EXHIBIT CONSERVATION GUIDELINES FOR THE CHICAGO HISTORICAL SOCIETY

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OUTLINE

INTRODUCTION

Collaboration and communication between the exhibition designers, collection managers and conservators are essential for eliminating problems and conflicts that arise during the exhibition of artifacts. There are often differing opinions regarding the safety of the artifacts and their exhibition potential. An exhibit development process that balances the competing criteria from either perspective and incorporates conservation methodically is essential. By following the conservation guidelines, exhibitions can highlight the beauty, uniqueness, aesthetic quality of objects, and significance of object without compromising the objects' stability and safety. In his article SHARING THE RESPONSIBILITY FOR PRESERVATION: A Call for Partnership Between Exhibition and Conservation Specialists Toby Raphael suggests the following:

- Integrate conservation early
- Share responsibility among team members
- Unify and consolidate preservation recommendations
- Promote practical ad well-balanced conservation criteria
- Explain alternative strategies and options
- Encourage appropriate levels of conservation response
- Promote practical design that is both "buildable and maintainable"
- And find solutions within the budget and timetable.

In order to understand the magnitude of care that the collection may require it is necessary to recognize the sorts of things that can negatively affect artifacts. Exposure to high light levels, fluctuations in temperature and relative humidity, human intervention, improper handling, poor quality case materials, pest infestation, improper mounts or supports, vandalism, and theft are among the main ways that damages can occur. Usually the damages are visible by the presence of accretions (corrosion on metal or efflorescence on leather), discoloration (stains on paper, discoloration of textiles), tackiness (on plastics and photographs), fading, cracking or distortions, and losses. Some damages are not caused by external or environmental factors, but from the innate instability of the objects themselves.

When determining what types of materials to use in proximity to artifacts, it is necessary to utilize the most stable materials or compatible materials that will prevent serious damage. Compatibility is determined by considering the nature of the artifact and the exhibit material in question and through examination of the case environment. Questions to consider include:

- Is their direct physical contact between the artifact and a case material?
- What are the normal ranges for regulated temperature and relative humidity?
- What type of volatile emissions may be present from case materials?
- Are emissions harmful to the artifact in question?
- Does they artifacts require a special temperature or relative humidity, and if so, can this case maintain a microclimate?
- Does this case require a specific volume of space/ rate of air exchange?
- Are the artifacts displayed susceptible to pest infestation?
- Should this case be gasketed to prevent infestation or to buffer the environment?
- What are the acceptable light-levels for each type of artifact on display?
- What is a reasonable time of exhibition of each type of artifact displayed? Is this compatible with the stability of the materials chosen?

Once conservation and exhibition design have examined all possible problems between the artifacts to be displayed and exhibit materials being considered, necessary changes should be made to the exhibit case design to ensure the safe display of artifacts.

INTEGRATING EXHIBIT CONSERVATION INTO EXHIBIT DESIGN & PRODUCTION[1]

EXHIBIT PLANNING

- Integrate conservation early in the exhibit planning phase by committing to preserve objects placed on exhibition with the assistance of conservators.
- Allow enough time for development and review of technical designs, case prototypes, lighting mockups, and the testing of proposed materials. The schedule must also allow for safe handling, exhibit mount making, and installation of objects including the costs concerning preservation issues, such as treatment and special casework, in the budget.
- Employ solutions that are appropriate for the specific exhibit circumstances and balance conservation criteria with other exhibit requirements.
- Avoid open display except in historic house museums and some gallery settings or when an object's size makes enclosure impractical. Open display should never be a routine exhibition option or one chosen solely for financial reasons.
- Design the exhibit to avoid accidents. Provide adequate space through the exhibit and around exhibit cases for the easy movement of individuals, groups, and people in wheelchairs.
- Consolidation the location of collections with similar conservation criteria will make it easier and more economical to meet the design goals. Consider ease of installation, maintenance and object removal.

EXHIBIT TEAM

- Team members should take responsibility for understanding basic conservation issues and working with other members to achieve preservation-responsible displays.
- Use designers who are experienced in working with exhibit conservators and firms that have a history of producing preservation-responsible exhibits.
- Develop drawings and specifications that clearly articulate the intended conservation features; consider including performance criteria.

THE ROLE OF THE EXHIBIT CONSERVATOR

- Select a conservator who is qualified in the specialty of exhibit conservation.
- An exhibit conservator should be involved in the earliest stages and throughout the exhibit development by setting conservation criteria, participating in planning and designing meetings, reviewing conservation-related decisions, and assessing prototypes and exhibit work after installation.
- Examine each object chosen for display to determine its current condition and individualize its conservation requirements. Complete a written condition assessment of the objects.
- Base the requirements on an assessment of the individual objects, the likely environment in the exhibit space, and current conservation research.
- Incorporate the conservation recommendations into the exhibit design. The designer, conservator, curator, and other team members must work cooperatively to ensure practical display methods that preserve the objects.

SELECTING OBJECTS

- Make the selection in conjunction with a conservator who can establish whether the objects are stable enough to exhibit (with or without treatment) and the ramification of exhibit them.
- Review the number of objects that can be accommodated sagely within the available space.
- Object selection should include curatorial review of the visual message presented. Incomplete, deteriorated, or dirty objects may require extensive treatment.

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[1] Adapted from *Exhibit Planning*, section A:1-A:6
Raphael, Toby. *Exhibit Conservation Guidelines: Incorporating Conservation into Exhibit Planning, Design and Fabrication.* National Park Service, Division of Conservation, Harper's Ferry Center, 1999.

- Consider rotating vulnerable objects, substituting alternate objects, or using reproductions (to demonstrate the function of an object). Many artifacts can only be safely exhibited for short periods of time and require rotation every 6-12 months while on display. Costumes, textiles, paper, photographs, some plastics, fur, feathers, and artifacts made from natural plant materials are some of the artifacts that fit into this category. Whenever possible, reproductions should be made of fragile artifacts and used in place of the original for permanent exhibitions.
- Allow enough time and resources to safely prepare, mount, install, or replicate exhibit objects.

COLLECTION MANAGEMENT

- Provide training for anyone who handles an object during the exhibit process; dedicate a clean, secure space for temporary storage of objects during exhibit development, construction, and installation.
- Have a conservator document their condition and provide a treatment proposal for those that require treatment.
- An exhibit object list should include the accession or catalogue number of each object. Photographs of the objects and floor plans should also be marked with the accession number to facilitate security and condition checks.
- Limit an object's total exposure to light, and avoid overheating objects with studio lights. Use a flash system especially for light-sensitive objects.

GENERAL RULES FOR EXHIBITION OF THE ARTIFACTS AT THE CHICAGO HISTORICAL SOCIETY

- All artifacts must be exhibited in cases unless otherwise noted by conservation.
- If artifacts are ever displayed in the open, barriers must be installed to prevent the viewer from touching any artifact. Barriers should be at least three feet tall or provide adequate protection to keep viewers four feet from each artifact.
- Costume and textile material should always be displayed cases. In the open air, these materials act as filters. They trap the dust, dirt, and pollutants present in the gallery environment within their fibers.
- Original costumes, textiles, paper artifacts, and photographs should not be displayed for longer than 3-6 months. Reproductions should be made to replace originals whenever possible. The schedule for the production of reproduction artifacts and artifact rotation should be part of the initial exhibit design process.
- Routine maintenance of the galleries is required. The Collection Services Department is responsible for the maintenance of artifacts, case micro-environments, and routine condition assessments. The Exhibition and Properties Departments should handle maintenance to all non-artifact components.
- The use of carpeting in the galleries should be avoided whenever possible. Carpeting attracts and encourages dust, dirt and pests.
- Any person handling artifacts for exhibition design, conservation, installation or maintenance must attend an artifact handling session given by Collections Services before working with the collection.
- When on exhibition, all artifacts should be mounted. Designing object mounts should be a direct collaboration between the exhibit designers, mount maker and conservator.

1. TEMPERATURE AND RELATIVE HUMIDITY

Moisture moves from areas that are more humid to areas that are less humid. This movement causes wood, leather, ivory, and similar materials to swell and shrink. If the swelling and shrinking are rapid, then the material will crack. Moist areas also promote bacterial and fungal growth (mold and mildew) for many organic artifacts like wood, leather, paper, varnish, textiles, and fur and promote movement of water soluble materials like salts.

FOR EXHIBIT CASES AND GALLERY SPACES:

IDEAL TEMPERATURE: 20°C OR 68°F ± 2°

IDEAL RELATIVE HUMIDITY: 50% ± 5%

The following paragraphs provide general consequences of what humidity causes in different materials and the levels of relative humidity at which the damage is caused.

CONSTANT HIGH HUMIDITY: ABOVE 70% RH

- Mold and mildew form on surfaces of paper, parchment, leather, and organic materials.
- Changes in tension and/or expansion of dimensions of cellulose, protein and bone objects, with softening of materials making handling dangerous.
- Corrosion of ferrous metals and of copper alloys.
- Movement of salts within stone and ceramic materials; development of opacity in old glass.
- Condensation on surfaces with resultant water damage when ambient temperature drops below the dew point.

CONSTANT LOW HUMIDITY: BELOW 35% RH

- Desiccation and embrittlement of cellulose, protein, and bone objects causing shrinkage and changes in tension, and an increased difficulty in handling.
- Shrinkage and warping of wood and wooden structures, causing cracking and splitting.
- Movement of salts within porous objects.
- Drying out of adhesive and support layers.

VARIATION IN HUMIDITY

- Rapid variations between low and high RH values are irreversibly damaging and can cause stress and structural damage to artifacts. Seasonal slow drifts are less harmful to structures than abrupt changes, but can be harmful if the range of RH in the seasonal drift is outside the acceptable parameters for an individual object (see Table 1).
- The expansion and contraction of humidity sensitive materials can result in warping, cleavage, splitting, loss of layers of support, and design elements.
- The movement of salts within inorganic objects like stone, plaster, or ceramic can cause disruptions to structures and surface decoration.
- Periodic condensation and moisture formations that occur at dew-point temperature will result in water staining, rusting, solubility problems, corrosion, and possible recrystalization when the condensation dries.
- Use sealed cases where appropriate to slow air exchange and thus stabilize environments inside cases. When called for, create a microclimate by incorporating. In general, keep temperature between 60 and 70

°F (15.5 and 21 °C) and relative humidity between 40-60%. Use silica gel or other climate control products within cases that contain moisture-sensitive materials.

- Do not place moisture-sensitive collections in the path of direct sunlight, near heating or air-conducting ducts, against external walls, or in damp locations such as basements. Avoid putting cases and framed works along exterior walls.

TABLE 1: RECOMMENDED RH LEVELS FOR COLLECTIONS AT NORMAL TEMPERATURES

OBJECT TYPE	% RH	REASON
ARCHAEOLOGICAL SPECIMEN	40-60%	For humidity-sensitive items like wood, leather, fiber, or carbonized material.
ARCHAEOLOGICAL SPECIMEN	20-30%	Lower RH necessary if corrosive products or salts are active for stone, ceramics, metallic.
ARMS, ARMOR, METAL	15-40%	In general metals prefer a lower RH. Polished metals, for example, brasses and bronzes will tarnish at 15% or above. Note: wood components on metal artifacts require a higher RH.
ETHNOGRAPHIC BARK CLOTH, BASKETRY, MANILA, SISAL, MASKS, FEATHERS, LEATHER	40-60%	According to specific reactivity.
CERAMIC, TILE, STONE, PLASTER	20-60%	Depending on embedded salts present. Susceptible freeze/thaw damage.
COINS, NUMISMATIC COLLECTIONS	15-40%	Depending on corrosion products oxides and patina formations, and their degree of stability
COSTUMES, TEXTILES, RUGS, TAPESTRIES	30-50%	Silk and wool are more sensitive to moisture damage than cotton or linen. Painted textiles are most sensitive to RH changes. Synthetic fabrics are less reactive, but exhibit electrostatic properties at low RH values, and readily accumulate dust.
FURNITURE	40-60%	Depending essentially on wood content, grain, joining, and condition of surface or barrier coating; especially affected by seasonal RH drifts or cycles. Some woods are less sensitive than others owing to resin content or construction.
GLASS	40-60%	Crizzled or unstable glass requires a low RH, 40%, to prevent advance of this condition. For stable glass, up to 60% RH.
LEATHER, SKINS, BINDINGS	40-60%	Variable according to tanning process.
PARCHMENT, VELLUM	55-60%	Narrow control required because of great hygroscopicity.
PAPER	40-55%	NOTE: some authorities recommend less.
STRETCHED PAPER	45-55%	Paper screens, oriental screens, drawings on stretched frames need narrow RH control.
PHOTOGRAPHS, FILMS (CINE, AUDIO, AND VIDEO MATERIALS)	30-45%	All photo materials are very sensitive to high humidity and are responsive to moisture. RH control and monitoring is required.
PAINTINGS ON CANVAS	40-55%	Unlined paintings or paintings lined with hygroscopic adhesives are more reactive than those lined with wax or synthetic materials.

PAINTING ON WOOD, POLYCHROME SCULPTURES	45-60%	Depending on thickness, wood grain, ground, and method of joining sections. Some panel paintings need narrow RH levels to minimize warping. Massive wooden sculptures are particularly susceptible to seasonal drifts.
PAINTED, VARNISHED WOOD, VARIOUS	45-60%	In this category are musical instruments, models, and decorative objects having painted and coated wood as the principal components.
PLASTIC MATERIALS	30-50%	In general, plastic materials have a slight humidity response, but do warp when in thin sheets and exposed to varying conditions. Electrostatic properties at low RH levels with dust accumulations.

In a microenvironment, like a case or vitrine, it is more crucial to maintain a constant temperature and relative humidity. When cased, objects have a close relationship with their environment. If the environment is not carefully monitored the objects can be severely effected in a short amount of time. Although a sealed environment may have a constant RH, heat from interior and exterior light sources will cause the temperature to fluctuate and alter the relative humidity. If possible, cases need to be lit and stabilized with regard to RH and temperature prior to object installation.

ENVIROMENTAL CONTROL/ PREVENTION METHODS

- A heating, ventilation, and air-conditioning (HVAC) system for all gallery space.
- Building fans inside exhibit cases when air circulation is required (or when cases are lit from the interior).
- Block out light from all natural light sources and following guidelines for interior light sources (Section _?)
- Keep light sources as far away from artifacts as possible.
- Create a buffered environment to slow the rate of change using a substance that can act as an energy and moisture reserve. As heat emitted from a light source occurs, the buffer absorbs energy and release moisture. In addition, as the temperature lowers, the buffer releases energy and absorbs humidity. The buffering method works in most instances except when the object casing is made of metal. The ratio of case volume to object should be 5:1 preferably for the buffer to work efficiently. Some of the substances, hydrophilic, that can act as buffers are:
    - Silica gel is a chemically inert substance with drying properties. It can be bought preset to a specified relative humidity in granular form, packets, or as compressed tiles. It can stabilize a case environment for a large range of RH, 20-60%. Silica gel also acts a buffer when used in cases to prevent cases from fluctuating rapidly with the surrounding gallery environment.
    - ArtSorb® is a similar silicate material that can be conditioned either in cassettes or loose in moisture permeable sacks. It comes in bead form and can be conditioned to stabilize a case environment from at least 40-60%RH.

  NOTE: any buffered environment requires routine monitoring and maintenance. These issues should be discussed if a buffered environment is required for long-term exhibition.

MONITORING DEVICES

- **Thermohygrometer** is an instrument that measures both temperature and relative humidity by electronic means. It is useful because of its small size; however, it does not have the ability to record changes, thus, the readings are at the time of observation.
- **Recording hygrothermograph** also measures both the temperature and relative humidity and its advantage is that it records continuously over days and weeks although its large size prevents it from being inside the vitrine with the object. If a recording hygrothermograph is chosen, it should be placed in the same conditions as the objects and at the same height because temperature and humidity levels vary widely throughout a vertical space.

- **Data Loggers** are small digital hygrothermographs with microchip recording capabilities. When hooked up to a computer, data loggers allow you to download thousands of different environmental readings from a remote location. Their small size makes it possible to place them inside a sealed case. Some data loggers gather light readings in addition to RH and temperature. Dataloggers are used routinely at CHS to monitor general gallery conditions.
- **Psychrometer** measures temperature and relative humidity in such a way as to give instantaneous readings, but it is used basically to calibrate the thermohygrometer and the psychrometer.

2. LIGHT

Light is required to illuminate exhibitions, but it is damaging to most museum artifacts. The effect of light on different materials should be understood so informed exhibition lighting practices may be implemented, and inevitable damage minimized.

The Nature of Light

Light is the visible portion of the electromagnetic spectrum. It behaves both like particles or "bullets" of energy *(photons),* and like waves *(wavelengths)* of different frequencies and colors. *Frequency* relates to the distance between measured peaks of waves. Shorter, (high frequency) wavelengths ( ) are associated with high-energy violet/blue radiation (Ultraviolet light or UV). It makes up 50% of Daylight and is also present in artificial light from fluorescent and halogen sources. UV is very damaging to artifacts and must be eliminated from museum exhibitions.

At the opposite end of the visible spectrum are long wavelengths of low-frequency, red radiation (Infrared or IR) ( ). These waves damage artifacts by heating them and causing "vaporization" of water from materials such as wood, paper, and basketry. Materials become increasingly de-hydrated and altered in appearance and structure. Incandescent lamps emit varying amounts of infrared radiation. They should be positioned sufficient distance from museum artifacts to prevent damage from heating.

Photochemical Deterioration

Photodegradation in materials is a complex process based on the absorption of radiant energy. When molecules absorb a photon, energy supplied activates them to react in ways that lead to photochemical change. Some molecules are more susceptible to absorption than others. Absorption makes a molecule react more readily with oxygen and water vapor, or respond to increased temperature. Peroxide may be the product of such a chemical change in paper. Oxygen is necessary for most light damage to occur.

- Decreasing the intensity of light will decrease the *rate* of photochemical damage, but will not completely prevent damage.

- Photochemical damage is proportional to the total length of display and intensity of illumination. In other words, exposure for one month at 50 footcandles is the same as display for 10 months at 5 footcandles.

- When considering potential photochemical damage, intensity of illumination *perpendicular* to the surface of the artifact is most important. (Stolow) Lamps positioned high overhead have a more limited effect on paintings displayed on walls below because of distance and angle of illumination. In galleries with lower than usual ceilings, track lighting is very close to artifacts. The lamps radiate heat and more intense, direct light energy.

- High energy UV will readily alter materials on a molecular level. Molecules are irreversibly altered by chemical changes fueled by radiant energy. Chains of molecules ruptured by chemical reactions cannot be re-joined. Neither can brittle fragments of paper be satisfactorily reattached one to another.

Damage to Materials

Damage from light is permanent and irreversible. Natural organic materials are among the most sensitive to light. Paper and textiles may be the most easily damaged because of their thin, planar arrangements of molecules and fibers. Light damage is generally limited to the surface of an artifact, to a specific depth (seen in faded pigments). Paper and textiles are all surface. Stone, ceramic and metal are hardly affected by exposure to light if they are unpainted, but UV affects clear, protective coatings on artifacts made of these materials.

- Colorless materials such as coatings, films, oils in inks and pigments, varnishes, and even photographic binders like gelatin and Albumen absorb little visible light, but they are significantly affected by UV.

- High efficiency incandescent lamps emit little UV, but radiate considerable heat. Lamps should be dimmed or filtered, and positioned a sufficient distance from artifacts to reduce intensity of light and heat exposure.

- Chemical changes in materials from exposure to radiant energy are fueled by elevated temperature and humidity in the environment.

Measurement of Light

1 Lumen = 1 Footcandle = 10 Lux

Light is measured in foc about 10 lux. The human eye loses its ability to distinguish color at a level of 5 footcandles. The most sensitive materials, ink drawings, watercolors, 19th c. photographs and textiles, are typically displayed at 5-10 footcandles. The light meter does not differentiate between UV and Infrared light, but reads light much as the human eye does.

Visible light is measured with a lux or light meter. A protected, sensitive surface called a photocell is connected electrically to the meter. When measuring light levels, the photocell should be held near the artifact and parallel to the surface. The photocell should face the light source just as the artifact does.

A UV monitor is used to measure the ultraviolet component of light. Every attempt should be made to eliminate UV from exhibitions because it is even more damaging to materials than visible light. Neither fluorescent light nor daylight shall be used to illuminate galleries, but they are used in other areas where collections are stored, and used by researchers and staff. Readings for UV in tungsten bulbs are in the range of 60-80 microwatts per footcandle. In contrast, direct sun carries 400 microwatts, fluorescent lamps 40-250 microwatts, and blue sky 1600 microwatts per footcandle. Most tungsten lamps do not require UV filters, but any reading exceeding 75 microwatts should be filtered.

Recommended Light Levels for Materials

50–100 Lux *(5-10 footcandles)*	200 Lux *(20 footcandles)*	300 Lux *(30 footcandles)*
Dyed and treated organic materials	Undyed & untreated organic materials	Metal (without active corrosion)
All textiles	Undyed leather	Stone (unless salts are present)
Watercolors, ink drawings	Finished wood surfaces	Ceramics (unless salts are present)
Prints, manuscripts	Painted inorganic materials	Glass (applies only to stable glass)
19th c. photographs (salted, albumen prints)	Unstable metal, stone, ceramics, & glass (see a conservator for advice)	
Dyed leather	Oil and tempera paintings	
Natural history specimens		
Fur, feathers		
Artifacts made of mixed materials		

- Viewers more easily accommodate lowered light levels if they don't have to make a sudden adjustment from areas of higher illumination in the museum. Visitors understand and accept the need to protect irreplaceable collections.

- Plan a display around the most sensitive artifacts. Lighting should be considered early in the design process to allow for special measures to limit exposure, and optimally illuminate artifacts.

- Painting walls a darker color behind sensitive, framed artifacts gives the impression that light levels are higher than they actually are.

Time Limits for Exposure

- Preservation, not deception is the goal. A rigorous effort to protect original documents should be made by replacing them with quality digital reproductions, and costumes with fabricated reproductions after display of a specific duration. Visitors understand and accept the need to protect irreplaceable collections. (Perkinson)

- Resting an artifact between periods of exhibition will not undo damage done. **The effect of exposure to light is cumulative!**

- Keep ongoing records of exposure time for important, sensitive artifacts.

Control of Exposure

Since any amount of exposure of museum artifacts to radiant energy will result in progressive damage, it is necessary to limit the length of display and intensity of the light. Consideration should be given to the distance of lamp to artifact and the angle of illumination.

- An aging population with lowered visual acuity raises the demands on exhibition designers to illuminate artifacts sufficiently for viewing, and still protect them from photochemical damage.

- Sensitive objects should not be on continuous display. They should be returned to storage, and a facsimile or reproduction should take the place of the original on display.

- Especially for extended-term exhibitions, install visitor-activated dimmers or timing devices to limit exposure to the time when artifacts are actually being viewed.

- Particularly sensitive artifacts or materials may be individually covered with a cloth, curtain or other device to provide an extra measure of protection. For example, early salted print photographs with unprotected, filamentary silver particles and paper fibers are readily faded and require .

- Every conceivable method of controlling light and heat striking the surface of an artifact should be examined. Use UV-filtering Plexiglas on cases, and cover particularly sensitive paper documents with Mylar which also filters some light.

- Titanium Dioxide and Zinc White pigments and paints are UV light-absorbers. They will reflect light and illuminate a space, but *do not* reflect UV. They can be applied to walls and ceilings to absorb UV where fluorescent lighting is in use to protect collections from additional exposure. *(research center, collections areas)*

Lighting for Cases

Lighting fixtures must be located outside the interior display area of a case, isolated by a sealed pane made preferably from heat-reflecting glass and double-glazing so heat build-up from lamp ballasts does not accumulate in the display area.

Fiber optic lighting is an option for specific point lighting, and ideal for directional illumination for Daguerreotype displays.

- Reducing light levels outside the enclosure minimizes reflections of viewers and surroundings. Do not place internally lit cases opposite one another.

- Non-reflecting glass is an option when cost is not a strong consideration. A specially coated glass, not common non-glare glass.

- When lighting is within a case, heat build-up from incandescent lamps and transformers in fluorescent systems can raise temperatures of exhibited materials, and air temperature, thus changing the RH in the case. Pressure differentials created elevated temperatures cause air to be sucked into case as it cools during non-lit hours.

Tips on Planning for Case Lighting

- Produce the plan early in the process to allow enough time for coordination of the complex issues that determine final lighting choices and levels. Create a technical plan, which identifies the best-suited light source, fixtures, lamps, light modifying and heat reducing equipment.

- Provide separate lighting for security checks, exhibit cleaning and maintenance, object installation, and other routine work. Turn off lights during nonpublic hours so as not to expose objects to light unnecessarily. When possible, use occupancy sensors in the room or at the case to turn lighting on and off during visitation hours.

- Use commercially available filters on all light sources to reduce the levels of ultraviolet radiation to 10 microwatts per lumen.

- Locate objects at least 24 inches from fluorescent lights and at least 36 inches from incandescent or tungsten halogens lights. Place all lighting fixtures outside the display area of a case. Contain any lights that are integral to the case in a separate compartment. Seal off the lighting chamber to prevent the entry of insects, heat, and dust into the display chamber.

- Design exhibit spaces to prevent daylight from reaching display objects. Daylight already present in the exhibit space should be filtered for UV radiation and lowered in intensity.

- Construct lighting mockups to evaluate the amount and quality of light provided by the proposed lighting plan. Measure final light levels and adjust them accordingly during installation.

- Ventilate the lighting chamber to dissipate heat from fixtures and lamps. In larger cases or cases located in enclosed spaces, electric fans may be required. Heat gain inside the display chamber should be no more than 2°F when lights are turned on.

- Consider heat-reflecting glass or double-glazed construction for panels that separate the lighting and display chambers. To help prevent heat buildup, insulate lighting compartments below the display area and use a non-insulating material such as metal products to construct light attic chambers.

Track Lighting

The position of the track is important to avoid glare, unwanted reflections, and emphasis on surface features of an object. The light beam should be at an angle of 60° to the horizontal. The distance between light fixture and wall depends on ceiling height. The most flexibility is offered by a double track system where tracks are 60cm – 90cm apart, or a single track with short sections perpendicular to the main track. (CCI notes 2/3)

3. BIOLOGICAL ORGANISMS

Museum collections are at high risk from attack by a variety of biological organisms. By the time an infestation is discovered, it is firmly established, and damage has already occurred. There are simple ways these organisms can be kept from gaining access to the museum and artifacts.

TYPES OF ORGANISMS

INSECTS

Bugs are attracted to specific material food sources, and are therefore indicators of conditions in the environment that may need to be corrected.

Moisture-Seeking Insects: Psocids (booklice), Fungus Beetles, Silverfish, Mealy Bugs, Springtails, Cockroaches.

While these insects (excluding Silverfish and Roaches) are seldom harmful to collections, their presence is an indication of excessive humidity or moisture in the environment that could lead to more serious consequences such as mold growth on artifacts or structural surfaces. The insects can be an annnoyance as they seek mold spores in books and inside frames on gallery walls. Roaches and Silverfish are attracted to starches in papers. They are capable of inflicting significant damage on papers and other cellulosic materials. Roaches are also attracted to food.

Wood-Boring Insects: Furniture Beetle, Powderpost Beetle, Larder Beetle, Drugstore Beetle, Termites.

These beetles may be found in both old and new material. Their presence is detected when exit holes and powdery frass (waste resembling ground wood) is found beneath an object. When beetles exit the wood they can infiltrate other collection items, even those made from other materials.

Fabric, Plant and Grain Pests: Webbing and Casemaking Clothes Moths, Carpet Beetles, Odd Beetles.

Larvae of these insects are voracious eaters, attracted to a variety of proteinaceous materials such as feathers, fur, hair, wool, spices/medicine in collections, and even other insects. They are detected when adult stages seek light, and mates. Infestation can go unnoticed if collections are not periodically inspected.

BIRDS AND MAMMALS

Rats, Mice and Pigeons

These pests are a double hazard to museum collections. They are capable of direct damage to collections by ingestion. Their carcasses, should they die in traps, between walls, or on the exterior of the building, attract insects that easily infiltrate the building to find a varied, and readily-available food source.

MOLD & MILDEW

There are many types of mold. They too are specific to a substrate, or material food source. Some molds are toxic and may cause serious respiratory ailments and sensitivity. Mold spores are everywhere, and remain viable or capable of generation, under high humidity conditions, even after many years of dormancy. Particularly toxic molds often occur in walls and ceilings from chronic leaks. All serious, active mold infestations in the museum environment or in collections should be identified by a specialist to determine potential health hazards involved in cleaning up.

PREVENTION

- Housekeeping is key to preventing infestations. Even accumulations of dust consisting of textile fibers and hair under storage furniture or at baseboards attracts harmful bugs. Large dead insects left lying attract other bugs. Vacuuming is the preferred method of cleaning to eliminate insect pests.

- Food and beverage wastes, wrappers, and containers should not be left near collections. They should be carefully disposed of, and surfaces used for food thoroughly cleaned.

- Protect susceptible collections on display and in storage with gasketing in display cases, and plastic wrapping when hazardous insects are a known or potential threat.

- Maintain conditions in the museum that do not foster development of mold, below 70% RH (lower is better) since fungal growth can occur in some environments on some materials even at lower levels.

- Do not use wool carpets and other materials that attract and harbor insects. Avoid using organic exhibit props. Fumigate any organic props or expose them to freezing temperatures before bringing them into the museum.

- Avoid introducing suspect materials into exhibitions (untreated woods, sand, plants) to enhance a design concept. They may harbor insects and place collections at risk.

- Establish a regular gallery maintenance program to keep exhibitions presentable for the public, and to keep dust from accumulating and posing a biological threat to susceptible artifacts on display.

MONITERING

- Place sticky traps in designated areas. Inspect and replace them regularly, and keep a record of insects trapped. It will become obvious when an area needs vacuuming.

- Routinely monitor susceptible artifacts on display, looking for telltale signs of infestation: frass, webbing, insect casings or loss.

- Be sensitive to environmental changes: high RH, odor of mold, water-staining, puddles of water, or increased presence of insects in certain locations. Report incidents or suspected problems immediately.

ELIMINATION

- Consult a specialist if a significant infestation or outbreak is discovered. Mold or insect types should be identified to learn what food sources, collections or materials may be affected, and whether they pose a health hazard to staff. A specialist may also recommend a procedure for clean-up.

- In the museum environment, non-chemical means should be used whenever possible to eliminate infestations. Artifacts can be vacuumed and frozen. Storage areas should be vacuumed and disinfected. Always use a vacuum with a HEPA filter. Wrap vacuum bags and discard after use. When cleaning up a mold infestation, always wear face masks to prevent inhalation of irritating or harmful mold spores. Even more elaborate protection may be required if an infestation includes toxic molds.

- Keep records of insects trapped and removed from artifacts, the methods and practices used to eliminate them, and note problem areas that require regular monitoring.

4. SECURITY

EXHIBIT CASE DESIGN

When designing exhibition cases please remember the following:

- **Artifacts must be exhibited in closed, locked and/or alarmed cases for protection from theft, handling, dust, environmental pollutants and pests.** Under extenuating circumstances, permission may be given to display objects in the open; however, this should only be done after discussion with a conservator.
- **It is crucial that safe, high quality materials are used in the design and production to ensure the long-term preservation of museums collections** (see Table 2).
- **Mount all objects to panels or shelves, bolt freestanding cases to the floor, and lock exhibit cases.** Each artifact should be readily removable without removing or disturbing artifacts.
- **The design and security offered by the cases should also allow access to the artifacts without difficulty.** Preferably and to the fullest extent possible, exhibit cases should be designed to allow be opened, serviced and closed safely by only one individual. Cases will need to be opened for various reasons: cleaning, replacement of biocides and moisture absorbers, curatorial inspection and maintenance of the objects, and emergencies. Each object in an exhibit should be readily accessible without major disruption to the other objects. Legitimate opening should be facilitated to the fullest extent possible without unduly compromising security.
- **Case vitrines should be removable by a single person whenever possible.** 30 " x 30" x 30" is generally considered the largest vitrine safe for removal by a single person. No vitrine should ever exceed 48" in any direction. Special requirements for larger vitrines should be discussed with conservation. **Mannequin cases require front or side entry access. No vitrine should ever be lifted over the head of a dressed mannequin.**
- To guarantee better protection for the displayed artifacts, especially from human-caused damage, all exterior screws on cases should be concealed. The use of security devices such as tamper-resistant hardware is recommended, particularly hardware made from alloy steel rather than carbon steel-since alloy steel is more deterrent against drilling, cutting, and hammering. Tamper-resistant hardware and fasteners provided high security when surveillance by museum staff is poor or is not afforded because these devices make disassembly difficult or too time-consuming without specialized equipment. Tamper-resistant screws and bolts together with keyed lock systems should be mainly used for case entry doors, light chamber access panels and climate control access panels.
- Where necessary, electronic sensors should be installed.

EXHIBIT SECURITY OPTIONS

Security features should be tailored to fit the requirements for each artifact on display. The following physical security options have been adapted from T. Raphael's *Exhibit Conservation Guidelines, 1999*. All permanent exhibitions should provide at least Level 2 security features.

Level 1	Level 2	Level 3	Level 4
No special security *Sample features:* Infrequent staff presence, visible barriers (stanchion, cases, Plexiglas), no visitor entry control	**Minimal security** *Sample features:* Conventional construction materials, tamper resistant screws & fasteners or locks, periodic presence of trained staff	**Moderate security** *Sample features:* Better construction materials, concealed screws, tamper resistant fasteners, locks, and low level alarms, full-time trained staff, limited visitor entry control	**High security** *Sample features:* Level 3 plus highest rated materials, high level locks, sensors, and alarms tied to central dispatch

DURING INSTALLATION

- **Gallery spaces must be completed prior to object installation.** This includes cleaning of the flooring and case materials.
- **Once objects are moved into a gallery space, the doors to that space must be locked** until objects are secured in exhibit cases. Required personnel should be given access to these spaces. When an entry area can not be locked, a security guard should be present and should monitor access to the exhibition space.
- **When exhibit cases are opened, the gallery must be secured from visitors.** A staff person from Exhibitions and Collections Services should both be present to open exhibit cases. The work area must be closed off from the public. If necessary, a security guard should also be present.

5. REACTIVITY OF MATERIALS

The reactivity of materials depends on their inherent composition and the environment in which they will be displayed. When choosing materials to be used in exhibition or storage, it is important to select materials that will remain stable and will not interact chemically with artifacts. There are two primary pathways in which artifacts are damaged by chemical reactivity, migration and emission.

- **Migration can occur either by direct contact or by diffusion of volatile gases.** For example, vulcanized rubber will penetrate several sheets of paper when in contact for several months. Plastic containing high percentages of plasticizers, such as PVC, will move to surrounding objects as a liquid. Acidic packing or mount material will transfer acid to paper artifacts through direct contact and galvanic corrosion (migration of ions) may occur if two different metals are in contact.

- **Emissions from volatile compounds can harm artifacts as a vapor.** Typical volatile compounds include sulfur, acid vapor, alkaline vapor (ammonia), aldehydes (mainly formaldehyde and acetaldehyde) and peroxides. The damaging effects of these chemicals are both qualitative and quantitative. Some artifacts will be harmed immediately damage will be apparent in a short period of time (like silver tarnish in the presence of sulfur), while others may undergo invisible but detrimental chemical changes that, in time, will catalyze degradation (acid hydrolysis of organic material in the presence of acid). Certain materials are known to be extremely corrosive. These include formic acid released by alkyd paints and acetic acid emitted by certain types of silicon sealant, some epoxy paints or adhesives, polyurethane foams and some polyurethane paints.

PREVENTION

Avoiding harmful materials is an essential part of exhibit design and conservation. Many materials have already been identified in terms of their chemical stability. These materials have been listed in **Table 2** under three categories: most stable, less stable, and unsuitable. **Materials in the unsuitable category should not be used for display cases or exhibit environments at any time.** For all permanent exhibitions, case materials should fall in the most stable category. Materials in the less stable category may be acceptable depending on the artifact displayed, consult with conservation. Information about chemical makeup and possible byproducts can be obtained from the product label or from the Materials Safety Data Sheet (MSDS) obtained from the manufacturer. If question arise regarding the safety of a material that it not listed below, contact a conservator. **Conservation can test materials to determine their relative reactivity. Please allow six weeks for materials testing by conservation. Testing will require a sample of the material (usually a 5" x 5" section is plenty) and all technical and/ or manufacturing data available on the product.** For more technical information on volatile emissions see Table 3.

Controlling the emission of volatile compounds in an environment can be achieved as follows:

- Avoid any materials that emit high concentrations and highly volatile (see Table 2)
- Use vapor barriers to reduce or block the concentration and migration of harmful materials. Wood products, even when coated, must not come into direct contact with objects. Physically isolate objects with safe fabric coverings, acid-free paper or board, foil, or an acceptable plastic barrier such as polyester or polyethylene sheeting.

    - Paint film on wood will reduce emission of acids in wood by 60-80%, Note: paints chosen need to be chemically stable and requires a three to four week curing period before installation.
    - Polyester film (Mylar-D) is often used as an isolating barrier because of its impermeability to water, oxygen and carbon dioxide. (Note: a plastic film, like any other isolating materials, does not stop the transfer of harmful compounds; it only reduces the rate of transfer).

- Sheets of plastic laminated aluminum applied on material surfaces with a hot iron: like polyethylene/aluminum foil/nylon (Marvelseal) or polypropylene (Marvelguard).
- High-pressure laminates (Formica, Micarta) can also function as an effective barrier.
- Sealants: epoxy (certain 100% solid, two part coatings) or moisture cured polyurethane.

- Aerate the exhibition spaces before object installation. Allow time for initial levels of off-gassing from new materials to dissipate.
- Use low power fans in large exhibit cases. Note: although adequate air circulation will lower total pollutant concentrations; high rates of airflow over or near objects increases their exposure.
- Design the exhibit layout to minimize the objects' exposure to pollutants.
- Reduce the relative humidity. The rate of tarnishing in silver, for example, is highly increased by the presence of moisture; so decreasing the relative humidity (see section 1) is more effectively than decreasing the concentration of hydrogen sulfide.
- Reduce the temperature since chemical reactions proceed more rapidly under high temperatures. An increase in temperature not only modifies the emission rate but also increases the rate of diffusion from materials and the rate of hydrolysis.
- Reduce the period of exposure, especially if there are high amounts of volatile compounds in a small, closed system.
- Use high-efficiency filters in environmental systems for rooms housing exhibits. HVAC filters should remove particles down to 1-0.3 microns (60-80%); and change filters frequently.
- Incorporate air filters in ventilated case designs or seal exhibit enclosures sufficiently to prevent particulate entry.
- Use scavenger substance (e.g. microchamber paper, activated charcoal, porous and fibrous materials, calcium carbonate impregnated in cardboard, Silver cloth, Zeolite papers). To optimize the lifetime of scavengers the air exchange rate must be low, and the concentration of the compound and its rate of emission must be very low. For susceptible collections or in highly polluted locations, include activated charcoal or potassium permanganate filters in the environmental system. **Cases that incorporate a chemical pollutant scavenger provide a high level of protection for sensitive objects.**
- Remove the oxygen from the case environment. High concentrations of oxygen, although more difficult to remove, can be achieved using hermetically sealed cases under inert gas or by using oxygen absorbers such as iron oxide compounds (e.g. Ageless) in a closed system. In this system, the case needs to be constructed and tested prior to use with artifacts.

6. EXHIBIT CASE DESIGN

Designing a Conservation-Grade Case

- Take advantage of a well-designed case to control the microenvironment of sensitive collections. A case designed with the participation of an exhibit conservator is an efficient and often cost-effective way to meet conservation criteria for an object.
- Determine what conservation features will be built into each case, and clearly identify performance criteria for each feature. Design the case to provide this performance.
- When possible, build and test a prototype case to decide whether it meets design objectives. Modify the case until acceptable performance is achieved.
- Inspect cases during fabrication to ensure that the fabricators stick to specifications and construction tolerances.
- Test the fully assembled case in its final location to ensure that conservation criteria have been met. Such testing should occur before object installation to allow for adjustments.

Case Stability, Security, and Access

- Limit vibration by using movement-dampening devices. When floor or wall attachment is not possible, include space for a weight ballast to prevent jarring and tipping.
- Choose from security options to include the level of protection that the design team considers prudent. The case strength, resistance, and security devices should match the projected threat from vandalism and theft.
- Incorporate doors or other practical access options in the case design. Ensure that a single person can enter the case and remove artifacts with ease and in a short amount of time.

Sealed Exhibit Cases

- Determine which objects, if any, require protective microenvironments, and design cases accordingly. Design cases to avoid the risks presented from interior contaminates and from condensation due to exterior temperature change.
- Choose construction materials that limit air exchange and, for climate-controlled case designs, are not moisture-permeable. Well-sealed cases should allow no more than one complete air exchange every 72 hours.
- Minimize leaks with adequate gaskets and caulk. Always choose non-hazardous materials.
- When possible, use leak detection equipment to identify air leaks ad determine air exchange rates. Modify the case design or add caulk and gaskets to reduce leakage.

Ventilated Exhibit Cases

- Select vented cases fro use in an exhibit space with a good climate-control and pollutant-control system that functions 24 hours a day.
- Design well-sealed cases, and place an adequate number of vents to provide for air movement. Filter the vents to prevent dust, insects, and chemical pollutants from being drawn into the case.

Humidity-Control Principles

- Use moisture impermeable construction materials.
- If the environmental maintenance chamber is located beneath the objects use a perforated deck or a floating deck with a sufficient perimeter gap to avoid impeding the air from circulating throughout the display.
- Access panels to the environmental controlling equipment should be as small as feasible and tightly sealed with gasket materials. Large cases may require numerous point of access.

- Ensure that the humidity inside the case meets the conservation criteria, even when exterior conditions are at projected extremes.
- Monitor the interior relative humidity for the duration of the exhibit.

Active and Passive Humidity-Control

- Stabilizing the humidity inside a case is usually sufficient unless objects require a highly restrictive or specific RH range.
- When using a passive system, design the case to include a holding area for the moisture-absorber medium with easy access for maintenance.
- Locate equipment in a maintenance area that does not transfer hear or vibration to the objects. Provide a constant power supply (including emergency generators), a monitoring alarm to alert staff to equipment malfunction, and adequate water supply, and drain lines.
- Carefully calculate the type and quantity of silica gel or cellulosic materials to be used. The better the case seal the less absorber is required; the more surface area of absorber exposed the faster its responsiveness.
- Evaluate the initial performance of active or passive systems before enclosing objects. Monitor the relative humidity for the duration of the exhibit to alert staff when maintenance is required.

Pollution-Control Systems

- Incorporate enough absorber to remove pollutants for six months to one year. Objects must never touch a chemical absorber.
- Case design should encourage passive air movement across the surface of the pollutant absorber. Ensure that the case is well-sealed.
- A small access port can serve both moisture and pollutant absorbers.
- Renewal of activated charcoal is critical to prevent secondary outgassing. To ensure continual filtration, both activated charcoal and potassium permanganate must be replaced when exhausted.

5. CASE RETROFITTING

Retrofitting is important in some museums because their old exhibit cases fail to meet museum standards for collection preservation and conservation. Because the resources needed to build new exhibit cases with appropriate conservation standards are limited, the rehabilitate of existing cases becomes a viable option. To ensure that conservation criteria are met, a conservator should supervise retrofitting. Once the deficiencies have been identified, a retrofit plan can be devised using a combination of solutions adhering to the materials guidelines and safety as if a new exhibit case were being built.

DOES YOUR EXHIBIT CASE HAVE ANY OF THE FOLLOWING DEFICIENCIES? IF SO, RETROFIITING MAY BE REQUIRED[2].

PRESERVATION FUNCTION	
Case Construction Materials	•Harmful construction materials or unsealed wood products (e.g. plywood, chip board), oil-based paints
	•Unstable interior decorative fabric/materials-acidic paper, wool fabric, cork, cardboard
Amount of Case Seal	•Large gaps in cases allow for ingress of dust and pollutants, fail to buffer objects from harmful RH fluctuations, fail to protect objects from water and smoke in case of flooding/building system failures
Lighting	•Interior lamps generate heat, create excessive light levels, are difficult to access for maintenance
	•Light not filtered for UV radiation
Security	•Locks and closure devices absent or inadequate
	•Construction does not utilize tamper-resistant material (tamper-proof locks/screws)
	•Non-safety glass makes it a hazard for objects and the public
Access to Objects	•Rear doors: awkward for installation of objects, object inspections and rotation, routine interior case maintenance
EXHIBIT FUNCTION	
Case Design	•Fixed shelving: makes it difficult to mount objects at different levels, inefficient use of space
	•Limited locations for graphics and text panels
	•Inability to change backgrounds and backboards
	•Uncomfortable viewing height
Exhibit Lighting	•Interior lighting fixtures are visible and produce visitor glare
	•Lighting is uneven with upper regions overlit
	•Shadows are cast over lower objects and label copy
	•Lighting is diffuse without highlighting and point sources

Chart adapted from Bosworth, Jennifer. *Retrofitting Old Exhibit Cases: A Search for Economical and Safe Cabinetry,* The Exhibitionist. The National Association for Museum Education, Vol. 20, No. 2, Fall 2001.

[2] Table taken from:
Bosworth, Jennifer. "Retrofitting Old Exhibit Cases: A Search for Economical and Safe Cabinetry." Rounds, Jay, ed. and Toby Raphael._*The Exhibitionist*_. National Association for Museum Education. Vol. 20, No. 2, Fall 2001.

8. MOUNTING[3]

The creation of secure and stable mounts plays a key role in the protection of many fragile and flexible objects, and is an essential means of preserving collections both on exhibit and in storage. Mounts for display present additional challenges. They need to support the object, be made from safe and appropriate materials, and be unobtrusive. Mount making should be thought of as an art form in and of itself. A good mount maker is a skilled art handler and is sensitive to the weaknesses inherent to each object mounted, in addition to be artisans who create supports for objects that virtually disappear from view, yet secure each artifact fully.

Museum artifacts may be particularly vulnerable over time do to their inherent deterioration, therefore, a mount maker must consider the effects of stress and strain on and object over time and what effect that might have on the safety of the artifact throughout the life of the exhibition. To quickly explain some key terms, **stress** is the force applied to an object while **strain** is the physical change in shape of an object under stress. Stresses as normal to us as the force of gravity can cause **elastic deformation**, where an object returns to its original shape, **plastic deformation**, where the deformity is permanently set, or **creep**, a gradual deformation over time.

In summary, objects require support for three reasons:

- The object is weak, fragile or deteriorated
- The object may be damaged when handled
- The object needs to appear a certain way for exhibition

Table 4: Overview of Elements to Consider when Creating a Mount for an Object[4]

Materials	Design	Securing Ties or Tabs
Strong enough to support weigh of object	Object balanced on mount using its center of gravity	Monofilament, fasteners, or other mechanical means prevent object from toppling off mount
Stable or compatible with those of object	Not in conflict with the objects original intended position	Not too tight
Padded where in contact with objects	Compatible with display height and angle in display case or area	Padded
No sharp edges	Points of contact correctly placed and of sufficient area	Non-abrasive
Non-abrasive	Long-term effects such as droop or sag prevented	No permanently attached so object can be easily removed when necessary
Colorfast	Effects of vibrations dampened	Unobtrusive
Economical and durable	Object can be easily removed from mount when necessary	
Unobtrusive	Weight of object supported by mechanical joins rather than adhesive joins	
	Reasonable fabrication time	
	Unobtrusive	

[3]Much of the information from this section was adapted from Barclay, R., Bergeron, A., and Dignard, C. *Mount-making for Museum Collections, Second Edition*, Canadian Conservation Institute, Ottawa, CA, 1998.

[4] Taken directly from *Mount-making for Museum Collections*, p. 7.

Mounts can fail to fulfill their function for one or more of these five reasons:

- The points of support are poorly placed and cause distortion or damage. Taking into consideration the forces of gravity and the weakest points on your object can eliminates this.
- An object is not balanced properly and held onto its mount firmly. Balance is achieved by taking into account your objects center of gravity when placing it on or in a mount. Sideways shocks from building vibrations or visitors should also be considered.
- The points of contact cause damage. Mounts are often made of hard materials; metal, plastic, wood, etc., and need to be adequately padded where they contact an object. Consult with a conservator to be sure the padding chosen will not abrade or distort the object.
- The mount is made of unsuitable material. (See Tables 2 for suitable and unsuitable materials).
- The finished mount is obtrusive. Even if the four conservation considerations listed above have been met, an obtrusive mount can ruin the effect of the object on display.

Mounting Tips (as per Toby Raphael's *Exhibit Conservation Guidelines*)

- Design and fabricate mounts for object installation ahead of time. Use a qualified mounting specialist who has conservation training; some objects require the direct involvement of a conservator.
- No object can be physically altered or dismantled to accommodate placement or mounting in the exhibit. Use mechanical designs to lock mounts in place.
- The object's center of gravity or originally intended attitude should be considered when designing a mount. Support provided by the mount must prevent physical stress or unbalanced weight distribution.
- Create custom-padded mounts for organic materials that support the structure over its entire contour. Textiles, papers, organic materials, and other susceptible objects should not be creased or folded, nor should heavy objects be placed directly on top of them.
- Fragile objects, including textiles, should be supported over as large an area as practical. Attached parts, such as straps, may require independent support.
- The mount design should reduce vibration when a case is opened or bumped. A cushioning material is often required. The mount should fit the object with precision to prevent vibration and abrasion.
- Attach framed pieces to the wall with appropriate hardware such as "D" hooks and braided metal wire. Anchor the wall fastener firmly to the wall and be sure that it can support the weight of the framed object.

9. EXHIBIT PRODUCTION AND OBJECT INSTALLATION

SOME GENERAL RULES TO LIVE BY

- Avoid transporting objects into production areas. Implement techniques to reduce, contain, and collect dust in areas where objects must be transported. Complete construction before object installation. The exhibit area should be cleared of debris and dust.
- Ensure the safety of objects during measurement and fitting sessions.
- Include several inspections during the production phase to ensure that the preservation elements are built to specifications. Test and approve exhibit cases with conservation features before object installation.
- Review the exhibit process and evaluate the exhibit environment to assess how well the final product addressed the initial conservation concerns. Include any improvements and adjustments to the exhibit process for the next project.

INSTALLATION TIPS

- Choosing Conservation-Appropriate Materials: Use high-quality, non-hazardous materials to construct case interiors, and case furniture. Avoid materials known to outgas, become acidic, or lose their physical or chemical stability. Consult lists of materials that have been researched, talk with other museum professionals, and test proposed materials.
- If necessary within the object display area, use a conservation-quality adhesive with a successful track record in exhibits, such as one based on tested resins-acrylic, polyvinyl acetate, or certain high-temperature heat-activated adhesives.
- Select 100% acrylic paints with low volatile emissions for wood and metal surfaces; powder coatings can also be used for metal surfaces.
- Allow sufficient curing time before installing objects. Caulk sealants and finishes require a minimum of three weeks to reduce emissions.
- Separate objects with a mount or a layer of inert paper, foil, or other acceptable barrier, such as polyethylene or polyester sheeting.
- Check fabrics for dye stability and fastness; have the conservation staff pre-wash and dry them before installation to preshrink and remove excess dyes and finishes. Use a mechanical attachment method or sew fabric to itself- reducing the need for adhesives. Occasionally, archival-quality double-sided adhesive tape is useful for temporary exhibits.

10. GALLERY MAINTENTANCE

Routine gallery maintenance is an essential step in the long-term preservation of artifacts. Pest prevention, environmental monitoring, check on buffered environments and recondition silica gel or other materials as needed, periodic light-level checks—sometimes when light bulbs are changed by Properties, the new bulbs emit brighter light, increasing the amount of foot candles projected onto an artifact. Often the lighting plan for a gallery may leave lights unused to achieve an appropriate level for display. Over time, if these lights are replaced or illuminated it could adversely effect artifacts. Maintenance personnel are also responsible for periodic condition checks and mount checks. Is there a notable change in condition? Are their visible damages, like flaking paint under are around an artifact, or changes, like tackiness, bubbling, cockling, or cracking. Are there any new stains or notable fading. These checks are particularly important for long term exhibition of artifacts. Often, the people doing gallery maintenance have the best knowledge of the condition of an artifact. Routine dusting can prevent...

Toby Raphael, in his Exhibit Conservation Guidelines[3], lists the following aims of a comprehensive gallery maintenance plan:

- Provide a maintenance manual. Document the construction details, lighting, and conservation features for future reference. Outline procedures and schedules for maintaining the exhibit and conservation criteria for the objects.
- Assign a staff member or members to routinely inspect artifacts on display. Any controlled environment-either in the overall exhibit space or in a case-must be monitored to identify when maintenance is necessary.
- Replenish relative humidity and pollutant control systems as needed. When replacing lamps, refer to the maintenance plan for the lamp type and aim of the beam. Monitor light levels after the new lamps have been installed.
- A regular cleaning schedule facilitates preservation of the objects and offers an opportunity to assess any change in the conditions of the exhibit or the objects. Consult a conservator for appropriate methods and products.
- During object rotations and inspections or at the close of the exhibit, systematic removal of objects is necessary and requires proper equipment. Before beginning demolition of an exhibit, ensure that objects are carefully removed.

Supplies that may be needed for gallery maintenance:

- Soft, natural hair brushes (various sizes)
- Dust Bunny cloths (anti-static cloths for dusting furniture)
- Cotton and plastic gloves & lab coats
- Vacuum cleaner with a HEPA filter, window screening, and elastic bands
- Small ladder or step stool
- Flash lights
- Magnifying loupe
- Tweezers
- Zip-lock® baggies
- Scraps of foam and tissue
- Extension cord
- Notebook
- Pencils
- Object tags
- Light meter
- RH and temperature gauge or digital probe
- Measuring tape
- Drill (Collections or Exhibits)
- Pliers
- Screwdrivers
- Scissors
- Plexi cleaner and paper towels (Exhibits)
- Glass cups (Exhibits)
- Digital Camera (needed to document problems)
- Large ladder for dusting objects up high (see Properties when needed)
- Floor plans of galleries for note-taking and recording data from any metering that is done.

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[3] Raphael, Toby. *Exhibit Conservation Guidelines: Incorporating Conservation into Exhibit Planning, Design and Fabrication.* National Park Service, Division of Conservation, Harper's Ferry Center, 1999.

ARTIFACT HANDLING & STORAGE

1. GENERAL GUIDELINES

All objects within the collection require careful handling. Even seemingly stable objects have most likely already undergone some degree of deterioration. In order to ensure the proper care of objects, the procedures outlines below should be observed at all times. Should any object be damaged during handling or transport, please notify a Collections Manager or Conservator immediately, keep any broken pieces no matter how small, and supply information on how the accident occurred.

- Consider each object as unique an irreplaceable.
- Handle objects only when necessary or a little as possible. Keep objects in trays, boxes, drawers and bags if at all possible.
- Do not eat, drink, or smoke when handling objects. Do not place objects on any table that contains food, drink, or personal items.
- Use only pencils or personal computers for note taking. Leave all backpacks, briefcases, coats, computer cases and other personal items with the collections management staff or in a designated office area.
- Lab coats and nitrile or clean cotton gloves should be worn at all times. This is for the protection of both the artifact and the handler. Avoid using cotton gloves when handling slippery or smooth objects (like glazed ceramics and glass) and when handling flaking material, corroded metal, and jewelry—cotton gloves can often catch and snag fragile material. Do not wear gloves that are too large because slippage can occur. Discard or wash gloves after use. Note: Glove use does not pertain to handling paper items; but lab coats should be worn at all times.
- Wash your hands thoroughly with soap and water before and after handling objects, and especially before eating. It is good practice to wash your hands whenever you remove your object handling gloves.
- Remove or cover all jewelry, watches, rings, belt buckles, ID cards or any other item that might bump or scratch artifacts. Do not handle objects with tools or other items in your lab coat pocket as they might fall out during handling and harm an artifact.
- Plan relocation of your object in advance. Check for a clean well-lit work areas and a clear route of transport.
- Make no sudden moves around artifacts-always be aware of what's behind you and how close you are to it.
- If an object must be handled, examine it carefully for previous damages or insecure areas. Look for removable or detachable parts and old repairs. Secure loose or mobile parts of an object before handling it—like hinges, swing doors, or handles. If necessary separate component pieces prior to handling. If an object has multiple parts, move each part separately. Whenever possible avoid areas of applied decoration that might be damaged—for example paint, feathers, beading, gilding, makers marks, labels, and accession numbers.
- Speak with a conservator if you think moving an object might damage it.
- Carry only one object at a time, no matter how small. ALWAYS USE BOTH HANDS to carry and object. Small objects are often more easily carried with an auxiliary support like a tray or padded board.
- Know your object and its center of gravity. Do not assume to know the weight of an object based on its size.
- Always lift an object from underneath, supporting its full weight. NEVER pick up or carry an object by its handles, projections or appendages as these areas are often weaker in structure and are frequently the site of old repairs. Instead lift the body of the object with a firm but gentle grip. Small or lightweight object can be picked up with one hand while the other hand cradles the object or acts as an additional support.
- When carrying object keep them close into your body and use both hands.

- Two or more people should handle large or heavy objects, when this is necessary, a third person should be available to direct the movement of the object and spot the move, i.e. look for hazards along the route, avoid bumping of the object, and open doors for the handlers. Carry only what you are comfortable with—always ask for help if you feel uncomfortable or uneasy about handling any object.

- Move slowly and be aware of your object and surroundings.

- Never walk backward.

- Never carry objects further then necessary, bring the cart to the object, not the object to the cart.

- Never place an object directly on the floor.

- Do not clean any object except under the direction of a Conservator.

2. SPECIAL CONSIDERATIONS FOR COSTUME & TEXTILES

- Remove watches and rings or any jewelry that might snag.

- Do not rest objects on top of textiles. When textiles are to be piled for storage or handling, keep like materials together and use muslin or tissue interleaving. Stacks should be no more than 3-4 textile or costume pieces high.

- Costumes should be lifted with two hands. Once hand to support the upper portion of the garment and the other to support the lower portion. If a costume is on a hanger, support the hanger with one hand and the remainder of the garment with the other. Never lift a garment off a rack by the shoulders.

- Carry fragile costume pieces and accessories in a box or on a padded board.

- Use a rigid support under very fragile or flexible artifacts- like jewelry, fragile costumes, flaking metal objects, or flexible materials.

- If possible, avoid wearing lipstick and foundation. Makeup is easily transferred from you to an object if you touch your face while handling.
- Wash hands frequently for general handling. Make sure hands are fully dry before handling textiles.

- Use gloves when handling metallics: fabrics, buttons, jewelry, ornaments, etc…

- Never place textiles in contact with acidic materials, unwashed cloth, plastic films, or adhesive tapes.

3. SPECIAL CONSIDERATIONS FOR DECORATIVE & INDUSTRIAL ARTS

- Frames should be lifted with two hands on both side rails or the side and bottom rail. Avoid lifting or pulling at the top frame rail.

- Furniture and mirrors should always be moved in their proper orientation, that is, in their orientation of intended use. Never turn furniture on its side.

- Always secure loose elements, including drawers, hinges, and handles prior to lifting or moving furniture.

- Never push, pull, drag or slide heavy objects; call for assistance if an object is too heavy for you.

- Separate sculpture from its base prior to moving.

- Ceramic or glass vessels should not be stored inverted on their rims. These areas are often thinner and more fragile therefore more susceptible to cracking or loss.

- ALWAYS wear gloves when handling metal objects—NO EXCEPTIONS. The acids and salts from your hands will etch into the surface of the metal, plus some metals are actually toxic to humans and can be absorbed readily through the skin.

4. IN CASE OF AN ACCIDENT

- Notify a Conservator or Collections Manager immediately.
- Keep all broken pieces no matter how small. Fragments should be placed in a Ziplock bag and labeled with the object number and date.
- Supply information on how the accident occurred. This can be useful when determining a future conservation treatment, storage location, mount, or handling procedure

5. OBJECT TRANSPORT PROCEDURES

- Never hand-carry an object for any distance-- use a box, tray, or cart. Bring the cart to the object, not the object to the cart.
- Before using a cart, be sure the bottom and sides are padded with foam or another cushioning material. Use foam or tissue between objects when placing more than one object on a cart. Replace cushion materials when they become dirty.
- Center objects on the cart; do not allow objects or protrusions to hang over the side or end of cart.
- Make sure the object is well supported and use padding where necessary for additional support. Safe padding materials include sheets of Ethafoam®, washed cotton muslin, or tissue.
- Protect areas of applied decoration. When possible, an object should not rest on a decorated surface or a protrusion—like a handle, arm, nose, or finial.
- Do not overload carts and trays. Never place an object on top of another object.
- Do not wrap objects in tissue or foam in such a way that the object must be rolled in order to remove the wrapping.
- Protect large objects in transit with pads, foam, blankets and ties if necessary.
- Make sure you have a clear route of transport.
- Have a spotter if you have a full cart. A spotter can watch for objects that move with vibration or that become top-heavy during transport.
- When pushing a cart, go slowly and avoid bumps and shocks to the cart. Vibrations and shocks and cause severe damage to fragile objects.
- Never pull or drag a cart or object. Always push the cart in front of you.
- Two staff members should be present when moving a cart through public areas of the building.
- Two staff members are recommended for the handling and move of any dressed mannequin.
- Avoid placing lightweight and heavyweight objects together on the same cart or shelf in storage.

Remember that these are general guidelines. There are exceptions to every rule. If you are unsure about handling an object or want additional advice, please contact a Collections Manager or Conservator.

6. PAPER ITEMS (PRINTS, DRAWINGS, BOOKS, AND OTHER DOCUMENTS)

Exhibition and any museum personnel should be aware that paper might be exposed to light for long periods of time during the exhibition planning process; and appropriate precautions may be necessary such as protecting them within folders, or covering them with opaque paper to ensure any increased wearing, tearing, and discoloration. Paper artifacts chosen for exhibition and awaiting photography, conservation and installation, should be arranged on shelves so they may be easily located, and retrieved safely without any type of crowding.

STORAGE

The best protection for prints, drawings, and other works on paper is to store them in complete darkness in properly designed, dust-proof storage cabinets or portfolios in environmentally controlled rooms with filtered air.

- Matted prints and drawings should be protected with acid-free tissue.
- Store prints ad drawings in drawers or solander boxes without excessive stacking to prevent too much pressure on the bottom pieces. It is better to occupy more shelves than to put fragile artifacts at risk.
- Books may be stored in plastic envelopes to protect them from dust or friction. Envelopes should be perforated to prevent the possibility of condensation and the build-up of harmful gases.
- Large, flat items should be placed in low shelves for easy retrieval.
- Unlike materials should not be shelved together in the exhibition workroom or storage room. Paper artifacts should be isolated from metals, ceramics and other heavy, potentially damaging objects

HANDLING

- Use clean hands and wear white gloves because dirt combined with the oils in fingertips leave smudges that are difficult to remove from paper, and leave marks on photographs that can fade the image over time.
- Use two hands when lifting objects to prevent bending, creasing, tearing, or otherwise causing tension or undue stress of objects.
- Unmatted prints or drawings should never be stacked directly to the backing board.
- Prints and drawings should be matted to ensure maximum protection, in addition, to being covered in acid-free folders or envelopes as a second level of protection.
- Do not drag or slide anything across the surface of prints or drawings; especially, pastel drawing, etchings, and mezzotints.
- Never use pressure-sensitive tapes, gummed brown wrapping tape, rubber cement, synthetic glues, or heat-sealing mounting tissue on prints, drawings, books, or paper documents that are to be preserved.
- Always lift mats with two hands from the outer edge. Never allow fingers to come in contact with the picture surface with or without gloves.
- Mail, ship, or otherwise transport loose prints or drawings packed in flat boxes or containers, never rolled.
- When writing is necessary on prints, use a no. 2 soft pencil, and place the writing on the extreme edge of the margin for prints and drawings and on the edge of the beginning or end flyleaves of books. Never use library-type markings on spines or bindings.
- Always se a cart to move artifacts. The cart should be appropriate to the task, clean and padded if carrying fragile items, and should not contain unlike materials, such as ceramics with paper. Do not carry installation hardware and tools on the same cart surface.[8]

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