum Climatology. […] Today just as in medicine, the ultimate objective is seen to be the prevention of disease. Hence fair proportion of the best scientific and technical work in museums is coming to be devoted to the subject of museum climatology."[7]

An attendant examines a recording thermohygrograph in a subterranean chamber at Manod Quarry, north Wales, where paintings from London's National Gallery were moved for safekeeping during World War II. Experiences like these increased understanding of the effects of indoor climate on vulnerable materials. Photo: Fred Ramage/Keystone Features/Hulton Archive/Getty Images.

PRAGMATIC PREVENTIVE CONSERVATION

The pragmatic preventive conservation approach prevails as an outcome of these earliest discussions of the museum environment. Scientists at museums had a profound influence on the profession's early understanding of the interrelationship between the environment and deterioration. While they did not shy away from suggesting a temperature or RH range, greater emphasis was often placed on avoiding climatic extremes (especially extreme fluctuations), rather than precisely hitting a specified climatic range. The term "optimal conditions," which appears frequently, is never associated with an absolutist vision of what constitutes a "zone of safety," to use Pleinderleith and Phillipot's wording. Local climate mattered. Historical conditions of objects mattered. And "optimal conditions" did not refer to a universal standard; it was something that could be defined locally.

This pragmatism is also an undercurrent in the work of the man whose name is virtually synonymous with the museum environment—Garry Thomson. He is often considered the scientist who gave conservation clear and indisputable specifications for the environment, but this characterization is inaccurate. In fact, Thomson was as much a pragmatist as the scientists who came before him. He argued for choosing an RH level according to climate zone: "An air-conditioned museum should reflect average indoor RH at the locality. The old objects of local origin will have been made in this climate and will have adapted to it […] keeping near the local RH results in economy of energy use."[8]

Thomson also foresaw what would eventually lead to a standardized approach for loans: "Most museums these days […] will

borrow and lend. For the larger museums this implies exchange between countries, possibly of very different climate. The lending museum may very properly demand conditions reasonably close to its own. This will strengthen a trend towards median RH values (50 or 55%)."

Few will disagree that the narrow environmental parameters pursued by many museums in recent decades were influenced by the very thing that Thomson alluded to—the facilitation of loans from one climatic zone to another. A single environmental specification for temperature and RH neatly eliminated the trouble of taking into account the climatic history of the object, as well as a number of other considerations, including whether borrowing or lending institutions were actually able to maintain such conditions.

Were loans the only factor in establishing the narrow environmental specifications museums have long favored? Or were other forces at play, and were other voices influencing the discussion? The 1970s saw the start of a several-decades-long museum building boom, which included renovations and expansions, as well as new buildings and other capital improvements. Architects and engineers had to design ever more sophisticated buildings and systems, and they demanded target numbers for engineering and designing purposes. In major building projects, conservators often participated during the planning stage and thus had some input, but "designing to the numbers" soon took hold, and as it did, architects and engineers became major shapers of the museum environment.

This shift was aided by conservators who, at least initially, found reassurance in a published set of numbers that seemed definitive and that could be applied almost universally. Best of all, by handing over the numbers to climate systems designers, they could get tightly controlled environments, applying the "best available technology," designed to minimize the risk of damage. HVAC technology had grown more reliable, permitting people to think that "if tight control is good, tighter is better." Museums in general appeared to have sufficient resources to maintain tight control, and there seemed to be plenty of fuel to keep systems running. Sustainability was a concept that rarely crept into museum life.

However, there were some who expressed concerns for the impact of these tight controls on museum buildings. Stefan Michalski recalls: "In 1979, after recognizing that most Canadian buildings [...] could not sustain winter levels of 50% relative humidity (RH), CCI advised Canadian museums to consider a seasonal adjustment from the summer setting of 50% RH down to a winter setting of 38% RH."[9]

Over time it became apparent that tight control was often difficult to achieve and maintain within certain buildings, as well as within certain budgets. Moreover, some began questioning whether it was even necessary. In the early 1990s, research carried out at the Smithsonian Institution indicated that some materials were likely more resilient when subjected to wider ranges of RH. The significance of this new discovery lay in its potential to save millions of dollars in construction and energy costs.

These other viewpoints were widely, and sometimes fervently, discussed, and they raised important concerns for the field to confront. The debate about the museum environment might have remained an internal one that conservators conducted among themselves with occasional insights from scientists or HVAC engineers; however, once museum directors weighed in, the debate expanded dramatically.

CURRENT VIEWPOINTS

In 2008, directors associated with the International Group of Organizers of Large-scale Exhibitions—also known as the Bizot group—kick-started a complete rethinking of the environmental specifications for museum objects on loan, stating that museums should stop imposing standard environmental conditions. Urging consideration of sustainability, the Bizot group called for new guidelines with broadened environmental parameters.

The conservation field has responded. Professional bodies representing conservators at the national and international levels have developed interim guidelines, balancing points about sustainability raised by directors with preservation concerns expressed by conservators. The American Institute for Conservation of Historic and Artistic Works (AIC) Environmental Guidelines Working Group drafted interim guidelines for loans that were presented to the Association of Art Museum Directors meeting in 2012. The same year, the Bizot group unanimously adopted a set of Guiding Principles and Interim Guidelines, and the British Standards Institution released *PAS 198:2012—Specification for Managing Environmental Conditions for Cultural Heritage* (basically, a kind of interim standard). In April 2014, the Australian Institute for the Conservation of Cultural Material published interim guidelines based on those developed by international professional conservation groups such as AIC.

It is interesting that these guidelines are all "interim," as if we are waiting for confirmation of their appropriateness. Is it because we realize that guidelines like these do not address the full range

Detail of *Portrait of Isabella of Portugal*, from the workshop of Rogier van der Weyden, about 1450, the Netherlands. Possibly contributing to the cracking seen here were past fluctuations in climatic conditions. Photo: Courtesy of the J. Paul Getty Museum.

The Guggenheim Museum in Bilbao, Spain, designed by Frank Gehry. The iconic building, which opened in 1997, is emblematic of the construction boom in museums that has occurred in recent decades, with architects and engineers becoming major shapers of the museum environment. Photo: Ardfern, courtesy Wikimedia, licensed under the Creative Commons Attribution–Share Alike 3.0 Unported license.

of issues associated with the museum environment? Or because they don't seem to reflect a widespread consensus within the field? Discussions surrounding the question of whether environmental parameters should be revised—and to what extent—raise the valid concern that there may be insufficient understanding of the reactions of some materials to environmental changes, especially materials in composite objects.

Today, even though there is agreement in conservation that museums must contribute to reducing their carbon footprint by implementing sustainable strategies, there are different viewpoints about how to achieve this and at what cost to collections preservation. While the reasons behind any professional opinion are generally complex and nuanced, current discussions of what constitutes an appropriate museum environment often reflect clear and definable attitudes toward risk. These attitudes are at the core of three distinct positions currently found in the field; these can be described as *precautionary safety, proven safety*, and *pragmatic risk management*.

Precautionary Safety

The precautionary safety stance derives from the precautionary principle, as applied in public health and environmental law. It holds that an action or policy that *may* prove harmful, even without full scientific proof that it is harmful, must nonetheless be avoided. A proponent of precautionary safety in conservation might consider a wider range of RH an unacceptable risk because there is not enough scientific evidence that materials will not be adversely affected. This stance argues that a single target of RH and temperature, combined with the smallest specifiable fluctuations, is the only confirmed path to unconditional safety.

This position remained strong through the 1970s, '80s, and '90s, and today it is supported by several institutions, such as the Doerner Institut in Munich. The Doerner issued a 2014 statement called "Stable Is Safe: The Munich Position on Climate and Cultural Heritage," in which it opposed the interim guidelines and argued that "a reduction in the ecological footprint of our institutions can be achieved far more effectively, and with no risk to the cultural heritage in our care, by other means. […] The Interim Guidelines increase the risk for all lenders."[10]

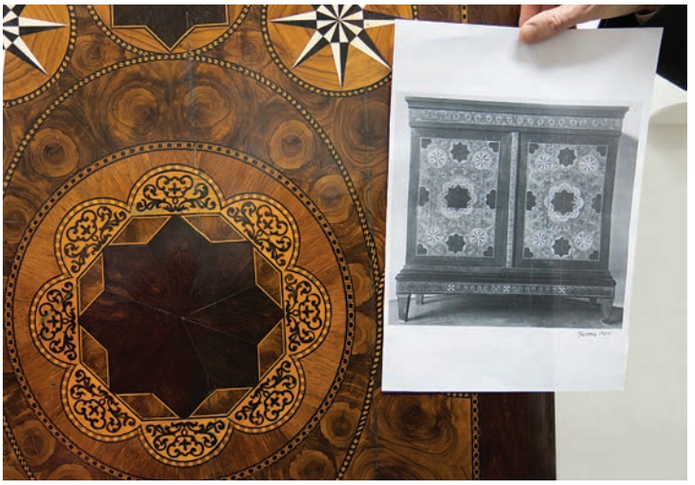
But it is not at all certain whether an absence of visible damage in a strictly controlled environment is, in fact, the result of a high level of climatic control. Colleagues in museums that do not have stringently controlled environments have also observed a lack of visible damage due to climatic factors. Having experienced this phenomenon, some conservators have adopted a different attitude—they endorse the concept of *proven safety*.

Proven Safety

The proven safety stance argues that even in museums with stringent environmental specifications, the conditions that are actually maintained have ranged outside these specifications, yet reports of noticeable damage are infrequent. Many conservators have conceded that their own museums cannot do better than 40%–60% RH and 15.5°C –25°C (60°F–77°F). Those experienced with traveling exhibitions attest that their objects routinely survive such ranges without apparent harm. These de facto conditions therefore appear to be safe. The proponents of proven safety were among the first adopters of the concept of "proofed fluctuations" when it was introduced by Stefan Michalski (this concept, simplistically put, uses the past experience of an object as a determinant of whether future damage is likely). They also share kinship with those who first wrote about the museum environment, placing an emphasis on the avoidance of extremes and fluctuations, and on a consideration of local conditions.

Pragmatic Risk Management

In the 1990s, risk management gained a place within conservation, having migrated from the public policy, health, and insurance industries. The pragmatic risk management stance argues that the goal of preservation is the minimization of loss due to a variety of causes, and that for each cause—such as an inappropriate environment—the decision maker needs to know the quantitative interrelationship among the intensity of the hazard (e.g., climate



Comparing the present condition of a late seventeenth–century Dutch marquetry cabinet from the Rijksmuseum with a photograph of the cabinet dating from before 1907, as part of the Climate4Wood project. Photo: Foekje Boersma, GCI.

fluctuations), the damage caused (e.g., cracks), and the cost of controlling the hazard (financially, environmentally, and socially). Priorities are identified and decisions are based on significance or value assessments. This kind of thinking is reflected in the chapter on museums and archives in the *ASHRAE Handbook*, as well as in *PAS 198:2012*.

Although the proven safety stance is compatible with this perspective, pragmatic risk management goes further and recommends that resources be applied toward reduction of the biggest risks, which may not in fact be climate fluctuations.

These three positions are by no means static—conservators may well find themselves moving from one stance to another. It may be that one believes in theory that a pragmatic risk management approach is more sustainable but feels insecure in implementing it in practice because of a lack of information or experience. It is only human to take a precautionary approach.

This partitioning of the debate reflects the confusion many of us face with respect to making appropriate decisions both for our collections and for the cause of greater sustainability. But despite the differences in opinion, the conservation community has confronted these issues. Professional bodies such as AIC, ICOM-CC, and IIC have provided platforms for discussion and exchange of ideas and experiences by facilitating conferences and meetings. Not only has more scientific research been initiated, several museums, libraries, and archives have taken leadership roles in implementing new climatic strategies. It looks promising that energy efficiency and appropriate climatic conditions for collections may be shown to be compatible, making sustainable collection care more widely achievable.

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THE MANAGING COLLECTION ENVIRONMENTS INITIATIVE

IN HIS 1978 BOOK *THE MUSEUM ENVIRONMENT*, Garry Thomson raised a question we are still trying to answer: "How much RH [relative humidity] variation can be tolerated? There could not be a better question than this to expose the inadequacy of the quantitative data so far collected on the effects of climatic factors on deterioration. [...] The question of how constant RH needs to be to ensure that no physical deterioration will occur at present remains unanswered. The standard specification of +/– 4 or 5% in RH control is based more on what we can reasonably expect the equipment to do than on any deep knowledge of the effect of small variations on the exhibit."

To help address Thomson's question and related uncertainties, the GCI has embarked upon a five-year initiative called Managing Collection Environments, a joint effort of the GCI Science and Education departments. This effort seeks to inform environmental strategies for collections, taking into consideration a range of contributing factors, including collection materials, types of buildings and environmental systems, and potential risks.

Addressing the need for more research on real objects in real conditions, GCI Science will combine laboratory research on a microscale with empirical studies of climate-induced damage in the field. These studies will help identify more precisely the conditions under which irreversible damage occurs as a result of climatic agents of deterioration.

Responding to the necessity of interdisciplinary collaboration in implementing sustainable environmental strategies, the education component will target the wider conservation community, including conservators and allied professionals. The education program is designed to improve understanding of preventive conservation issues by building technical expertise. It also strives to enhance conservators' leadership skills, increasing their capability as a profession to lead the debate.

CONSERVATION RESEARCH INTO THE MUSEUM CLIMATE

The Current Landscape

BY STEFAN MICHALSKI

IN THE WORLD OF RESEARCH AND ITS INSTITUTIONS, there is a useful if simplistic distinction between developing knowledge "for its own sake" and developing knowledge that answers a practical question. I believe conservation science falls into the second category, and so results must be judged by how well they answer practical questions. For climate control, my preferred formulation of the guiding question is this: "What are the risks to a collection from the various types and levels of incorrect relative humidity (RH), and what tools can be provided to practitioners for assessing these risks?"

ADDRESSING RELATIVE HUMIDITY

In several important areas, considerable work has been done that gets us much closer to answering the question I posed above. Here are three of them.

Mold Re-Reviewed

In 1994 I reviewed the literature on conditions supporting mold growth and published two summary curves—the RH and temperature combinations that allowed mold growth, and the grace period between the onset of those conditions and the appearance of mold. In 1999 these graphs entered the *ASHRAE Handbook* as tools for estimating mold risk. In his 2012 doctoral thesis, Thomas Strang added vast amounts of data to show that my line of safe conditions, while in general agreement with later building industry results, must be pushed a few percent RH lower for worst-case scenarios, and my curve on the grace period must also be pushed a few percent RH lower. Strang did not need to "do" mold research any more than I needed to in 1994; his research was the tedious and painstaking work of finding, compiling, and organizing a lot of data from disparate sources spanning decades. The goal was not simply to find the typical vulnerability of a collection, but, more important, to determine the highest reliably measured vulnerability. For all practical purposes of risk estimation, Strang's plots are definitive in laying out the parameters for RH with respect to mold. Users can only wish now for an Internet tool based on these plots!

Magic for Archives

To those of us raised on the paper-and-film conservation science literature before 2000, the field seemed stuck in quibbling over how to use a century-old equation named after Swedish scientist Svante Arrhenius. Dependence on humidity was also mooted, and still is—Barry Knight in 2014 concluded that the available data is not good enough to settle which of several competing models is correct for the role of humidity in paper deterioration. For risk analysis purposes, however, these rivalries are not significant. We long ago reached the point of good-enough estimates to justify cool to cold storage for vulnerable material, to understand that low RH, while beneficial, was not necessary in addition to low temperature, and to calculate how operational parameters such as regular retrieval of archival material from a repository would compromise these benefits. Our big hole in advice was the absolute calibration of these lifetimes—and what we meant by *lifetime.*

Then a breath of fresh air. In 2008 Jana Kolar and Matija Strlič, with others, introduced a method to calculate the statistical distribution of object lifetimes in a library collection, based on a straightforward optical (spectroscopic) measurement, calibrated against a known collection. In 2009 they added a method based on sampling the library air. To us old fogies, it looked like black magic, but the approach simply had been borrowed from fields grappling with the same problem—finding reliable trends in variable populations of chemically complex things. These methods abandon the classical method of building a model of simplified reality based on carefully controlled experiments on carefully controlled bits of that reality. Like sociologists, these researchers observe complex reality itself, looking for correlations between the research findings on a certain topic—paper usability as it ages naturally, for example—and a suite of chemical measurements.

Eric Hagan in the Canadian Conservation Institute machine shop, operating a digitally controlled milling machine during fabrication of his automated and climate-controlled apparatus for measuring stress relaxation in ten paint samples at once. Photo: © Government of Canada, Canadian Conservation Institute, CCI 122219-0004.

Why are the cracks of the seven-hundred-year-old panel painting on the right primarily horizontal, even though the wood grain is vertical—and why are they unrelated to the wood grain in a similarly old panel painting on the left? When we understand how widely or frequently humidity and temperature must fluctuate in order to cause cracking or flaking, then we can better assess the risks of more sustainable climate control targets. Right: Detail of *St. Luke*, Simone Martini, Siena, Italy, 1330s. Left: Detail of *Madonna and Child*, Master of St. Cecilia, Italy, 1290–95. Photos: Courtesy of the J. Paul Getty Museum.

Once correlations have been discovered in a known population, the chemical measurements can be used to predict answers, such as the number of years left at the current temperature before books become too weak to handle. These methods come in mysterious flavors, like multivariate analysis, principal component analysis, and "-omics," but they all depend on the brute force of computer calculation, as well as on advances in portable tools that collect vast amounts of digitized chemical signatures.

Iron

Long ago, Robert Brill noted that unstable glass posed a dilemma for RH control and that even a Goldilocks RH—not too high for one damage mechanism, and not too low for another mechanism—could not resolve this dilemma perfectly. And David Scott clarified the multiple RH thresholds that a caretaker of bronzes needed to know. However, for iron, whose vulnerability can be compounded by the ubiquitous contaminant salt, there was no comprehensive overview of the RH decision until 2005, when David Watkinson and Mark Lewis of Cardiff University were asked the following: "Given capital and maintenance costs, what RH control should we use for our very big and very salty iron thing, the SS *Great Britain*?" Systematically measuring all the RH thresholds was only the first step; the second was answering the practical question: Which RH was most cost-effective? Their work exemplifies how to do our kind of research within the realities of museum budgets, time lines, teams, public outreach, and—increasingly important—sustainability.

FLUCTUATIONS AND MECHANICS

The beginning of useful mechanical modeling was Marion Mecklenburg's 1982 "hockey stick"-shaped plot of tension in a painting as the humidity changed from low to high and back again. The sparse literature prior to 1982 either contained vague appeals to terms such as *rheology*, or was simply wrongheaded. In the late 1980s, in response to the many risk questions arising about traveling exhibitions, research institutions in Canada, the United States, and the United Kingdom joined forces for the Art in Transit project. This was not simply a conference but a structured set of articles plus a handbook (1991) with authorship assigned to appropriate staff—not to mention some strenuous vetting of draft lectures by a users group. Reexamining climate specifications was not yet in our sights, but implicit in the project was a focus on reducing the worst hazards of transit and a recognition that the trough in the hockey stick plots represented a safe zone that might be wider than assumed.

While I was scouring technical journals back to the nineteenth century for my review in *Art in Transit: Handbook for Packing and Transporting Paintings*, it became clear to me that our field was woefully unaware of relevant work from even the obvious industries, let alone the less obvious. We confused our "special" profession with special science. Key insights of the 1980s had been made long ago: Humidity changes the elasticity of linseed oil paint (1920s); canvas, when stretched, tightens at high humidity, not low humidity (1920s); and linseed oil paints develop internal strain during curing (1950s). Not that a full understanding was available—in the 1980s the paint industry itself was still trying to understand paint failure. But equations describing stress in varnishes due to solvent curing and stress in paints from RH and temperature change were available. These were, in fact, the equations for our hockey stick plots.

The decade after Art in Transit was a bit of a lull. Data accumulated but not systematically. The necessary concepts of viscoelasticity and fatigue gained traction. Christina Young applied the research to designing a less vulnerable artists' support. Meanwhile,

most of us in the first research wave were moved to other important tasks, and we were asked to draw the best advice we could from what we already knew.

The new millennium finally brought forth new players with new tools, such as the group led by Kozłowski, Bratasz, and Łukomski at the Jerzy Haber Institute in Krakow. They attacked the question of the climate response of panel paintings and polychromes not only energetically but systematically, from comprehensive measuring of expansion coefficients for many wood species, through acoustic emission and computer modeling, culminating in cyclic fatigue testing of real gesso on real wood. With this systematic research in hand, they concluded that panels with gesso will tolerate 15% RH cycles without cracking, even for the maximum number of humidity cycles possible in a century.

In the last few years, academics in university departments of mechanical engineering (Loughborough University in Leicester) and building physics (the Technical University of Eindhoven) have collaborated with museums to apply their state-of-the-art computer physics models. Such collaborations have produced promising nuggets, but the graduate student life cycle inhibits momentum in a topic; it is the interests of supervisors and their funders that sustain it. The task of assembling these nuggets into a practical whole will fall to our own community.

In his 2009 doctoral research, Eric Hagan resolved a key question for modelers: Could the strength of paints, as pigmentation and climate varied, be modeled within the same (viscoelastic) framework that was now well established for paint stiffness? His data for acrylic paints said clearly, "Yes." The full chain of response to fluctuations was now possible to model: from dimensional change and stiffness change to stress (the hockey stick curve) and, now, to fracture.

My own recent work uses a type of software developed for risk analysis, Analytica. It allows one to build up a model by linking bits and pieces of other models and available data, all within a user-friendly graphic called, appropriately enough, an influence diagram. At the same time, it permits one to simulate variability in all the factors considered by the model, such as variations in how artists mixed their paints, variations in wood strength, and variations in how objects were constructed—and to see how the possibility of fracture changes as these variables interact. These interacting variables are the crux at the heart of our climate advice dilemma.

WHAT'S NEXT?

The science of climate risk evaluation of potential damage from mold, metal corrosion, and chemical decay in archives is already sufficiently accurate for institutional decisions. In our experience, the dominant uncertainties during risk analysis for protection issues lie elsewhere, in the monitoring data or lack of it, in the inventory of vulnerable items or the lack thereof, and in the estimates of value loss due to predicted damage. The science of mechanical risk from fluctuations cannot claim that yet.

Every year, exciting new tools for the analysis and measurement of mechanical phenomena appear, and hundreds of probably relevant articles are published in the industrial and materials literature. We have perhaps half a dozen people worldwide who are supported long-term to work on this issue, and maybe a dozen graduate students working on directly related theses.

Details of crack variations related to climate fluctuations in one of many oil-on-canvas portraits of Bavarian monarchs in the Ancestral Gallery of Munich Residenz. Unrestored and unmoved, the portrait shows the effects of centuries in one place. There are almost no cracks in the area over the wooden stretcher bars since they moderated daily climate fluctuations. But do we fully understand the crack variations, their formation, and their potential propagation? Photo: Stefan Michalski, CCI.

We must accept the strengths of both research tactics: synthesis using models and controlled experiments, as well as correlational studies of actual collections. And we will have to be honest and ruthless with ourselves whenever paths of inquiry prove of limited value in answering the practical questions.

For the modeling approach, we need to address some major holes in our data. The most important deficiency, I think, concerns the effect of natural aging of the materials on their mechanical properties, especially strength. No amount of studies on artificially aged samples will convince the users; we need to measure these properties on well-characterized natural samples. This means adopting microscopic mechanical analysis, one of the exciting new tools to appear in the last decade.

For the correlational approach, we need to engage the caretakers of collections as well as those who know the history of objects fabrication. We need educated guesses from scientists about what measurements to collect to look for patterns, but we scientists also need to be open to the serendipitous suggestions of those with a feeling, a hunch, about what indicators tell them about an object's vulnerability, and we must find a way to code that, too, for the machine. Not that every hunch will stand up under careful scrutiny, any more than every scientist's model will—but when the best of both coincide in their predictions, we will have found our useful advice.

It is an exciting time for collaboration.

Stefan Michalski is a senior conservation scientist at the Canadian Conservation Institute.

CLIMATE EFFECTS ON MUSEUM OBJECTS

The Need for Monitoring and Analysis

BY PAUL VAN DUIN

ONE OF THE MOST IMPORTANT CONCERNS OF CONSERVATORS AND CURATORS is the museum climate in which their objects are displayed or stored. This is not without reason. Everybody has seen damage, such as cracks in wooden furniture and warped and/or cracked panel paintings, attributed to improper environments. Loose veneer and flaking paint are also often blamed on climatic fluctuations.

Even though the mechanisms behind environmentally induced damage to wooden museum objects—and museum objects generally—are understood to an extent, there is still uncertainty about the point at which damage actually occurs. Conservators and curators tend to speak of a good or a bad climate, but no one is really certain when a climate is "bad," because we cannot predict exactly when damage will occur. We tend to draw conclusions from climate graphs without really knowing when objects are at risk. Why do we look at graphs rather than at objects? Probably because they are easier to read than objects. Of course, once an object shows new damage, it is too late. But if objects are not monitored, how do we know if the damage is new and when and under what circumstances it occurred? Given the high cost of climate installations and the damage that they may inadvertently cause, there is urgent need to develop a clear understanding of the relationship between the museum climate (recorded in climate graphs) and the response of museum objects. It is noteworthy that research related to this relationship has rarely included systematic analysis of the behavior of museum collections. Analyzing large groups of museum objects could give the museum community much insight into the reaction of objects to variations in their environment.

CLIMATE, RISK, AND SUSTAINABILITY

Because of observed damage, the museum community adopted strict climate specifications in the last century, such as a relative humidity (RH) of 52 ± 2%. In recent decades, there has been a tendency to relax these specifications slightly. Still, these broader climate specifications, which generally allow for seasonal fluctuations as well as a range of ± 5% RH, remain quite strict. Recent research indicates that these revised specifications will not result in damage, but the findings have yet to fully convince the museum community. The involvement of conservators and curators in systematically monitoring museum objects instead of only looking at climate graphs is essential in developing more rational guidelines for climate specifications.

Article author Paul van Duin examining a 1607 oak cabinet in the Rijksmuseum. The cabinet's remarkably good condition, with only minor shrinkage cracks, may be explained by the thin panels that were used. Similarly constructed cabinets and wall paneling of that period are often in comparable condition. Photo: Foekje Boersma, GCI.

A related question (which might either complicate or simplify matters) is how much risk we are prepared to take. Museums and conservators do not wish to take *any* risks with their objects—but perhaps that is not the best way to avoid risks. Because it is not clear when climate damage will occur, avoiding risks at any cost actually might increase risks. For example, the failure of an extensive air-conditioning system may result in abnormal conditions. Damage to historic buildings can be caused not only by the accommodation of air-conditioning, but also by excessive moisture buildup in walls or heavy condensation on windows. Costs for installation, maintenance, and energy consumption are high. Perhaps the limited funds of museums would be better used for other purposes. We could employ more staff, buy objects to enhance our

Details of a cabinet attributed to Jan van Mekeren, Amsterdam, ca. 1695, now in the Rijksmuseum. Left: A 1964 photograph taken upon acquisition. The vertical crack in the marquetry is caused by shrinkage in the oak construction. A hairline crack alongside the discolored filling material indicates further shrinkage of the oak or filling. Right: The same corner of the door photographed in 1995, prior to conservation. The door's condition remained virtually unchanged in thirty years. Photos: ©Rijksmuseum.

collections, and improve visitor facilities. It is important to know how much climate risk we actually take and to weigh this risk against other threats such as theft, vandalism, and accidents.

Striving for a "greener" environment and reducing energy consumption is, fortunately, achieved not only by widening climate specifications. Much energy can be saved by designing "greener" buildings and improving the energy efficiency of systems in existing buildings. Museum climate graphs often resemble shark teeth; this pattern implies that air-conditioning systems are constantly overreacting. It would be sufficient to bring RH and temperature back into safe ranges instead of returning them to their initial settings. Systems can be switched off in daytime if climate conditions are moderate or turned off at night when buildings are not in use.

Although conservators probably belong to the group most concerned about climate effects, the bulk of research seems to have been carried out by engineers and conservation scientists. This research is mostly performed in laboratories, with mock-ups made of new materials—or by the study of single museum objects. For obvious reasons, groups of museum objects are not used for experiments in climate chambers. Engineers and conservation scientists are less familiar with the actual behavior of museum objects because they usually have little access to museum collections and do not have the specific knowledge and experience that conservators have. For their part, while conservators have less knowledge of physics, engineering, and the technology of wood, their knowledge, intuition, and experience should not be underestimated in discussions about climate. Questions or even skepticism that conservators have about work by engineers or conservation scientists should be taken seriously. It is equally important for conservators to respect and try to understand the work of engineers and conservation scientists. Moreover, conservators must assume a responsibility to be engaged in the climate research.[1] It is essential for professionals from different backgrounds to make the effort to understand one another in order to share their knowledge. Only then might the whole field agree on new climate specifications.

RESEARCH ON OBJECTS

As noted, relatively little research has been carried out on groups of museum objects.[2] In 2011 a Getty-funded experts meeting at the Rijksmuseum about setting a research agenda for the conservation of panel paintings recommended making information available on changes in condition and conservation treatments of large numbers of objects.[3] The 2012 "Climate for Collections" conference in Munich included some studies about groups of objects. These studies included the relationship between the fuel bills of Swedish churches and damage to church furniture,[4] damage development in veneered furniture at the historic Kenwood House,[5] climate effects on the furnishings in Linderhof Palace,[6] and, as a prelude to the Climate4Wood project, a preliminary study of actual museum objects.[7] Each study reflected the difficulty in detecting new damage and included a variety of techniques to monitor and quantify it.

The Climate4Wood research project is an example of the kind of study of groups of museum objects that can provide insight into the museum environment issue. The research itself is a collaboration among the Rijksmuseum, Eindhoven University of Technology, the Cultural Heritage Institute of the Netherlands, and Delft University of Technology, funded by the Science4Arts Program of the Netherlands Organisation for Scientific Research (NWO). This program funds six collaborative projects among museums and universities to develop a new perspective on conservation.

Climate4Wood performs research on the effects of climate fluctuations on panel paintings and decorated panels in furniture. Panels were chosen as the subject because they are considered to be highly sensitive to climate fluctuations. The two main parts of the project are the Museum Study, carried out by furniture conservator Stina Ekelund and started in December 2012, and the recently begun Modeling Study by constructional engineer Rianne Luimes. For the Museum Study, the construction, materials, and damage development of a large number of Dutch cabinet doors in the Rijksmuseum collection are being systematically analyzed. In fall 2014, the same analysis will be carried out on the Rijksmuseum

collection of panel paintings. The results will be compared to various well-documented objects in other collections. The parameters from the Museum Study are used as input for and verification of the Modeling Study, which will model climate- and age-induced stresses and deformations. Together with experimental research and in situ monitoring, this collaborative project should give us a better understanding of the mechanisms of damage development, with the goal of making an important contribution to formulating sustainable climate guidelines.

The Museum Study has already delivered some interesting preliminary results.[8] The construction of around one hundred pieces of furniture, the properties of the materials used, and their condition were analyzed in detail. Shrinkage is usually 1% of the original width in seventeenth- and eighteenth-century panels, with the exception of thin (6–8 mm) restrained panels, which survive with virtually no damage. Most interesting and relevant is the observation that objects with similar construction and materials have identical damage patterns. This finding is interesting since the objects entered the Rijksmuseum from different owners and therefore do not share the same climate history. One might have expected the observed damage to vary widely, but the observed damage is identical. Perhaps the objects' specific climate history is not so relevant. Or is it possible that the accumulated climatic experience of the cabinets was similar before they entered the museum?

Furthermore, the furniture panels have not suffered any climate-induced damage since they were photographed upon acquisition. Even cabinets that have been in the Rijksmuseum for over one hundred years do not show development of this kind of damage. Cabinets in historic houses, with identical construction to those in the Rijksmuseum, have identical damage patterns, which appear stable. The climate history of the galleries in the Rijksmuseum has not yet been researched, but it is known that the RH could sometimes reach extremes of 45% or 70%. It is a paradox that we consistently witness shrinkage cracks of approximately 1% of the original width, but that this shrinkage process seems to have stopped at some point. Does new damage only occur in extremely unusual conditions? In the former furniture conservation studio, which was housed in the Teekenschool, a building separate from the museum—a single brick wall structure with single-pane glass, central heating, and mobile humidifiers—RH was known to drop below 30% during very cold weather. When the canals were frozen, occasionally (but not always) new hairline shrinkage cracks appeared.

Another important observation, also highly relevant to the Modeling Study, is that shrinkage cracks are nearly always glue joints that have opened up. Cracks within a single board are rare. This finding suggests that engineers who model a panel in the future should include glue joints in their planning.

Although it is too early to draw major conclusions, the systematic study of large groups of real objects, carried out as part of the Climate4Wood Museum Study, has already provided interesting new information. The shrinkage cracks that caused concern about climate conditions actually occurred before the objects entered the Rijksmuseum and are consistent among objects with the same construction and materials. Perhaps the Modeling Study can provide us with an explanation. The study of the Rijksmuseum panel paintings planned for 2014–15 will undoubtedly offer other valuable insights.

Future climate research in the context of the museum environment should, like the Climate4Wood studies, focus on the systematic study of large groups of real objects. At the same time, it is important that conservators fully participate in this research, as they have the knowledge and experience required to analyze groups of objects. Collaboration with engineers and conservation scientists is essential in the effort to establish climate guidelines that will gain ultimate acceptance throughout the entire field.

Front and back views (prior to conservation) of Allaert van Loeninga's panel painting *The Regents of the House of Correction in Middelburg*, the Netherlands, 1643. The support consists of seven horizontal oak boards (the bottom board is a later addition). At some point, in order to restrict movement of the boards (which would damage the painting), the joints were reglued and reinforced with dovetailed inserts, as well as battens (which were removed sometime in the twentieth century). The wooden fillets on either side of most joints probably date from the same intervention. Photos: © Rijksmuseum.

Paul van Duin is the head of Furniture Conservation at the Rijksmuseum and is one of the coordinators of Climate4Wood, which seeks to establish a safe and sustainable museum climate for panels.

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5. Ibid., 257–70.
6. Ibid., 299–310.
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GREEN MUSEUMS

A LEED Primer for Preservation Professionals

BY RACHAEL PERKINS ARENSTEIN AND SCOTT RAPHAEL SCHIAMBERG

AS MUSEUMS SEEK TO IMPROVE THEIR RECORD ON SUSTAINABILITY, conservators worldwide are grappling with reevaluating environmental control guidelines and other elements of the exhibit and storage environment. Museums are a challenging building type with diverse programming, from preserving and displaying collections to providing and maintaining visitor facilities, each with its own climatic requirements. The complexities involved in building or renovating a museum, combined with undertaking a sustainable design certification effort, can be daunting for someone unfamiliar with the process. To ensure that preservation concerns are integrated into the design, conservators must both understand the process and be an effective part of it.

THE BUILDING PROCESS

In any building project, there are multiple design phases that begin with large-scale programming and concept design and conclude with detailed construction drawings, construction, and commissioning of the building. An early step is the selection of the architect. The background research the museum does on an architect is as important to the final outcome as the working relationship itself. Previous projects and references will speak volumes about what can be expected from your architect. The museum should remember that architecture is a service industry, and that the museum is the client. A good architect balances the client's requirements with a design that satisfies all parties.

Effective project management is critical in creating a successful in-house, collaborative process that includes all museum stakeholders. Museum building team members should understand the basic design phases, the activity that occurs at each stage, and the people involved. In the cacophony of voices in a building project, it can be difficult for conservators to be heard. Because conservation requirements and related building systems may be complicated and can necessitate extensive knowledge and hands-on experience, it is critical for conservators to be integrated early into the design process to ensure that this knowledge is transferred accurately to both the museum building team and the architect. Collections needs should be assessed within a larger framework of risk management and overall sustainability goals. Conservators must ensure that the guidelines they give to the architect and building team are coherent and specific to the particular project—not a one-size-fits-all solution.

Conservators at institutions that have undertaken recent building projects offer colleagues the following advice: (1) be a leader in preventive collections care projects, (2) learn who the project team members are and their areas of expertise so it is clear who is responsible for what, (3) respect the design team hierarchy and do not, intentionally or unintentionally, subvert the chain of command, (4) be an ally, not a critic, and (5) pick your battles wisely.

The Shelburne Museum's new Pizzagalli Center for Art and Education, built with constructive input from the preservation team. It is expected to achieve LEED Silver status. Photo: Peter Vanderwarker, courtesy of the Shelburne Museum Archives, Shelburne, Vermont.

SUSTAINABLE BUILDING CERTIFICATION

Institutions are increasingly volunteering—or are required—to enroll in an official sustainable building certification program, of which there are several worldwide. In the United States, Leadership in Energy and Environmental Design (LEED), a program managed by the US Green Building Council, is one of the benchmark models, guiding the design, construction, and operation of high-performance green buildings.

LEED certification is sought by museums undergoing renovation or new construction, for the environmental benefits derived from achieving it as well as the cachet it lends. LEED design goals are used as tools for fund-raising, and certified ratings are trumpeted in post-opening press releases. At the same time, LEED participation inevitably adds complexity to the creation and management of suitable museum environmental and lighting conditions.

The LEED program and the Green Building Certification Institute provide third-party verification of green buildings. The LEED overview states, "Building projects satisfy prerequisites and earn points to achieve different levels of certification."[1] LEED ranks buildings according to four levels of sustainability—Certified, Silver, Gold, and Platinum—and distinguishes projects according to five building types, each of which share the same credit categories (Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environmental Quality), with a range of prerequisites and credits worth up to a total of 110 possible points. Working with a project architect to achieve Platinum, Gold, or Silver certification shouldn't feel like an Olympic medal event. Conservators with a basic understanding of the program's goals and methods are better prepared to discuss with colleagues and architects the implications of various "green" choices for the long-term care of museum collections.

A view of the south wall and interior of the LEED Silver Johns Hopkins Archaeological Museum, highlighting the museum's classical collections from ancient Greece and Rome. Photo: Courtesy of the Johns Hopkins Archaeological Museum.

While LEED is not perfect, the program is regularly updated to more accurately measure sustainability. Conservators and architects who have gone through a LEED process make a number of suggestions. First—don't chase points. There are 110 possible LEED points, but only 60 are needed for Gold certification. It is vital that an analysis of the desired LEED certification level, the points required, and the best practices for preservation is performed early and holistically. Don't pursue points that are inconsistent with preservation needs. For example, achieving the Indoor Environmental Quality credits of LEED can be challenging for conservation laboratory and exhibition prep spaces. These might not be the easiest places to look for LEED points. The daylight credit is also a frequent cause of contention between architects and preservation professionals.

It is worth noting that because historic building materials generally are not renewable, low volatile organic compound (VOC) emitting, or locally sourced, historic preservation projects can be challenging within the LEED system. There are ways to gain points involving rigorous record keeping, but everyone must be on board from the beginning to ensure that documentation is accurate. In addition, it is highly recommended that a museum hire an independent commissioning agent to oversee the final stage of a project, when systems are tested to ensure they are performing as designed. In a LEED project, the commissioning agent reviews each operation to make sure that the building does not use more energy than required to maintain the specified conditions. Finally, while it is commonplace to face minor adjustments when moving into a new facility, it is inadvisable to rely on later retrofitting to solve lighting, environmental control, or pollutant issues that should have been properly addressed during the design process.

Green, sustainable building choices need not be at odds with the mission of a museum or the requirements of conservators. Sustainable design, if properly understood and coordinated as part of the design process, can benefit everyone. Conservators don't need to be experts in the building process or the nuances of sustainable building certification but must understand enough to be able to communicate their needs effectively. By being a constructive part of the process, preservation professionals can help sustain our planet, our heritage, and our collective sanity through the rigors of a building project.

Rachael Perkins Arenstein is currently the conservator at the Bible Lands Museum Jerusalem and is a partner in A.M. Art Conservation, LLC, a private practice she cofounded. Scott Raphael Schiamberg is an associate principal with Perkins Eastman Architects in New York. This article is based on a paper, "A LEED Primer for Conservators," presented by the authors at the 42nd AIC Annual Meeting in May 2014.

1. www.usgbc.org/leed

PRAGMATISM AND RISK

A Discussion about Collection Environments

ANNA BÜLOW is deputy head of the Conservation and Scientific Research department at the British Museum in London. She previously served as the head of preservation at the National Archives, UK.

MARTIJN DE RUIJTER is a conservator at the Tropenmuseum in Amsterdam (part of the National Museum of World Culture). He is also a lecturer in collection management at the Reinwardt Academy in Amsterdam.

MERV RICHARD has worked in conservation at the National Gallery in Washington, DC, for three decades. In 2009, he was appointed chief of conservation, having previously served as deputy chief.

They spoke with **FOEKJE BOERSMA**, a senior project specialist at the Getty Conservation Institute, and **JEFFREY LEVIN**, editor of *Conservation Perspectives, The GCI Newsletter.*

FOEKJE BOERSMA One of the reasons for inviting you all to this discussion is the fact that you are all working at different kinds of museums with different types of collections in different parts of the world. When it comes to environmental requirements, should art museums set different standards than archaeological or ethnographic collections? Or should the museum world work with one set of parameters for all kinds of collections?

MERV RICHARD I don't think that anyone would agree that one size fits all. An institution located in Phoenix, Arizona, is in a very different situation than a country house in Great Britain. The environment and the building structure that you are working with are dramatically different. This alters the decision-making process. A collection of works on parchment is unlike a collection of outdoor sculpture. The key point is that this is complicated, and we cannot make assumptions about what is appropriate for diverse institutions and locations.

MARTIJN DE RUIJTER I agree. It's very important to take into account the local climate and the country you are in. If you are in Tunisia, your objectives must be different from a country like Holland. In addition, the kind of building you are in—and a place like Holland has many old buildings where collections are kept—is also an important factor in considering the general environment for your collection and level of collection management. This means your approach and solutions must be adapted to achievable standards for that country.

ANNA BÜLOW I agree that it depends on the collection and the location. If you loan things to other places, then of course, you have to take that into account. I also think it is a matter of scale. Some collections are relatively small, so they're dealing with thousands of objects, while others, such as the British Museum, are dealing with millions of objects. We simply can't afford to be as precious as those institutions that have only a couple thousand objects. We need to be pragmatic in order to achieve the best for the collection as a whole.

RICHARD The only caveat I would add is the environment in storage areas would be important for preservation, regardless of the number of objects inside. High humidity that leads to biological activity or corrosion is always a concern, whether a room holds ten objects or a million objects.

BOERSMA The international discussion about environment requirements has been driven in part by the issue of loans. Merv, how does this discussion affect your current loan policy and how you deal with it?

RICHARD Well, firstly, we face the question of what has been our actual practice—which is not necessarily reflected in paperwork—and, secondly, what are the specific concerns of conservators about lending to institutions with different environments. At the National Gallery, our loan agreements specify 50% +/- 5%, but historically, in a large percentage of cases, we have freely lent to institutions with relative humidity specifications of 55% +/- 5% or 45% +/- 5%. A 40%–60% range has been acceptable for many of our loaned objects. However, our decisions are based on reviewing the object and the environment together. If we have concerns, we make special requests, such as adding silica gel to display cases. I think an issue that raises a red flag for many conservators is not whether you maintain 45% +/- 5% or 55% +/- 5% but whether

Photo: Courtesy the British Museum

> Within the conservation community we sometimes miss the bigger picture. If we're too fussy about single items, we might forget that by spending a lot of resources on one thing, those resources aren't available for the rest of our collection.
>
> ANNA BÜLOW

the environment is reasonably stable during a twenty-four-hour period. Many conservators are concerned about frequent, large fluctuations during the day. Additionally, if buildings are designed for a specification on the order of +/- 5%, regardless of the set point, how often would the environment fall outside that specification? Systems fail, they need maintenance, or we occasionally face weather extremes. If we design for +/- 10%, can we accept occasional RH fluctuations of +/- 15% or +/- 20%?

BÜLOW The British Museum uses a very pragmatic approach. We ask for the relative humidity to stay below 65% and the temperature between 16°C and 25°C. The museum is one of the biggest lenders worldwide and has a lot of experience with other venues. In most cases we know the colleagues and venues where the objects are going, and if we don't, we will negotiate and come to an agreement on how to mitigate the risks. Although we have criteria and we use them as guidelines, the bottom line for us is never to ask anything of our borrowers that we don't do ourselves. Basically, if we can do it, we expect others to do it. If they can't and it's really a significant object, then we consider other options.

RICHARD For twenty-five years at the National Gallery, I have been the person in conservation reviewing facility reports and discussing loan issues that arise with conservators and registrars. We have acquired knowledge and experience with many institutions over the years. If we have concerns, we contact our colleagues and discuss the issues. This approach has served us well. Some professionals are concerned that a broader, internationally accepted standard would lessen the ability to make decisions based on case-by-case evaluations of situations.

JEFFREY LEVIN Each of you seems to be saying that a pragmatic approach has been in place at your institution for quite some time. Is that a fair characterization?

BÜLOW Yes, I think that is true.

RICHARD Same here.

LEVIN Is it your sense that among your colleagues at other institutions this approach is fairly well embraced?

DE RUIJTER I think it is, at most larger museums in the Western world. If you have a problem with museums that are a little stricter, and you send them information about your approach, they are usually flexible in the end.

BÜLOW It's my feeling that among the lenders—certainly those in the Western world, or even amongst the large lenders worldwide—this has been the practice for some time.

BOERSMA The International Group of Organizers of Large-scale Exhibitions—known as the Bizot group—has, among other things, called for a review of the conservator's role as a courier in loans because it's a carbon footprint issue. So there might be pressure to reduce the courier trips that conservators take to accompany objects.

RICHARD My career at the National Gallery was initially dedicated to working with special exhibitions. I have often been a courier and was involved in the Art in Transit research project. In my opinion, there is no question that the presence of a courier for moving and installing artworks increases safety. It is important for someone to monitor activities at airports and truck transfers, and there are situations where, as a courier, one alters planned handling or installation procedures. However, I think we probably could do a better job of consolidating shipments to reduce the number of couriers.

Photo: I. de Groot, courtesy the Tropenmuseum

> It's very important to take into account the local climate and the country you are in … This means your approach and solutions must be adapted to achievable standards for that country.
>
> MARTIJN DE RUIJTER

DE RUIJTER That's common practice here. Sometimes I go, and sometimes a conservator from another museum goes. If we think it is not necessary—or if we can ask other professionals to do it—we are happy to do that.

BÜLOW At the British Museum, it's often museum assistants who do basic care work and the bulk of the couriering. But while that means fewer conservators are going, the carbon footprint remains the same because it's still a person on the plane. One thing the museum is considering is to try and find a trusted venue locally to store objects for a short period of time when it has a group of objects on a touring exhibition and there is a gap in the exhibition schedule. If we feel we need to inspect objects, it is still more efficient to send a conservator to the objects rather than the other way round, especially where several shipments are concerned.

RICHARD These issues are complicated and not easily generalized. The National Gallery has arranged for items to be stored when there were gaps between venues and we did not want to subject the objects to unnecessary travel. The driving motivation was object safety, not the carbon footprint. With regard to the courier question, we have a large pool of couriers who are not conservators. Everyone goes through courier training and must make domestic courier trips before international ones. However, we insist that conservators accompany some objects.

DE RUIJTER We also make a distinction between sending a conservator or someone from collection management. We have the conservator, registrar, museum technician, or the head of the department. If it's going to a museum in Holland and we know the people, we let them install it. It all depends on the fragility of the object and the way the object will be mounted.

LEVIN In considering altering environmental specifications, colleagues at the Doerner Institute in Germany and others take the position that we should separate specifications from energy conservation. They say we should conserve energy, but that doesn't mean that we should alter the specs.

DE RUIJTER I think that's a bit defensive. As a conservator, I believe I can judge the risk. They have a right to this opinion, but you really need the research to defend it. You have to make a better effort to convince people of the real need of what you are asking for.

RICHARD Some of the issues raised by the Doerner Institute are, in fact, primary concerns in the conservation field. The question being asked is, "What is the motivation behind trying to adopt changes?" To reduce energy use for sustainability reasons? To reduce budgets? Or is it an effort to facilitate the loan process? Many conservators recognize that these different motivations are in play. The Doerner Institute is stating, "Until there's better research, we should be slower in adopting changes in our specifications—but that said, there are many other ways we can make some museums and historic houses more sustainable." This is an important question. Are there better alternatives than changing our environmental specifications? I am sure there are, but I also believe we can accept, in some situations, greater flexibility in our RH specifications.

LEVIN Do you have other colleagues who feel as you do that a wider range is possible?

RICHARD Absolutely. Some colleagues are comfortable with +/- 10% RH. However, I believe many conservators in America feel more comfortable with the AIC guidelines that identify +/- 5% as the acceptable range within a twenty-four-hour period, while accepting seasonal changes within a 40%–60% range. For many conservators, it is the possibility of fluctuating from 40% to 60% in a single day that sends up a red flag. Colleagues feel that we need more research to determine which objects are most vulnerable.

BÜLOW The question of what motivates us to do this is an interesting one. I think that the environmental guidelines and the tight restrictions we had in the 1970s, '80s, and early '90s were possible because the technology was there to do it, so we did it because we could. We still have the technology, but something else is missing—and that's money. As a conservator, of course I'm concerned about the objects, but within the conservation community we sometimes miss the bigger picture. If we're too fussy about single items, we might forget that by spending a lot of resources on one thing, those resources aren't available for the rest of our collection. Money is an absolutely valid reason to reconsider what you're doing.

DE RUIJTER You have to take into account risk. As we do with students—and as I do together with a friend and colleague, Bart Ankersmit—we look at risks in museums. You have to think about that kind of thing as a conservator.

BOERSMA Using the risk management approach, you try to spend the money you have on reducing the bigger risks in order to get the greatest benefit. Is the collections environment the biggest risk we face in preserving collections?

BÜLOW I don't think it is, but I'm a convert to risk management, which is like a religion—either you believe or you don't. Institutions will differ. For us, I don't think environment is the greatest risk. There are other things that come under the category of physical forces that I believe are a more substantial risk.

DE RUIJTER I fully agree. Handling and lighting are larger risks.

RICHARD I agree.

BOERSMA What is each of your institutions doing to cut its carbon footprint and to become more sustainable?

BÜLOW The British Museum does have targets, but they haven't featured high on our agenda because our financial issues are bigger than our carbon footprint issues. In fairness, the museum has a complex collection in an old building—founded in 1753. I think my colleagues would agree that there has been underspending on building maintenance for some time, and now, of course, we sit there not only without money following the financial crisis but also with a building that requires significant investment in basic maintenance. Closing the funding gap through touring exhibitions is higher on the agenda than reducing carbon footprint. When I talk about reducing our carbon footprint, my colleagues in facilities are very interested; they're good allies to have because facilities pay the energy bill and know how the systems work. I am sure more will be done in the future.

BOERSMA Will the new collection center being opened at the museum change things?

BÜLOW Yes. Obviously, the new building was planned seven or eight years ago, so it is not necessarily what one would technologically design now. But the building has the carbon footprint in mind. That said, it is fully air-conditioned, and I am curious to see whether we actually need full air-conditioning throughout the storage areas. Storage goes three stories underground, and my guess is that once the concrete has dried out it might actually be quite stable in there.

BOERSMA Martijn, you told me that the Tropenmuseum in Amsterdam has experimented with turning off the air-conditioning at night.

DE RUIJTER We turn it off in our storage for ten hours at night, and it's more stable, to be honest. In the museum itself we also run it on low speed so the exchange rate is decreased. We work together on this with our facility department, and one issue we've noticed is that the machinery is temperature driven. We would like it to be RH driven. We've asked the facility manager if we can adapt the machinery to our wishes, and if that's possible, we'd consider that a step forward.

RICHARD At the National Gallery, we are in the midst of a multi-year renovation project that focuses on the infrastructure. We brought in an engineering group specializing in sustainability issues to provide recommendations. We have installed variable-speed fan motors, adjusted air circulation rates, and reduced the quantity of outside air introduced at night when the building has few people inside. We are also using LED lighting in many areas. Some recommendations were acceptable while others would be too disruptive. But the effort is being made.

BÜLOW When I was at the National Archives, we found that the way we talked about the environment was not how engineers talked about it, so one of us made an effort to learn to speak in their terms. We also undertook a big collaborative project with University College London to model the environment in the Archives, and once we had that, we looked at options for energy savings and for stabilizing the relative humidity. As a result, air-conditioning at the Archives is now switched off on weekends, providing huge savings and reducing the energy bills and the carbon footprint without impairing the environmental conditions within the repositories.

RICHARD One important aspect of discussing sustainability is it encourages people in different disciplines to ask questions, not just about our environmental specs but also about other ways to reduce our carbon footprint. It is important for professionals

to evaluate where we are spending money and using energy. Many assumptions about energy usage prove to be inaccurate. One might assume that if you do X, it will have little impact, when in fact the opposite is true. This discussion is encouraging colleagues to look carefully at their energy usage and the associated costs.

BÜLOW At the National Archives, there was nothing too small to be considered. We were urged to switch off the lights when we went to a meeting and to switch off our monitors when we went home or when we were spending half a day at a meeting. There were many things that were done to reduce the carbon footprint. We even calculated whether electricity-driven hand dryers were more environmentally friendly than paper towels or linen, which needs washing. It was very systematic.

BOERSMA Martijn, you undertake exhibitions in tropical countries. In your experience, how do countries like Indonesia look at this debate regarding sustainability?

DE RUIJTER It's not yet on their radar. Last year with the RCE, the Netherlands Cultural Heritage Agency, we did a project and a workshop with fifteen museums in Indonesia and a university in Yogyakarta to explain the risk management approach. And it was difficult for them, to be honest—and by difficult I mean that it was difficult for them to forget conventional Western standards and to incorporate into their thinking the value and significance of certain objects in their collections. I feel very positive about how all the participants reacted to what we proposed, but we should do a follow-up. We should do this more often.

BOERSMA We did a good job in informing the general public that we needed strict climate controls. Do we now have a responsibility to introduce them to a broader perspective?

RICHARD We have always recognized an obligation to inform the public about agents of deterioration for works of art, whether it is relative humidity or temperature or light or water damage. And I think the topic of sustainability should be included, but it is a secondary component of our message, not our primary one.

BÜLOW I agree. People are quite fascinated if you do inform them of what you do and why you do it, in terms of sustainability. But I think that must be a secondary goal. It's also true that for the last twenty years we have tried to educate our colleagues about environmental guidelines, and now that they've understood, we've moved on. I often struggle to convince our curators that it is possible to do things differently and still not put the object at risk. Other conservators I know have had that experience.

RICHARD This is one of the issues leading to so much controversy. If you look at the diversity of collections—and the RH specifications that ASHRAE has provided for museums—there is no simple answer. Many institutions have embraced fairly narrow specifications that seem to work for a broad group of objects. Now, as we discuss broadening those specifications, we create confusion, and it becomes more complicated to assess risks.

LEVIN Is embracing a more complex approach and selling it to your colleagues who are not conservators one of the challenges you have?

BÜLOW For the longest time in the United Kingdom, most institutions have used BS 5454, which actually is an archive standard, but it has environmental criteria in it and has been widely adopted. More recently, the publicly available standard PAS 198 has come out, which takes a risk-based approach. The difficulty with it is exactly this educational element. It puts the question back to the collection manager—basically, "What is it that you want? How long are you intending to keep this for, or what would be an acceptable loss?" You have to answer these questions for yourself before you can specify anything, and that is difficult.

DE RUIJTER You also have to take into account the significance of the object. We try to find a balance between the benefit of use for the museum and the risk of use from the point of collection management. The conservator should not have to justify but has to clarify why he thinks it's a risk for the object. It's very important to talk about this. It is the director who has to make the final decision.

RICHARD The risk management approach is in essence what we've been doing for a long time. We have developed environmental specifications that have worked for our collections and local climates. When asked to loan objects to dramatically different environments, most conservators have applied a case-by-case evaluation approach. That is why the idea of adopting universal specs for all objects is challenging. Conditions vary so much from one place to another.

BOERSMA Are conservators ready for this new challenge of being part of the process of reevaluating environmental conditions?

BÜLOW Conservators are well placed to help in the process of making those decisions. However, it's my experience that conservation attracts a rather introverted breed of people, and now we're asking them to become communicators and analysts. A common mistake conservators make is getting stuck on what they think they need to do, rather than thinking of what the institution actually wants to do. It's when we think that we have to spend nine hundred hours conserving a single book that things go wrong.

Photo: Lee Ewing, courtesy the National Gallery of Art, Washington

> Are there better alternatives than changing our environmental specifications? I am sure there are, but I also believe we can accept, in some situations, greater flexibility in our RH specifications.
>
> MERV RICHARD

DE RUIJTER Management has to see that the conservator's role has changed. The conservator also wants to achieve an exhibition and is dedicated to the deadline. The conservator has to manage the use of the collection in a way that is best for the museum and has to keep an eye on cost-benefit.

RICHARD It is a credit to the conservation community that we have increasingly become part of helping institutions solve problems, as opposed to creating them. It is a gross generalization, but if we look back a number of years, conservators often were the ones who said, "You can't do that." Conservators today are trying harder to look at the big picture and to be problem solvers.

DE RUIJTER If you want to be part of the solution, you have to be part of the process to come to the solution—and I don't feel that we are always part of the process.

LEVIN As Anna said, this requires greater engagement on the part of conservators who traditionally have been accustomed to working in a more isolated way. Isn't the need to be part of the problem-solving process also an opportunity to bring conservation into more sunlight?

RICHARD It is incredibly important that we be part of the solution. With an increase in attention to preventive conservation, problem solving has become more important in conservation training. Knowledge of preventive conservation better equips young conservators to address sustainability issues.

DE RUIJTER Conservators sometimes do think too much about single objects when they need to think about the goals for their collections. Of course there are single objects that need special consideration, particularly if they are chosen for exhibition. But we conservators need to think more about the whole collection and not just the object.

BÜLOW Conservators too often see themselves as victims of other people's decisions. They need to step up to the plate and be more proactive rather than complain about others. They have to work to get themselves involved from an early stage. That does happen—but it's not as widespread as I would like. I've learned that I have to convince the other party that involving me at an earlier stage is an advantage for them. For example, at the National Archives I took the initiative, called people to the table, and said, "You are my stakeholders in this, and when you plan digitization projects you can do it cheaper and more efficiently if you involve conservation early. We can predict the problems, and we can tell you how long it's going to take." This is the attitude I'd like to see among my colleagues—trying to preempt problems by being right there at the front.

RICHARD At the National Gallery, I am a bit spoiled—or very lucky—in that conservation is engaged early in projects affecting the collection. For example, we have a team of people that focuses on special exhibitions, and the conservators become involved early. This has often improved safety for the objects, avoided some complications, and reduced costs.

KEY RESOURCES COLLECTION ENVIRONMENTS

ONLINE RESOURCES, ORGANIZATIONS & NETWORKS

For links to the online resources listed below, please visit http://bit.ly/keyresources_29_2

AIC Environmental Guidelines

CCI Agent of Deterioration: Incorrect Relative Humidity

CCI Environmental Guidelines for Museums

Climate for Culture, a project funded by the European Commission 2009–14. It investigated the impacts of climate change on historic buildings and their collections in Europe and the Mediterranean.

Collections Trust, a UK-based professional association for people working in collections management

Conservation Physics—Index, a web resource by Tim Padfield

Doerner Institut, *Stable Is Safe*

Image Permanence Institute's Sustainable Preservation Practices workshops and webinar presentations, funded by the National Endowment for the Humanities

Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Cultural Heritage Research

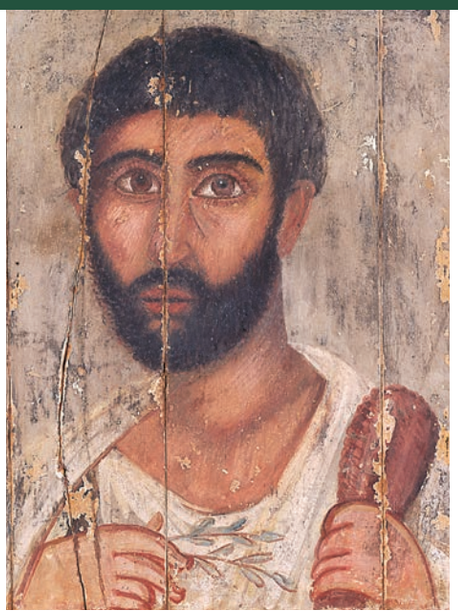
Managing Collection Environments Initiative, the Getty Conservation Institute

NMDC Environmental Sustainability—Reducing Museums' Carbon Footprint

Physics of Monuments, a website of the Technical University in Eindhoven, the Netherlands. It includes monumental buildings in the Netherlands and abroad that have already been examined.

The PIC-Green Network of the American Alliance of Museums (AAM), which is committed to establishing museums as leaders in environmental stewardship and sustainability through education, advocacy, and service

US Green Building Council website



Portrait of a Bearded Man from a Shrine in Egypt, dating from about 100 CE. Photo: Courtesy of the J. Paul Getty Museum.

BOOKS, JOURNALS & CONFERENCE PROCEEDINGS

"Climate Change and Museum Collections," IIC Roundtable, September 17, 2008.

Climate Change 2013: The Physical Science Basis, edited by Intergovernmental Panel on Climate Change (2013), New York: Cambridge University Press.

Climate for Collections: Standards and Uncertainties, edited by Jonathan Ashley-Smith, Andreas Burmester, and Melanie Eibl (2013), London: Archetype Publications.

Collections Demography colloquium, UCL Centre for Sustainable Heritage, London, July 23, 2013.

The Conservation Assessment: A Proposed Model for Evaluating Museum Environmental Management Needs, by Erica Avrami, Kathleen Dardes, Marta de la Torre, Samuel Y. Harris, Michael Henry, and Wendy Claire Jessup (1999), Los Angeles: Getty Conservation Institute.

"Cultural Heritage Conservation Science and Sustainable Development: Experience, Research, Innovation," international conference, Centre de recherche sur la conservation des collections (CRCC), Paris, October 23–25, 2013.

"Developing Professional Uncertainty," by Jonathan Ashley-Smith, in *Studies in Conservation* 45, Supplement 1 (January 1, 2000), 14–17.

Experts' Roundtable on Sustainable Climate Management Strategies, conference proceedings, Tenerife, Spain, 2007.

The Green Museum: A Primer on Environmental Practice, by Sarah S. Brophy and Elizabeth Wylie (2008), Lanham, MD: AltaMira Press.

"Heritage Science and Sustainable Development for the Preservation of Art and Cultural Assets—on the Way to the Green Museum," international workshop hosted by the Rathgen Research Laboratory, Berlin, April 11–12, 2013.

Manual of Museum Planning: Sustainable Space, Facilities and Operations, edited by Barry Lord, Gail Dexter Lord, and Lindsay Martin (2012), Lanham, MD: AltaMira Press.

The Museum Environment, by Garry Thomson (1986), London: Butterworth-Heinemann.

Museum Microclimates: Contributions to the Conference in Copenhagen, 19–23 November 2007, edited by Tim Padfield and Karen Borchersen (2007), Copenhagen: National Museum of Denmark.

"Museums, Galleries, Archives, and Libraries," chapter 23 of *ASHRAE Handbook— HVAC Applications* (2011), Atlanta: ASHRAE. At the ASHRAE store one can purchase a pdf of just the chapter.

PAS 198:2012—Specification for Managing Environmental Conditions for Cultural Collections (2012), London: BSI.

"The Plus/Minus Dilemma: The Way Forward in Environmental Guidelines—Dialogues for the New Century: Discussions on the Conservation of Cultural Heritage in a Changing World," IIC and AIC, Milwaukee, WI, May 13, 2010.

Studies in Conservation 59, no. 4: Environmental Standards and Monitoring Issue (July 2014), London: Maney Publishing.

"Summit on the Museum Preservation Environment," Smithsonian Institution webcast, March 5, 2013.

"Sustainability," Third IIC Round Table Readings (2014), Washington, DC: AIC.

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

GCI News

View of the Kasbah Taourirt in southern Morocco, where the GCI and Moroccan authorities are collaborating on development of a conservation and rehabilitation plan for the site. Photo: Scott S. Warren, for the GCI.

Project Updates

KASBAH OF TAOURIRT CONSERVATION

As part of the GCI's Earthen Architecture Initiative, the Institute has been working with the Centre de Conservation et de Réhabilation du Patrimoine Architectural des zones atlasiques et subatlasiques (CERKAS) to preserve one of the most important sites in southern Morocco, Kasbah Taourirt in Ouarzazate. Since 2011 the GCI and CERKAS have been collaborating on development of a conservation and rehabilitation plan for the site, with the aim of creating a methodology for preserving and reusing this traditional ensemble as a model for the other three hundred *kasbahs* and four thousand *ksour* located across southern Morocco.

A large earthen village and oasis dating from the sixteenth century, Taourirt is strategically located at the intersection of major trans-Saharan trade routes that once brought spices, gold, and other goods across the Sahara from Timbuktou to the rich imperial cities of Morocco. Registered as a national monument, Kasbah Taourirt was originally one of the residences of the Glaoua family, which ruled the region during the late nineteenth and early twentieth centuries. It comprises different earthen-building types of high architectural, social, and historic significance, and it includes important features, such as wall paintings and decorated wooden ceilings.

In October 2014, the GCI team will return to Morocco for the sixth time. The work to be performed during this campaign will include finishing the architectural survey of the site in collaboration with the Carleton Immersive Media Studio (CIMS), continuing conservation work in conjunction with CERKAS and project consultants, and planning for the building's future management and use. This campaign will also include a workshop on earthen building materials for CERKAS personnel and development of a proposal for the conservation of the site's wall paintings.

The GCI is also working with CERKAS, the municipality of Ouarzazate, and various community groups to define policies for future uses of the site. During the October campaign, the project will bring together for the fourth time representatives of several governmental organizations and NGOs to discuss a common vision for Kasbah Taourirt's future.

EAMES HOUSE CONSERVATION MANAGEMENT PLAN

This past July, staff from the GCI and GML Heritage, a consulting firm based in Sydney, Australia, undertook work on a conservation management plan (CMP) for the Eames House, an internationally recognized icon of modernist residential design. The house was constructed in 1949 by Charles and Ray Eames, noted American designers who occupied it for the remainder of their lives. The CMP represents the next phase in the Eames House Conservation Project—the GCI's ongoing partnership with the Eames Foundation to develop long-term conservation management and maintenance strategies for the site. The project is part of the GCI's Conserving Modern Architecture Initiative.

The Eames House Conservation Management Plan will combine historical documentation and oral evidence with a physical analysis of existing building fabric and site conditions, leading to an assessment of the heritage values of the place and the development of a series of conservation policy recommendations. An internationally recognized methodology, the CMP will provide the basis for creating a long-term conservation and maintenance framework for the house, its contents, and its setting. This will guide the Eames Foundation in its stewardship mission, ensuring the house's survival for future generations.

The GCI/GML team's meetings with Eames Foundation board members and extensive site visits were invaluable in developing a solid understanding of the house and

The Eames House in Los Angeles, where the GCI has partnered with the Eames Foundation to develop long-term conservation management and maintenance strategies to preserve the house. Photo: Scott S. Warren, for the GCI.

its environs, knowledge that will inform the ongoing work. With the CMP, the GCI will demonstrate the applicability and utility of this tool to twentieth-century heritage places, providing a model for other buildings from the era and encouraging widespread adoption of this model. Publication is anticipated for 2015.

The GCI is also providing the Eames Foundation with technical expertise and scientific analysis on specific materials, such as paint colors and wood finishes used in the house. The GCI will also perform climate monitoring, which will improve understanding of the current environment in and around the house and its effect on the building fabric and the important interior collection. In addition to serving documentation purposes, the results of these investigations will be instrumental in the development of appropriate treatment and maintenance strategies for the site.

Recent Events

XRF BOOT CAMP FOR CONSERVATORS

In late 2013 the GCI and the Yale Institute for the Preservation of Cultural Heritage (IPCH) launched the XRF Boot Camp for Conservators workshop series to provide training and resources to improve the use of handheld XRF instruments for the study of cultural heritage—a priority, given the use of these instruments by a growing number of cultural institutions and the relative lack of training opportunities tailored to cultural heritage and the arts.

The four-day workshop provides in-depth training in the principles of X-ray fluorescence spectroscopy and the collection and interpretation of data, and it focuses on qualitative analysis and the use of handheld instrumentation. Boot Camp participants explore the application of handheld XRF instruments to cultural heritage collections through interactive lectures combined with hands-on analysis, data processing, and data interpretation. The first three days of the Boot Camp focus on the principles of the technique, its application, and the interpretation of data, and the final day explores the practical application to a different kind of material and set of problems.

The first XRF Boot Camp was held in 2013 at Yale's Center for Conservation and Preservation and the Yale University Art Gallery. It addressed the analysis of painted surfaces found on paintings, objects, and works of art on paper.

This November the GCI and IPCH will welcome eighteen conservators, conservation scientists, and archaeologists to the Getty Villa for the second XRF Boot Camp. For this second workshop, objects from the collections of the Getty Museum and the Fowler Museum at UCLA will be used to illustrate best practices for the study of museum objects. Participants will also explore particular challenges encountered with the analysis of ethnographic and archaeological objects.

The XRF Boot Camp for Conservators is part of the GCI's Research into Practice Initiative, which develops education activities and resources to facilitate the practical application of new scientific research to conservation problems.

MOSAIKON REGIONAL TRAINING

The second MOSAIKON Regional Training Course on the Conservation and Management of Archaeological Sites with Mosaics began last April with an intensive three-week workshop at the World Heritage site of Paphos, Cyprus, home to spectacular mosaics of the Hellenistic, Roman, and early Christian periods. Building on the GCI's long history of involvement in the conservation of Cypriot heritage, this workshop was presented in partnership with the Department of Antiquities of Cyprus and the Archaeological Research Unit of the University of Cyprus.

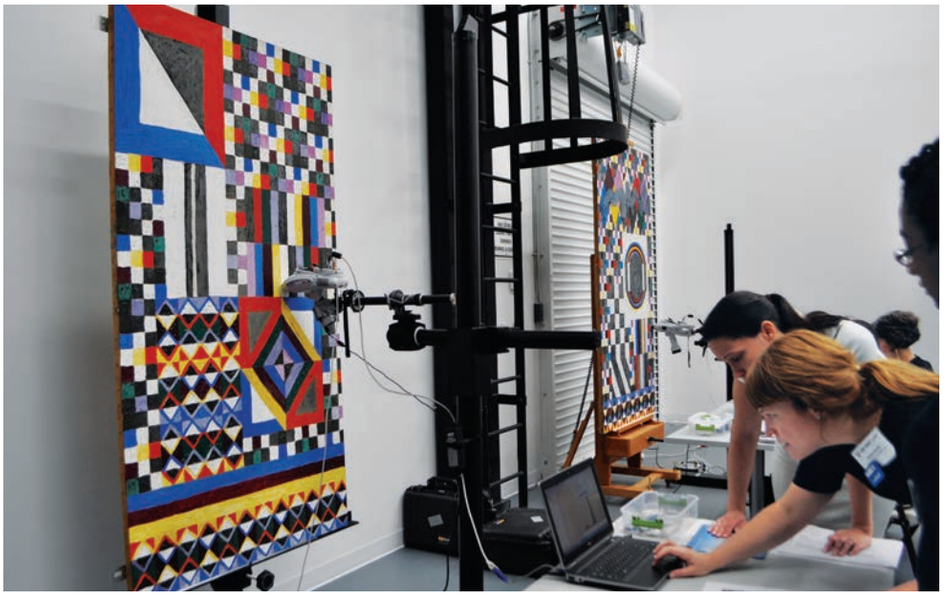
The 2014–15 course is training archaeologists, architects, and conservators, from twelve countries throughout the southern and eastern Mediterranean region, who are responsible for the management of archaeological sites with in situ mosaics. The workshop covered all aspects of conserving and managing archaeological sites with mosaics, including documentation and recording; site management planning; understanding the deterioration processes of mosaics; basic conservation interventions, both preventive and remedial; and site presentation and interpretation.

The course participants are currently in the next phase of the course, long-distance mentoring. During this phase, the participants, guided and advised by course instructors, develop and implement projects at their home sites or institutions.

The MOSAIKON initiative is implementing a series of regional courses specifically dedicated to the complex set of challenges presented by the conservation and management of in situ mosaics at archaeological sites. MOSAIKON is a partnership of the GCI, the Getty Foundation, ICCROM, and the International Committee for the Conservation of Mosaics.

LACQUER WORKSHOP AT THE LOUVRE

In July 2014 the GCI and the Centre de Recherche et de Restauration des Musées de France (C2RMF) held the third Recent Advances in Characterizing Asian Lacquer workshop at the C2RMF laboratories at the Louvre in Paris. Seventeen conservators and scientists from around Europe worked in teams throughout the week, using the specialized sampling and analytical techniques and data evaluation tools presented in the workshop to study samples of



Participants in the 2013 XRF Boot Camp using XRF to analyze panels from *The Title Makers*, an oil painting series by Alfred Jensen. Left: *To Aim and Excel*, right: *Lost, Entanglement, and Survival*. Photo: Courtesy of Yale University Art Gallery collection.

A workshop exercise at the second MOSAIKON Regional Training Course on the Conservation and Management of Archaeological Sites with Mosaics, held at the World Heritage site of Paphos, Cyprus. Photo: Scott S. Warren, for the GCI.

lacquered objects from their own collections and to present their findings.

The techniques presented at the workshop reflect research developed by the Characterization of Asian and European Lacquers project, carried out in collaboration between the GCI and the J. Paul Getty Museum. This research has led to important new discoveries about the range of materials used in the creation of lacquer objects and to great technical advances in characterizing and understanding these materials. The workshop makes these advances accessible and productive for conservators and scientists through a highly customized program of precision layer-by-layer sampling techniques, high- and low-tech analytical procedures, and specialized data evaluation tools that are capable of uncovering detailed information about lacquer composition.

The workshop also provides a unique opportunity for scientists and conservators to collaborate in the hands-on study of lacquer objects and to address their own research questions. Group discussions throughout the week bring a variety of perspectives to the conversation and generate valuable insights on technical, historical, and interpretation issues from workshop participants and instructors.

The Paris workshop is the third in the Recent Advances in Characterizing Asian Lacquer workshop series; previous workshops were held at the Getty Center and at Yale University. The project has reached over fifty conservators and scientists, and there are plans for future workshops in Europe and Asia.

Recent Advances in Characterizing Asian Lacquer is part of the GCI's Research into Practice Initiative, which seeks to facilitate the practical application of new research to conservation problems.

PHOTOGRAPH WORKSHOP IN BUDAPEST

From July 28 to August 8, 2014, the GCI and the Hungarian National Museum (HNM) welcomed sixteen conservators from thirteen countries (Australia, Bulgaria, Croatia, Czech Republic, Hungary, Ireland, Italy, Japan, Lebanon, Poland, Slovakia, Slovenia, and United Arab Emirates) to a workshop, Identification and Conservation Strategies for Color and Digital Prints. The workshop, held at the HNM in Budapest, was the second of the advanced-level workshops conducted as part of the GCI's Preservation of Photographs and Photograph Collections project.

The aim of the workshop was to present conservators with up-to-date research and current technological trends in color and digital prints. The first week focused on color photography and the second on digital prints. Lectures and hands-on activities offered conservators an understanding of color theory, as well as an in-depth view of different color and digital processes, including their characteristics, identification, common deterioration, finishing techniques and materials, management, and treatment. Frequent group discussions provided a forum for conservators to explore a diverse range of topics, among them the identification of difficult processes, personal treatment experiments, outstanding issues and problems for the field, and needs for future workshops.

The Budapest workshop was led by Sylvie Pénichon of the Art Institute of Chicago and Martin Jürgens of the Rijksmuseum. Other instructors were Jana Križanova of the Academy of Fine Arts and Design in Bratislava, Slovakia, and Tram Vo from the GCI.

The third Recent Advances in Characterizing Asian Lacquer workshop, organized by the GCI and the Centre de Recherche et de Restauration des Musées de France and held at the Louvre in Paris. Photo: Sean Charette, GCI.

Two participants in the Identification and Conservation Strategies for Color and Digital Prints workshop conducting testing of surface cleaning on digital print samples. Photo: Tram Vo, GCI.

Upcoming Events

SCHOLAR APPLICATIONS NOW BEING ACCEPTED

The GCI 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.

For information on the program and on applying, visit the Guest Scholars link on the GCI home page (getty.edu/conservation). The 2015–16 Conservation Guest Scholar program application deadline is November 17, 2014.

More information about the course, including application instructions and forms, is available on the ICCROM website (www.iccrom.org).

2014–15 CONSERVATION GUEST SCHOLARS

Thordis Eva Kristina Arrhenius
Oslo School of Architecture and Design, Norway, "Restoring the Welfare State"
January–March 2015

Jon Allison Brewer
Royal Household of the United Kingdom, Windsor, England
"Deteriorative Effects of Panel Painting Reinforcements"
January–March 2015

John Andrew Escarsega
US Army Research Laboratory, Aberdeen Proving Ground, Maryland
"Enhanced Coatings for Outdoor Sculptures: Understanding Structure Property Relationships to Formulate Durable Coatings"
January–June 2015

Susanne Grieve
East Carolina University, Greenville, North Carolina
"Evaluating Didactic Methods for Delivering Archaeological Conservation Education"
April–June 2015

Anna Laganà
Independent Scholar, Amsterdam, the Netherlands, "Repairing Transparency: Investigation into Materials and Methods to Restore Damaged Polymethylmethacrylate Objects and Works of Art"
April–June 2015

Frank Matero
University of Pennsylvania
"Deeply Superficial: The Conservation of the Painted Architectural Surface"
September–December 2014

Ralph Scott Wiegandt
George Eastman House International Museum of Photograph and Film, Rochester, New York
"Advancing Daguerreotype Research, Conservation, and Preservation"
September–December 2014

POSTDOCTORAL FELLOWSHIP OPPORTUNITY

Applications are now being accepted for the 2015–17 Postdoctoral Fellowship in Conservation Science, a two-year program designed to provide experience in conservation science to recent PhD recipients in chemistry and the physical sciences. The 2015–17 Postdoctoral Fellow will be an integral team member in GCI Science's newly formed Treatment Studies research area, working also with colleagues in related research areas, such as Materials Characterization.

Applicants should have a recent PhD (2010 or later) in chemistry, polymer science, or another relevant physical science; experimental research experience; and strong instrumental analysis skills. An aptitude for self-directed learning and for working across academic disciplines is desirable, as are good written and verbal communication skills.

Candidates should have an interest in the visual arts and a serious interest in pursuing a career in conservation science within the museum environment.

Application materials and the full terms of the postdoctoral program are available on the Getty Foundation website. Completed application materials are accepted online only. The deadline for receipt is November 17, 2014.

GCI graduate intern Elena Macchioni and GCI project specialist Benjamin Marcus (a former GCI graduate intern) undertaking a conditions assessment in the Kasbah Taourirt in Ouarzazate, Morocco. Photo: Scott S. Warren, for the GCI.

GRADUATE INTERNSHIP PROGRAM

Applications are now being accepted for the 2015–16 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 such as curatorship, education, conservation, research, information management, public programs, and grant making.

The GCI pursues a range of activities dedicated to advancing conservation practice, in order to enhance the preservation, understanding, and interpretation of the visual arts. Twelve-month internships are available in the GCI's Education, Field Projects, 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 December 1, 2014.

2014–15 GCI GRADUATE INTERNS

Catherine Defeyt
Université de Liège, Belgium
Modern and Contemporary Art Research: Outdoor Painted Sculpture Project

Suzanna Yasemin Etyemez
Dresden Academy of Fine Arts, Germany
Preservation of Plastics

Laura Matarese
University of Sydney, Australia
Conserving Modern Architecture Initiative and Contemporary Architecture in the Historic Environment

Seyedeh Aresou Ravazi Zadeh
University of Minho, Guimarães, Portugal
MOSAIKON Alternative Backing Materials

Emilio Roldán Zamarrón
z*University of Minho, Guimarães, Portugal*
Earthen Architecture Initiative

Tribute

Charles Selwitz, 1927–2014

Charles Selwitz, a highly respected research chemist who for a great many years—and on a great many projects—served as a consultant for the Getty Conservation Institute, passed away in July at the age of eighty-seven.

Charles earned a bachelor's degree in chemistry from Worcester Polytechnic Institute in 1949 and a PhD at the University of Cincinnati in 1953 before embarking on an extensive career in the petroleum industry that included well over one hundred patents issued in his name. At the age of fifty-six he retired, moved to Los Angeles, and ultimately commenced a new career in conservation science.

His association with the Getty began in the early 1980s when he served as a consultant to the Antiquities Department of the Getty Museum. When the GCI was formed in the mid-1980s, Charles was retained as a consultant. During the next few decades, Charles engaged in a wide variety of chemical research projects at GCI that included laboratory studies and field applications of organic consolidants for art objects. One of the first problems he studied was the degradation of cellulose nitrate, an early consolidant for stone and ceramics. His efforts to understand the degradation mechanism of cellulose nitrate resulted in his *Cellulose Nitrate in Conservation* (1988), a GCI publication that is widely consulted and remains a principal reference in the field. Another polymer that continues to be an important consolidant for conservation is the epoxy-type resin that was developed for industrial use.

Photo: Courtesy GCI Science

Again, Charles's work resulted in his authorship of a GCI book on the chemistry and uses of a wide variety of epoxies—*Epoxy Resins in Stone Conservation* (1992).

Charles's research on epoxy consolidants grew to include the application of these resins in the field. For many years he was engaged in a GCI study to preserve the remaining adobe buildings at Fort Selden, an early US Army post near Las Cruces, New Mexico. The ruins of these historic adobe buildings—a New Mexico state historic site—were degrading rapidly, and Charles carried out epoxy polymer impregnation studies at the site. The results of these studies were presented at conservation conferences and in GCI reports and papers.

In addition to the epoxy work, Charles was involved in a number of other GCI projects, among them the evaluation of the use of aliphatic isocyanates for adobe conservation, as well as a study on the use of inert gases to control insect pests, which resulted in a book coauthored with GCI scientist Shin Maekawa, *Inert Gases in the Control of Museum Insect Pests* (1998). He was a consultant on a number of other projects in the field, including evaluation of the degradation and proposed conservation of the Great Sphinx in Egypt and the conservation of the lintels of the Church of the Holy Sepulchre in Jerusalem.

In short, Charles's involvement in conservation began as the GCI began, and his role in the Institute's work helped shape the GCI's early scientific legacy. His GCI colleagues remember him fondly not only for his significant professional contributions but also for his personal warmth and many enthusiasms—for hockey, for health, and for bird watching.

New Publication

Historical Perspectives in the Conservation of Works of Art on Paper
Edited by Margaret Holben Ellis

This book is the seventh in the Readings in Conservation series, which gathers and publishes texts that have been influential in the development of thinking about the conservation of cultural heritage. The present volume provides a selection of more than ninety-five texts tracing the development of the conservation of works of art on paper.

Comprehensive and thorough, the book relates how paper conservation has responded to the changing place of prints and drawings in society. The readings include a remarkable range of historical selections, such as Renaissance printmaker Ugo da Carpi's sixteenth-century petition to the Venetian senate on his invention of chiaroscuro, Thomas Churchyard's 1588 essay in verse "A Sparke of Frendship and Warme Goodwill," and Robert Bell's 1773 piece "Observations Relative to the Manufacture of Paper and Printed Books in the Province of Pennsylvania."

These selections are complemented by influential writings from such figures as A. H. Munsell, Walter Benjamin, and Jacques Derrida, along with a generous representation of recent scholarship. Each reading is introduced by a short discussion of the rationale for its selection and the principal matters covered, and the book is supplemented by a helpful bibliography.

This publication can be ordered at shop.getty.edu.

For more information about the work of the GCI, see getty.edu/conservation and

CONSERVATION PERSPECTIVES
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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 works to advance conservation practice in the visual arts, broadly interpreted to include objects, collections, architecture, and sites. It serves the conservation community through scientific research, education and training, model field projects, and the broad dissemination of the results of both its own work and the work of others in the field. In all its endeavors, the Conservation Institute focuses on the creation and dissemination of knowledge that will benefit the professionals and organizations responsible for the conservation of the world's cultural heritage.

The GCI is a program of the J. Paul Getty Trust, an international cultural and philanthropic institution that focuses on the visual arts in all their dimensions.

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The Early American Room in Boston's Museum of Fine Arts, photographed sometime between 1909 and 1920. Photo: Library of Congress Prints and Photographs Division, reproduction number LC-DIG-det-4a24294.

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