SIXTEEN

Introduction: Developing Informed and Sustainable Responses to the Alteration of Cultural Artifacts; Materials Engineering Meets Material Culture

Jennifer L. Mass

Abstract

Our collective understanding of the physical, chemical, and biological reactivities of cultural materials has long guided our preservation of these objects. Even seemingly static objects are in a constant state of chemical change, interacting with their environment or even reacting with each other within a single museum case. This introduction provides a current overview of the field, through the lens of the four materials science chapters that follow. These projects include investigations of metal soap formation in paintings, the degradation mechanisms of holograms, biologically active time-based media conservation issues, and the use of materials analysis to undo long-held misconceptions about Meiji-era woodblock prints. Our understanding and acceptance of material activity are, like the objects entrusted to our care, in a constant state of change. In response to urgent environmental concerns, we are working toward a relaxation of traditionally strict museum climate standards to achieve a delicate balance between environmental and object preservation. We also must constantly adapt to the challenges of contemporary artists' media and confront the rapidly changing requirements of objects that perform in new ways for larger and more inclusive audiences.

The restiveness of the materials that constitute our global cultural heritage is something that the chemical, physical, and biological scientists who work in museum laboratories encounter daily. Historically, we have endeavored to monitor, retard, and in certain cases even arrest or reverse the chemical and physical changes that artworks undergo.

Jennifer L. Mass, "Introduction: Developing Informed and Sustainable Responses to the Alteration of Cultural Artifacts; Materials Engineering Meets Material Culture," in *Conserving Active Matter*, ed. Peter N. Miller and Soon Kai Poh (New York: Bard Graduate Center, 2022), 302–10.

We also elucidate the mechanisms of interaction and degradation of the diverse range of materials (and their combinations) that one encounters in an encyclopedic museum collection. These materials can span the plant fibers used to make Polynesian bark cloth or tapa, the intricate castings of depletion-gilded pre-Colombian alloys, and the late nineteenth-century semisynthetic plastics such as cellulose nitrate. In the past we have carried out these efforts (always in conjunction with our conservation and art history colleagues) to render objects' appearances and functionalities as close as possible to our perceptions of the intentions of the artist, craftsperson, or collective who produced the work. However, as the disciplines involved in the preservation and conservation of cultural heritage mature, we have passed through multiple eras that have demanded reevaluations of our work, in terms of both how it is practiced and the new values that may be assigned to the objects that we transform. These reevaluations can be internally driven (as in Andrew Oddy's publication of the British Museum's treatment of the Parthenon marbles) or they can come about through external stakeholders.[1] These stakeholders range from art historians (consider John Richardson's "Crimes against the Cubists") to environmental activists, social justice activists, Indigenous communities, the general public, and scholars in numerous adjacent disciplines.[2] Today the fundamental tenets of art conservation and cultural heritage science, especially those surrounding stabilization, are being tested in the face of new and increasingly urgent demands that are being placed on cultural materials. These include both climate change and a growing international desire for museums to be more than warehouses for objects of colonial conquest.[3] Cultural heritage is being stored, displayed, and accessed in new ways to tell larger and more inclusive narratives. Our improved understanding of how the materials that constitute these objects will react with their environments is a crucial component of our discussions regarding these new uses.

The inorganic materials used to make cultural heritage objects (glasses, minerals, and alloys) provide an excellent example of how this understanding has evolved over time. The ancient Romans started what would become an over-two-thousand-year inquiry into historic bronze surfaces when they first hypothesized about bronze sculptures' activity with respect to their surface color and texture changes. The nineteenth-century archaeologists who excavated these objects continued to postulate explanations for the phenomenon, and in the twenty-first century conservators and scientists are still exploring the scientific basis of this blue patina through technical studies of the

Jennifer L. Mass, "Introduction: Developing Informed and Sustainable Responses to the Alteration of Cultural Artifacts; Materials Engineering Meets Material Culture," in *Conserving Active Matter*, ed. Peter N. Miller and Soon Kai Poh (New York: Bard Graduate Center, 2022), 302–10.

Delphi Charioteer.[4] The legacy of millennia of study into these subjects is an unusual nomenclature for the physical and chemical changes that occur in inorganic works of art. This nomenclature includes such evocative terms such as “bronze disease,” “caries,” “métaux malades,” “malignant patina,” “glass sickness,” “glass disease,” “vitrum putrefactibilium,” “ultramarine sickness,” and “ultramarine disease.” Given that the scientists or natural historians who first used these terms were working without knowledge of microorganisms or information about their reaction with copper alloys or silicates, these terms make sense both from a phenomenological perspective and within their historical contexts. Scientists today work within rigid frameworks for what constitutes an inorganic versus an organic material and the possible realms of activity for these objects. However, by looking more deeply into the genesis of this ancient medical language for inorganic activity and alteration, we have an opportunity to explore the foundational concepts of cultural heritage science and how they changed to keep pace with the new discoveries and worldviews of scientists from the seventeenth through the nineteenth centuries. Such research also allows us to explore scientists’ evolving understanding of the range of agents of degradation responsible for the activity of inorganic materials. What emerges is a portrait of how scientists, artists, and craftspeople understood (and now understand) the natural world and its realm of possibilities. This portrait allows us to identify the different moments in history in which certain types of activity were allowed or disallowed under the paradigms of the day.[5]

An additional emerging challenge for cultural heritage science is artists’ exploration with novel materials, which are active owing to their biological basis or intentionally biodegradable nature, or as in the case of YInMn blue and Vantablack, because their alteration pathways are incompletely understood.[6] The materials science essays included here showcase a variety of objects that are actively changing—both chemically and in our understanding and interpretations of them. These objects include artworks as seemingly inert as oil paintings to ones as seemingly unstable as a multimedia installation with decaying organic matter at the center of its medium and message. We also explore here the documentation, alteration, and preservation of holograms and holographic images, raising important questions about conservation prioritization, decision-making, and where the art in imaging technologies truly lies. Finally, we consider how the technological innovation of surface-enhanced Raman spectroscopy has allowed for the identification of the brightly colored organic dyes in Meiji-era

Jennifer L. Mass, “Introduction: Developing Informed and Sustainable Responses to the Alteration of Cultural Artifacts; Materials Engineering Meets Material Culture,” in *Conserving Active Matter*, ed. Peter N. Miller and Soon Kai Poh (New York: Bard Graduate Center, 2022), 302–10.

woodblock prints. This research uncovers long-held Western misunderstandings about Japanese artists' materials and their significance during this period of rapid technological change.

Francesca Casadio's essay reveals critical misperceptions about the fundamental nature of oil paintings, a category of objects that includes some of Western art's most treasured cultural properties. Even after an oil painting appears to have "dried," fatty acids from the oil binder and metal ions from the pigments can combine to form new molecules that, because of their limited solubilities, slowly self-aggregate or agglomerate in ways that can have remarkably diverse and damaging consequences.[7] Manifestations of this phenomenon can include the formation of translucent regions of paint, the rise and eruption of spherical pustules the size of a grain of sand, and in the case of mid-twentieth-century paintings such as abstract expressionist works, the spalling of paint flakes that can be the size of potato chips. Even amid our growing realization of how destructive these undead molecules moving through our paintings can be, we have to balance this with the knowledge that removing them from a painting entirely would leave the painting less flexible and vulnerable to other types of mechanical damage. As a result, art conservators and scientists take a minimalist approach of limiting the mobility of these molecules using carefully controlled visual monitoring and relative humidity levels. Such an approach is a far cry from well-intended but aggressively interventionist nineteenth- through mid-twentieth-century treatments regarding the structural stability of paintings. These might include the "cradling" of paintings on wooden panels by adding a secondary network of wooden supports that would restrain the expansion and contraction of the wooden panel.[8] While the intent was to limit the interlayer cleavage and paint flaking that is caused by different degrees of expansion with changes in relative humidity (for the paint versus the wood), restraining the wood from movement simply led to increased internal stress and cracking. A less-is-more approach, accepting some degree of change but managing its rate, aligns Western cultural heritage conservation with more sustainable and global attitudes toward preservation and change. One notable example of this is the Japanese concept of wabi-sabi, which ascribes value to both imperfection and transience. This approach may also put Western conservators and scientists more in line with the original thinking of artists such as Vincent van Gogh, who was well aware of the fugitive and changeable nature of his pigment and who constructed the vibrancy of his compositions to accommodate this.[9] The idea that his compositions would reach a harmonious balance with age is in

Jennifer L. Mass, "Introduction: Developing Informed and Sustainable Responses to the Alteration of Cultural Artifacts; Materials Engineering Meets Material Culture," in *Conserving Active Matter*, ed. Peter N. Miller and Soon Kai Poh (New York: Bard Graduate Center, 2022), 302–10.

particular borne out by the Metropolitan Museum of Art's *Van Gogh: Irises and Roses* exhibit, where reconstructed images of how his works would have appeared when they were first painted can be compared with their current appearance.

Marco Leona and Henry D. Smith's essay on the materiality of Meiji-era woodblock prints examines how a recent technological innovation, surface-enhanced Raman spectroscopy, allows us to dismantle some of the long-held myths about the impact of Western synthetic organic dyes on the *nishiki-e* (ukiyo-e) art form. Western art history has long viewed these dyes as synonymous with the precipitous decline of the art form, resulting in prints that were considered unpleasantly bright, garish, and decadent in the twentieth century. Among Leona and Smith's revelations, however, is that the Meiji-era *nishiki-e* incorporated very few synthetic dyes, employing only eosin red (to obtain a delicate pink), crystal violet (toned down with Prussian blue), and the naphthol reds. The objectionable fields of bright red color that were viewed as unacceptably vivid and tawdry (and thus prepared with cheap synthetic materials that represented a decline of the medium) are in fact made with cochineal carmine, a traditional natural red dye similar to lac dye. This reveals how a greater understanding of the materiality of cultural heritage can challenge long-held misunderstandings about an art form and, perhaps more importantly, deeply held cultural prejudices. The dominant twentieth-century paradigm that any brightly colored art was cheap and gaudy was an outgrowth of an unstated but widely agreed-upon Protestant aesthetic that predominated in Europe and the United States. This paradigm has long been used to relegate Asian and other forms of non-Western art to the category of "lesser" or "primitive" art on the basis of the brightness of the media used. In doing so, status-conscious twentieth-century scholars and art historians revealed their ignorance of the recent past, ignoring the blazingly bright American Fancy period of the 1830s and the aesthetic-era interiors of the 1870s to the 1890s.

Chris McGlinchey's essay on working together with contemporary Cuban artist Tania Bruguera and his colleagues to reproduce Bruguera's multisensorial installation *Untitled (Havana 2000)* at the Museum of Modern Art explores the difficulties that arise when the decay of certain components of an artwork is an essential element of the work (in this case bagasse, sugarcane waste, used to protest the violence of Cuba's colonial past). This project is emblematic of a larger problem in the conservation of contemporary art installations, which commonly incorporate intentionally ephemeral materials that are meant to un-

Jennifer L. Mass, "Introduction: Developing Informed and Sustainable Responses to the Alteration of Cultural Artifacts; Materials Engineering Meets Material Culture," in *Conserving Active Matter*, ed. Peter N. Miller and Soon Kai Poh (New York: Bard Graduate Center, 2022), 302–10.

dergo dramatic transformations during the lifetime of the installation, such as the bananas in Zoe Leonard's *Strange Fruit* (1992–97). While the rotting fruit and sugar cane are used in these works to deliver powerful messages about brutal regimes and social orders, their inclusion in a museum environment is problematic from the perspective of the preservation of the rest of the museum's collections. Rotting organic materials release a number of gasses that can impact other collection objects and cause microbial growth that can be damaging to both museum objects and visitors. The successful installation of *Untitled (Havana 2000)* using a floor of kiln-dried bagasse combined with a simulated nontoxic rotting scent reveals how scientists in contemporary art museums must constantly innovate and collaborate across a variety of disciplines to bring an artist's vision to life without sacrificing the safety of other collection objects. The US Visual Artists Rights Act (1990) allows artists to disavow works that they contend were installed or conserved in such a manner that the work no longer accurately represents their vision. As more and more artists use this legislation to protect their moral rights, McGlinchey's work reveals a best-case scenario of creative problem solving that simultaneously protects the artist's vision, MoMA's collections, the live performers participating in the artwork, and the museum visitor.

Marc Walton and his colleagues' essay explores the role of the cultural heritage scientist in the preservation of a specific form of mid-twentieth-century innovative imaging technology—the hologram. This essay incorporates a number of themes relevant to conservators and scientists working not only on holographic materials but also in time-based media preservation and digital-born artworks. In this field of conservation, one of the most pressing questions to be addressed is which components, exactly, should be preserved. If the holographic image can be reproduced successfully through migration (by creating a new image plate), as has been done at MoMA with Louise Bourgeois's spectacular holograms, then what level of preservation does the exceedingly delicate and photosensitive silver salt-coated plate that originally generated the image require? Walton and his colleagues make the choice here that the technology that generates these images, in particular the technological innovations of holographic pioneer Stephen Benton, are well worth preserving given his mastery of the medium and role in growing it to produce dynamic, polychrome, and exquisitely detailed three-dimensional images. The concept of the medium being (part of) the message has a long history in cultural heritage preservation, from our preservation of Thomas Edison's original metal recording masters

Jennifer L. Mass, "Introduction: Developing Informed and Sustainable Responses to the Alteration of Cultural Artifacts; Materials Engineering Meets Material Culture," in *Conserving Active Matter*, ed. Peter N. Miller and Soon Kai Poh (New York: Bard Graduate Center, 2022), 302–10.

to national cellulose nitrate film vaults and repositories. Ironically, the reactive nature of these materials enables them to capture images, movement, and sound but works against their long-term preservation. Walton and his coauthors' development of strategies for diagnosing condition issues, retrieving images, and uncovering the working methods of a master holographer point the way to a rigorous approach for the preservation of a medium that captivated twentieth-century viewers with a startlingly present yet frustratingly noncorporeal image that always remains tantalizingly out of reach.

We often speak in materials science about our search for high-performance materials that push the boundaries of what constitutes a useful lifetime, whether their purposes are optical, electronic, or aesthetic. Museum objects are asked to perform far outside their expected lifetimes, in some instances for millennia, and in ways that their creators could never have anticipated. Our increasing understanding of the mechanisms of degradation of these materials is taking place in a shifting landscape of our expectations for them, and this will bring about a new set of concerns and objectives for the generation of scientists that succeed us. Will some of the forms of alteration and degradation that we now consider unacceptable become regarded as beautiful or at least intrinsic to artists' media? Will we learn to relax our visual "performance standards" for cultural heritage objects for the sake of the environment and become more forgiving of a certain degree of visual change? Andrew Juniper notes, "The tides of time should be able to imprint the passing of the years on an object. . . . It is the changes of texture and colour that provide the space for the imagination to enter."[10] By generating a clearer understanding of how exactly cultural materials are reacting with their environments and each other, we can perhaps continue to allow our environmental and aesthetic standards to evolve and keep pace with the emerging demands that are being made of global cultural materials.

NOTES

1. Oddy, "Conservation of Marble Sculptures," 145.
2. Richardson, "Crimes against the Cubists."
3. Both of these issues are addressed in Janes and Sandell, *Museum Activism.*
4. For the nineteenth century, see Villenoisy, "Patine du bronze antique." For contemporary investigations, see Franke and Mircea, "Plutarch's Report."

Jennifer L. Mass, "Introduction: Developing Informed and Sustainable Responses to the Alteration of Cultural Artifacts; Materials Engineering Meets Material Culture," in *Conserving Active Matter*, ed. Peter N. Miller and Soon Kai Poh (New York: Bard Graduate Center, 2022), 302–10.

5. A full discussion of the origins and implications of the glass disease, ultramarine disease, and bronze disease as cultural heritage science terminologies can be found in “Historical Perspectives on Inorganic Activity through the Lens of Glass, Bronze, and Ultramarine Diseases” on the *Conserving Active Matter* website, 2022, https://exhibitions.bgc.bard.edu/cam/.
6. For biological materials, see Antonelli et al., *Neri Oxman Material Ecology Catalogue*. For biodegradability, see Li and Subramanian, “Inorganic Pigments.” For new artists’ pigments with incompletely determined alteration pathways such as YInMn blue and Vantablack, see Adams et al., “Vantablack Properties in Commercial Thermal Imaging Systems.”
7. There are numerous important publications on this topic, but a comprehensive review can be found in Casadio et al., *Metal Soaps in Art*.
8. See, for example, Dardes and Rothe, *Structural Conservation of Panel Paintings*.
9. Brack, “Refreshing Van Gogh’s Faded Flowers.”
10. Juniper, *Wabi Sabi*.

BIBLIOGRAPHY

Adams, Arnold, Fred Nicol, Steve McHugh, John Moore, Gregory Matis, and Gabriel Amparan. “Vantablack Properties in Commercial Thermal Imaging Systems.” In *Infrared Imaging Systems: Design, Analysis, Modeling, and Testing XXX*, edited by Gerald C. Holst and Keith A. Krapels, 110010W-1–110010W. Proceedings of the Society of Photo-Optical Instrumentation Engineers 11001. Bellingham, WA: SPIE, The International Society for Optics and Photonics, 2019. https://doi.org/10.1117/12/2518768.

Antonelli, Paola, Anna Burckhardt, Emily Hall, Jennifer Liese, and Neri Oxman. *The Neri Oxman Material Ecology Catalogue*. New York: Museum of Modern Art, 2020.

Brack, Paul. “Refreshing Van Gogh’s Faded Flowers.” Chemistry World (website). Royal Society of Chemistry. October 1, 2015. https://www.chemistryworld.com/news/refreshing-van-goghs-faded-flowers/9005.article.

Casadio, Francesca, Katrien Keune, Petria Noble, Annelies Van Loon, Ella Hendriks, Silvia A. Centeno, and Gillian Osmond. *Metal Soaps in Art: Conservation and Research*. Cultural Heritage Science Series. Cham: Springer, 2019. https://doi.org/10.1007/978-3-319-90617-1.

Dardes, Kathleen, and Andrea Rothe, eds. *The Structural Conservation of Panel Paintings: Proceedings of a Symposium at the J. Paul Getty Museum, 24–28 April 1995*. Los Angeles: Getty Conservation Institute, 1998.

Franke, Walter A., and Magda Mircea. "Plutarch's Report on the Blue Patina of Bronze Statues at Delphi: A Scientific Explanation." *Journal of the American Institute for Conservation* 44, no. 2 (Summer 2005): 103–16.

Janes, Robert R., and Richard Sandell, eds. *Museum Activism*. Museum Meanings Series. New York: Routledge, Taylor & Francis Group, 2019.

Juniper, Andrew. *Wabi Sabi: The Japanese Art of Impermanence*. Tokyo: Tuttle, 2019.

Li, Jun, and M. A. Subramanian. "Inorganic Pigments with Transition Metal Chromophores at Trigonal Bipyramidal Coordination: Y(In,Mn)O3 Blues and Beyond." *Journal of Solid State Chemistry* 272 (2019): 9–20. https://doi.org/10.1016/j/jssc/2019.01.019.

Oddy, Andrew. "The Conservation of Marble Sculptures in the British Museum before 1975." *Studies in Conservation* 47, no. 3 (2002): 145–54.

Richardson, John. "Crimes against the Cubists (Protecting Cubist Paintings)." *New York Review of Books*, June 16, 1983.

Villenoisy, F. "La patine du bronze antique." *Revue archéologique* 1 (1896): 69–71.