Evaluating environmental conditions in shipping containers with recommendations on their reinforcement for the storage of cultural materials

Ayesha Fuentes and Geneva J. Griswold
UCLA/Getty Program in the Conservation of Ethnographic and Archaeological Materials

ABSTRACT: Metal shipping containers are often used for short and long-term storage in post-disaster remediation as well as in areas with limited permanent storage solutions. While shipping containers are widely available and inexpensive, their lack of climate control/buffering capacity may catalyze deterioration unless modified. Several case studies cite the use of shipping containers as post- disaster storage solutions; however, unsealed and uninsulated containers have been noted to cause more damage than was present before storage. The stability of shipping containers' interior conditions was assessed by monitoring their temperature and relative humidity over time in two differing climatic locations: Venice, CA and Bremerton, WA. Additionally, an online survey of conservators and allied professionals was conducted to evaluate their past or present experiences with the use of shipping containers, perspectives on the containers' shortcomings and strengths, as well as their priorities for improvement. Based on the results of monitoring and consultation, this project will later propose and test a number of hypothetical, low- cost, and technologically accessible adjustments to metal shipping containers in order to test their efficacy in producing a more archival and sustainable environment. These may include the use of buffering materials (e.g. cardboard, Styrofoam) as insulating layers, solutions for increased ventilation, exterior structures or tarpaulins, etc.

Previous studies

A literature review of the known and/or recommended uses of shipping containers for the storage of cultural materials was undertaken, yet there is a significant lack of published data on the topic, excluding those from the National Archives of Australia. Ted Ling (2002) reports evaluate the performance of shipping containers in Darwin, Australia, and outline steps for acquiring the container, site selection, interior environmental control methods, and the installation and retrofitting process, with a focus on the storage of cellulosic materials. In another study, Ian Batterham and Jessica Wignell (2008) testify that cardboard boxes buffer the humidity levels inside shipping containers yet polypropylene boxes do not, though neither material affects temperature fluctuations.

The need for further research prompted our development of a survey to further inform our research on finding a low-tech, cost-effective storage solution for diverse material types located in differing climactic areas.

Survey

Our survey asked participants to provide information on their experiences with shipping containers and rate the advantages and disadvantages of their use as storage. It was found that respondents were unanimously dissatisfied with the performance of shipping containers - specifically uninsulated models without electrical hook-ups for the installation of climate regulating equipment - because of the instability of their interior conditions (T/RH).

Survey results: Fast facts

72% of respondents use storage containers for long-term storage (12 months or more)

Cellulosic materials are most commonly reported type of material stored in shipping containers; Plastics and paintings on inorganic substrates were the least commonly reported

One half of respondents used non-archival cardboard boxes; almost 20% reported that they used no storage system or hardware

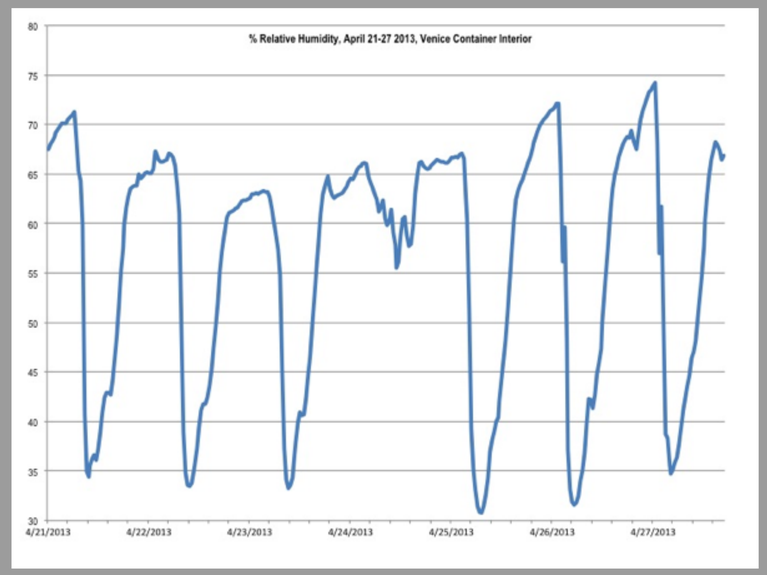
Uninsulated, front-loading shipping containers were the most commonly reported type of container used

Installation strategies reported: none (majority of respondents), lifting the container off the ground (one respondent)

Pest management and dust were considered the lowest priority challenges in the use of shipping containers as storage

Highest priority challenges were the lack of control of interior environmental conditions (temperature/ relative humidity) and organizational solutions

Low-cost and accessibility were the highest ranked advantages for the use of shipping containers



The percent relative humidity fluctuated by up to 56.5 percent during the course of each day inside the Venice container. On April 24th the percent relative humidity never dropped below 55 percent, illustrating a discrepancy likely caused by container use or a weather event.

Environmental monitoring

The stability of shipping containers' interior conditions was assessed by monitoring their temperature and relative humidity over a three month period in two differing climatic locations in the United States: Venice, CA and Bremerton, WA. The weather during the monitoring period in both locations varied extremely. Both test sites are uninsulated, single-walled 20-foot ISO standard shipping containers. They are situated directly on the ground, rely solely on natural ventilation, and are not outfitted with a canopy or covering.

The interior conditions of the shipping containers fluctuated wildly, yet exhibited lower average temperature and humidity values than the exterior climate overall.

•The difference between the average exterior and interior temperatures in Venice was 1.8 degrees Celsius, while the relative humidity was an average 13.4 percent lower inside the container than outside.
• The difference between the average exterior and interior temperatures in Bremerton was 3.1 degrees Celsius, while the relative humidity was an average 1.6 percent lower inside the container than outside.

We welcome monitoring data from other containers and environments, if available, as these regimes provide the foundation from which to compare materials testing results applicable to a broad range of collections and climates.

To participate in our survey please scan the QR code at right or visit:

http://www.surveymonkey.com/s/CCP32FW

The Venice container is an uninsulated, single-walled 20-foot ISO standard shipping container, positioned directly on concrete. It is painted tan, relies solely on natural ventilation, and is not outfitted with a canopy or covering.

Phase II of the Project

Phase II of the project includes construction of a mock-up shipping container employed to examine the effects of materials (such as cardboard or Styrofoam) as insulating or buffering layers, effects of aboveground elevation, exterior structures or canopies, and painted exteriors, as well as solutions for increased ventilation.

We seek to continue soliciting feedback from the international community via the online survey as well as to present phase II results within two years. We look forward to your comments, contributions, and ideas.

CONCLUSIONS: This poster summarizes the results of in situ environmental monitoring, survey responses from architects and conservators in the field, and proposals for future shipping container prototyping. The project seeks to realize a practical option for communities to better maintain their cultural materials and to provide a risk assessment-based guideline for creating storage solutions that is legible to both conservators and non-specialists alike. In sharing this project at an early stage, we intend to promote this topic as one deserving of rigorous study, as well as to solicit suggestions from viewers regarding creative material solutions for the environmental stabilization of metal shipping containers.

ACKNOWLEDGMENTS: The authors would like to thank Denese Easterly and the Social Public Art Resource Center for their assistance, the Indigo Arts Alliance, as well as the numerous colleagues who kindly provided insights and experiences during the consultation process.

REFERENCES: Batterham, Ian and Jessica Wignall. 2008. The mitigating effects of packaging on temperature and humidity fluctuations. 2008 AICCM Book, Paper, and Photographic Materials Symposium; Ling, Ted. November 2002. Use shipping containers for record storage: specification and description. National Archives of Australia. PARBICA, Pacific Regional Branch of the International Council on Archives.