Cost-Efficient and Environmentally Responsible Preservation Methods for Preparing Paper-Based Objects for Transit and Display

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Vulnerabilities

Collections are vulnerable to damage and loss when in use including, transit, handling, and display. Damage can be reparable or irreparable.

Chart B: Damage/Loss

Top Sources of Damage/Loss in Previous Two Years

- Improper storage or enclosure: 16% (Small), 22% (Large/medium)
- Handling: 14% (Small), 39% (Large/medium)
- Physical/chemical deterioration: 14% (Small), 33% (Large/medium)
- Light: 13% (Small), 18% (Large/medium)
- Pests: 12% (Small), 18% (Large/medium)

Percent of Museums

Overview: Collections Preservation at Museums
Vulnerabilities and Causes of Damage for Objects in Transit

**Vulnerabilities**

- Breakage of fragile surfaces
- Cleavage/loss of fragile surfaces
- Cracking, warping of moisture sensitive 3D objects
- Planar distortion of paper-based objects
- Abrasion

**Causes of Damage**

- Shock, vibration
- Incorrect ambient RH
- Incorrect ambient temperatures
- Incorrect temperature due to IR radiation (radiant heat)
- Improper packing
- Improper handling
- Water ingress
Paper-Based Collections

77% of collections are classified as paper-based objects.

- Photographic
- Unbound sheets
- Book/bound volumes

Vulnerabilities of Paper-Based Objects in Transit

Change in moisture content

- Incorrect ambient RH
- Fluctuations in temperature

Cockling
The Fine Arts Conservancy
Sealed Frame Package

Diagram of a sealed frame package
Packed Shipping Crates

Examples of museum shipping crate construction materials and packing materials and configurations.

Diagram of museum shipping crate packing configuration with trays.
Research

What are the most cost-efficient and environmentally responsible methods of preparing paper-based collection objects for transit and display while maintaining preservation standards?

Selection of materials used to make sealed frame packages
Project Goals

Collect and analyze data pertaining to:

• Shipping crate environments in transit
• The buffering capacity of shipping crates and crate packing configurations
• Materials, design and construction of sealed frame packages
Lab Research

Identify materials being used in the field:

- Sealed frame packages
- Shipping crate construction
- Crate packing

Materials research:

- ISO 18902 for Photo Safety
- Moisture diffusion rates
- Thermal insulating capacity
- Identify and test alternative environmentally responsible materials

Sealed frame packages and shipping crates in IPI test chambers
Field Research

Collect and analyze temperature and relative humidity data in museum shipping crates transporting framed paper-based objects:

- 11 partner institutions
- Various modes of transit
- Various climatic regions
- Different seasons

Field partner crate with external and internal datalogger; example of environmental data from crates in transit
Most Common Materials—SFP

**Backing boards**
- Corrugated plastic

**Glazing**
- Acrylic

**Vapor-proof barrier**
- Aluminized nylon and polyethylene barrier film

**Seal**
- Aluminum foil tape, polypropylene tape
Most Common Materials—Crates

Crate
- Birch, Medium Density Overlay (MDO)
  - Only 17% use Forrest Steward Certified (FSC)

Lining
- Aluminized nylon and polyethylene barrier film

Padding/Insulation
- Polyethylene foam

Tray base
- Foam board

Tray cavity and padding
- Polyethylene foam

Wrapping material
- Polyethylene bag

Diagram of shipping crate
Reuse, Recycle

Questionnaire data on reuse and recycling of crate construction materials

- 76 Respondents
- 52% of respondents were museums
- 2.6% of respondents were fine art packing and shipping companies, which are less likely to store and reuse crates. They likely make the majority of crates used in the field.
96% of respondents reuse or repurpose much of their interior packing materials.

Much of the material is not reused, repurposed or recycled.

79% reported sending some material to the landfill.

Because materials can only be used a finite number of times, most packing materials are eventually discarded.

### Questionnaire data on reuse, repurposing, recycling and disposal of crate packing materials

<table>
<thead>
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<th>Material</th>
<th>Landfill</th>
<th>Reuse/Repurpose</th>
<th>Recycle</th>
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<tbody>
<tr>
<td>Lining</td>
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<td>7</td>
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<tr>
<td>Foam Padding/Insulation</td>
<td>18</td>
<td>56</td>
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</tr>
<tr>
<td>Corner Pad</td>
<td>10</td>
<td>39</td>
<td>7</td>
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<tr>
<td>Wrapping</td>
<td>45</td>
<td>33</td>
<td>14</td>
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<tr>
<td>Trays</td>
<td>12</td>
<td>48</td>
<td>8</td>
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<tr>
<td>Slip cases</td>
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<td>21</td>
<td>13</td>
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<tr>
<td>Tray/slip case cavity foam</td>
<td>12</td>
<td>40</td>
<td>2</td>
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Plywood, why do we care?

Deforestation  
Air Pollution  
Water pollution  
Soil pollution  

Fossil fuel  
Particulate (wood dust)  
Methanol  
Formaldehyde  
Urea

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>SUB-CATEGORY</th>
<th>ITEM</th>
<th>QUANTITY</th>
<th>GHG/UNIT</th>
<th>TOTAL GHG</th>
<th>SAFETY DATA SHEET</th>
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<tr>
<td>Wood/Composites</td>
<td>Plywood</td>
<td>Birch plywood</td>
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<td>471.999</td>
<td>471.999</td>
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<td>TOTAL CARBON FOOTPRINT (kg CO₂ eq)</td>
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</tbody>
</table>

STITCH: https://stich.culturalheritage.org/carbon-calculator/#browse
Plastics, why do we care?

- Non biodegradable
- Photodegrade
  - Microplastics
    - Ocean, rivers, lakes
    - Food sources
    - Human body
- Plasticizers (phthalates)
  - Endocrine disruptors

Scientists find microplastics in blood for first time

[Content]

Not enough is known about the amount and effects of microplastics on fetuses and children

by University of Oulu

For the first time, researchers find microplastics deep in the lungs of living people

April 6, 2022 - 3:03 PM ET

RINA TORCHINSKY
Life Cycle Assessment of Shipping Crate

Figure 3a: Global warming impact of set 1: single trip, round trip type 1, round trip type 2, and reusable crates for flatwork size. For the round trip type 1, 2 urethane and esterfoam density was assumed to be 7.8 pounds per cubic foot.

Figure 3b: Global warming impact of single trip, round trip type 1, round trip type 2, and reusable crates for flatwork size. For the round trip type 1, 2 urethane and esterfoam density was assumed to be 1.55 pounds per cubic foot.

STiCH: https://stich.culturalheritage.org/crates/
Investigation of Alternative Materials

Packing materials:
- Biofoams
- Bioplastics

Alternate crate construction materials

Green Cell Foam
Material Use Analysis

Material financial cost

Material performance: thermal and moisture buffering

Material afterlife: waste, reuse, recycle
Outcomes

Allow collecting institutions to make informed, cost efficient, and environmentally responsible decisions for maintaining preservation standards and mitigating damage and risk when shipping paper-based objects.

Sealed frame package test sample

Field partner shipping crate
Project Team

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