The Future of History: Corrosion and Conservation

Emma L. Dambek

Emma Dambek is a senior History major from Decorah, Iowa. After graduating from EIU, she plans on attending the Cooperstown Graduate Program in pursuit of a master's degree in museum studies. Her goal is to work in collections at a museum or other site in public history.

As the production of air pollutants increase and climate change becomes more visible, it is not only the health of living things that are affected. Museum objects, documents, collections, and statues confront uncertain futures in the face of growing environmental threats. Although not all curators and collections managers agree about the threat posed by climate change to museum collections, for most, the mandate to preserve the past has never been as high as today.[1] In 2005, 30,000 institutions in the United States were surveyed regarding the threat of air pollution to historic artifacts.[2] Of the institutions surveyed, 47% responded that air pollution caused "some or significant damage to the collections."[3] The greatest risks to artifacts, as will be explained in this essay, are the increase of air pollutants, such as Sulphur Dioxide (SO_2) and the rapidly changing climate. These potential hazards affect artifacts in a variety of ways, not only statues in the open elements but also artifacts secure within museums. By raising awareness of these dangers to preserving history, the proper steps can be taken to stop the destruction of the past.

For the sake of this essay, an "object" will be defined as any three-dimensional historic artifact found in museums, including paintings. Any reference to "documents" will entail historic papers also found in museums or archives. A "collection" is any group of objects or documents found in either a museum or private facility; this will include archives as well. "Artifacts" will refer to objects, documents, or collections, as defined previously.

The effects of air pollution are not a recent phenomenon in the world of public history. Reports of poor air quality effecting artifacts come as early as 1850.[4] Michael Faraday, a nineteenth century British scientist, wrote about the impact of air pollution on works of art in the National Gallery in London, attributing them to the growing use of coal in an industrializing nation.[5] Though early museum workers were aware of the effects of the visible air contaminants, like smog, they were often unaware of the invisible pollutants, such as Sulphur Dioxide. Many would excuse the damage as natural decay, which is an understandable view. Still, by the industrial period, the rate at which artifacts began to become damaged was greatly accelerated.[6]

Sulphur Dioxide (SO_2) is created after sulphur is emitted while burning oil, coal, or diesel and mixes with oxygen.[7] After the SO_2 becomes air born, it will mix with water vapor and become H_sSO_4, which is the incredibly corrosive mixture known as acid rain.[8] The disastrous effects of SO_2

[1] David Saunders, "Climate Change and Museum Collections," *Studies in Conservation 53* (2008): 288.

[2] Morten Ryhl-Svendsen, "Indoor Air Pollution in Museums: a Review of Prediction Models and Control Strategies," *Reviews in Conservation* 7 (2006): 27.

[3] Ryhl-Svendson, "Indoor Air Pollution," 27.

[4] Stephen Hackney, "The Distribution of Gaseous Air Pollution within Museums," *Studies in Conservation* 29 (1984): 105.

[5] Ibid.

[6] Ryhl-Svendsen, "Indoor Air Pollution in Museums," 27.

[7] "Identifying and Reducing Air Pollution," *Museums Galleries Scotland*, accessed November 24, 2018, https://www.museumsgalleriesscotland.org.uk/advice/collections/identifying-and-reducing-air-pollution/.

[8] Hackney, "The Distribution of Gaseous Air Pollution within Museums," 106.

are best seen on the exterior of buildings and outdoor statues. The H_sSO_4 creates white streaks on limestone and pitting on sculptures of various materials.[9] Acid rain also has the capability to burn off the protective layers of material that keep the statues or buildings from the deteriorating effects of other pollutants and corrosive mediums, some as simple as rain water.[10]

Bronze statues are at a great risk for damage from acid rain, which can produce a streaky appearance along with black spots that would remain until restored.[11] Conservators in Ottawa, Canada, were particularly interested in the lasting effects of acid rain as many areas of Canada have seen an increase in acid rain from sources in both Canada and the United States.[12] Local sources of acid rain derive from the continued use of burning firewood in open fireplaces in both the public and private areas and the dominant use of coal in factories until the 1960s.[13] The Canadian study performed over a span of five years aimed to find harmless ways to conserve bronze statues from the lasting effects of acid rain. Researchers studied 34 metal samples and 168 surface samples and used a variety of methods to keep the H_sSO_4 from wreaking havoc on the samples.[14] Though some methods were more helpful than others, a general consensus emerged for the future conservation of outdoor art pieces and building exteriors. Water-soluble compounds would have to be cleaned off thoroughly to eliminate risk of damaging the protective layer, and a protective layer to keep all corrosive materials away from the statue or building medium must be permanently maintained.[15]

Marble is also very susceptible to the damaging effects of acid rain, as seen in many cities and national parks. The Gettysburg National Military Park in Pennsylvania has witnessed an increase in the acid rain production due to the growth of traffic in the area.[16] The effects of acid rain on the marble statues vary greatly due to the changing climate and the shape of each statue.[17] The various types of marble react differently, as well, which skewed the data compared to the consistent nature of the bronze statues.[18] Acid rain clearly affected each statue in some way at the Gettysburg National Military Park: from streaking to pits within the marble.[19]

Interior exhibits are not immune from the lasting effects of sulphur dioxide. Historic documents and paintings, like papers and textiles today, contain large amounts of cellulose, which is a large component in the cell walls of plants.[20] H_2SO_4 causes a reaction in paper and textiles called hydrolyzation. The hydrolyzation process is the unbinding of water molecules within an object of any sort, but especially within textiles and papers.[21] This process causes the document or canvas to "become brittle and yellowed."[22] This causes not only structural damage, but, can also make the document or painting difficult to read or examine. Due to the age of most artifacts and the lack of knowledge of air pollutants, it is very difficult to see the extent of H_2SO_4 damage since light pollution often has affected these artifacts for a number of years.[23]

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[9] Hackney, "The Distribution of Gaseous Air Pollution within Museums," 106.

[10] Martin E. Weaver, "Acid Rain and Air Pollution vs. the Buildings and Outdoor Sculptures of Montréal," *The Journal of Preservation Technology* 23 (1991): 17.

[11] Weaver, "Acid Rain and Air Pollution vs. the Buildings and Outdoor Sculptures of Montréal," 17.

[12] L.S. Selwyn et al., "Outdoor Bronze Statues: Analysis of Metal and Surface Samples," *Studies in Conservation* 41 (1996): 205.

[13] Selwyn et al., "Outdoor Bronze Statues," 205.

[14] Selwyn et al., "Outdoor Bronze Statues," 205.

[15] Selwyn et al., "Outdoor Bronze Statues," 205.

[16] Susan I. Sherwood and Donald A. Dolske, "Acidic Deposition and Marble Monuments at Gettysburg National Military Park," *APT Bulletin: The Journal of Preservation Technology* 23 (1991): 52.

[17] Sherwood and Dolske, "Acidic Deposition and Marble Monuments," 56.

[18] Sherwood and Dolske, "Acidic Deposition and Marble Monuments," 56.

[19] Sherwood and Dolske, "Acidic Deposition and Marble Monuments," 52.

[20] Stephen Hackney, "The Distribution of Gaseous Air Pollution within Museums," *Studies in Conservation* 29 (1984): 106.

[21] "Hydrolysis," *Wikipedia,* accessed November 24, 2018, https://en.wikipedia.org/wiki/Hydrolysis.

[22] Hackney, "The Distribution of Gaseous Air Pollution within Museums," 105.

[23] Hackney, "The Distribution of Gaseous Air Pollution within Museums," 106.

Many museums were constructed before the availability of climate control; this has also contributed to the deterioration of artifacts. The lasting effects of air pollutants in a public history setting have been noted for several hundred years, though few understood the implications of air pollution's effects on artifacts. Even as these air pollutants had been noted, scientists only recently became aware of certain pollutant's impact on artifacts, especially if the museum or archive lacked a central air system. The concentration of the various gases within museums have been measured in many different ways, some as simple as adding chemicals of various dilutions to a piece of canvas and marking down the amount of color change occurring on the parts of the canvas.[24] A certain degree of fading of the canvas's brown coloration shows the concentration of Sulphur dioxide in the air of the museum tested.[25] This test, while not especially useful for determining the exact amount of Sulphur dioxide in the air, is very helpful for showing whether or not cabinets, containers, or storage areas are useful in keeping the harmful gases away from artifacts.[26] As seen with the outdoor bronze and marble statues, it is critical to keep the gases or acid rain away from artifacts, since it is very difficult to stop the deterioration process once it begins. Protection and preservation are the best tools to save artifacts that tell the story of history.

Climate change is another contributor to the degradation of historic documents, artifacts, and outdoor art pieces. While some reject the authenticity of human-produced climate change, it is quickly becoming a challenging part of the lives of humans today, whether they believe it or not. Climate change has had an extreme impact on the well-being of many important parts of nature and life itself, but also the life of history, as many objects and documents were created hundreds of years ago during periods of time that had vastly different climates than that of today.

"Climate Change and Museum Collections," an article published in *Studies of Conservation* (2008), provides an in-depth look into the problems museum workers and archivists will face in the near future. It focuses especially on climate change within museums. While this article is ten years old, it is likely little progress has been made in terms of providing climate control, since museums and historic sites often have limited budgets, which are frequently dedicated to general upkeep or creating new exhibits. Additionally, according to this article, museum workers often feel overwhelmed in facing such as large scale problem as climate change.[27]

A related issue that affects the world of public history is humidity. It is not only difficult to manage, but if not kept at an appropriate level, humidity can damage historic artifacts in irreparable ways. Wooden objects can experience bowing and swelling of the wood, which can morph pieces and render them ineffective to teaching history.[28] The wood on panel paintings becomes warped on only one side of the wood since the paint is holding back the humidity, which leads to a more obvious warping.[29] Even museums that have climate control, like the Vesterheim National Norwegian-American Museum and Heritage Center in Decorah, Iowa, have a difficult time managing the humidity. This is due to the amount of foot traffic—usually a very good thing for a museum, but one that can allow in humidity and sulphur dioxide from the streets.

Like the Vesterheim Museum, most museums have objects within plexiglass or glass cases, but those cases can do very little to keep humidity and sulphur dioxide from affecting the objects or documents. There has been an increased use of "sorbents" to attract the gases and humidity from

[24] Hackney, "The Distribution of Gaseous Air Pollution within Museums," 108.
[25] Hackney, "The Distribution of Gaseous Air Pollution within Museums," 108.
[26] Hackney, "The Distribution of Gaseous Air Pollution within Museums," 108.
[27] Saunders, "Climate Change and Museum Collections," 288.
[28] Saunders, "Climate Change and Museum Collections," 290.
[29] "Paintings Aging Gracefully or Grievous Bodily Harm?" Valentine Walsh: Conservation and Restoration of Fine Art, 2009, http://valentinewalsh.co.uk/conservation/ageing/.

display cases and storage facilities.[30] These sorbents are made from activated carbons or Purafil in order to draw out the gases.[31] The activated carbons work best in removing the harmful gases from the display cases and storage facilities.[32] Other museums have taken to creating display cases that cut off all air circulation, while using the sorbents, in order to keep all bad air from existing in the vicinities of the objects or documents. The Getty Conservation Institute has been especially interested in this after noticing some of the artifacts and display cases were exhibiting signs of erosion or degradation from the toxic fumes within the museum.[33] The Philadelphia Museum of Art has also taken a special interest in preserving objects from air pollutants. The website of the Philadelphia Museum of Art includes a detailed account of its efforts to minimize the pollutants within the museum. This work can help educate the public and other conservators on how to keep artifacts safe.

While it is not a looming topic in the collective global consciousness, artifacts found in museums, archives, or any conservation space have a growing problem with the amount of pollutants in the air. Though pollutants are not noticed by the average person, these gases and particulates can greatly damage artifacts older than most cities. The only way to truly save history is to create a greater dialogue about the future of history.

[30] Daniel Grosjean and Sucha S. Parmar, "Removal of Air Pollutant Mixtures from Museum Display Cases," *Studies in Conservation* 36 (1991): 129.

[31] Grosjean and Parmar, "Removal of Air Pollutant Mixtures from Museum Display Cases," 129.

[32] Grosjean and Parmar, "Removal of Air Pollutant Mixtures from Museum Display Cases," 129.

[33] "Pollutants in the Museum Environment," *The Getty Conservation Institute,* The J. Paul Getty Trust, accessed November 24, 2018, http://www.getty.edu/conservation/publications_resources/newsletters/11_1/gcinews8_1.html.