SELECTING STORAGE FURNITURE AND STORAGE MATERIALS FOR OBJECT AND SPECIMEN COLLECTIONS

Catharine Hawks

Appropriate storage furniture is one of the best means to provide long-term care of collections at minimal cost. The use of good quality storage cabinets can reduce the impact of ambient environments on the collections; will provide acceptable environments through short-term failure of building systems; and will protect collections against pests, dust, and many gaseous pollutants. Properly maintained, good cabinets will last for several decades. Specimens too large for cabinets can be stored on shelving units, pallets, or dollies. It is easy to make cushioning supports and plastic film enclosures for specimens in open storage. It is essential for collections preservation that the right equipment is correctly installed and maintained, and that appropriate materials use inside cabinets or for production of enclosures.

Selecting New Storage Furniture

A number of things should be considered when purchasing new storage equipment.

- To the extent possible, standardize storage equipment to permit bulk purchases, which can result in substantial cost savings, and permits drawers and other interior fittings to be traded among cabinets to suit individual circumstances.

- Include the following in the specifications for storage equipment:

    - steel construction (some lightweight aluminum or molded high-density polyethylene shelving may be useful in some instances)

    - white powder coatings (these are not completely benign towards collections—according to coating manufacturers, all powder coatings offgas acetic acid and formaldehyde; abrasion resistance, an important property in storage furniture, is achieved only with epoxy or epoxy hybrid coatings, which offgas slightly higher amounts these gases than other powder finishes)

    - exterior surfaces that are flush (no indentations or recesses other than at door latches)

    - no interior spaces of any kind that cannot be reached with a vacuum cleaner—this includes hollow doors unless they are completely sealed

    - hinged, lift-off doors, or doors that open completely and fold back flat against adjacent cabinets to facilitate cleaning of the cabinet interiors, rearrangement of drawers and shelves, and installation/removal of specimens or objects

    - door locks for cabinets, generally keyed alike to prevent a proliferation of keys or a tendency to avoid locking the doors

    - d-style tubular neoprene or silicone door gaskets (these "rubberized" materials will off-gas minor amounts of sulfur), or neoprene or silicone foam gaskets for sulfur-sensitive collections (herbarium materials and specimen/object labels are sensitive to sulfur gases, but the advantages gained from the d-style gaskets in terms of stability of the interior climate of the case and protection against the ingress of pests suggest that the tubular

gaskets are likely to be worth the comparatively minor risk from the sulfur)

- alcohol-cure silicone sealants (no acetic acid should be present in any sealants used in cabinets)

- powder-coated steel interior fittings, with the exception that lightweight flat items can be placed on special polyester screen panels, and very heavy collections can be housed in drawers constructed of molded high density polypropylene or polyethylene, or in steel-framed drawers with composite bases—these drawers are lightweight, but exceptionally strong

- light-tight construction for all cabinets (where light can enter, so can insect pests and dust)

- leveling feet and, ~4" or higher legs on all cabinets

- hat-channel shelves for all large shelving units (not for narrow shelving and not for cantilever shelving); the hat channels allow large shelves to be adapted to various sizes of objects because each hat-channel section of each shelf can be removed separately; the hat channels also provide rigidity to the shelves, reducing the need for exterior braces that interfere with placement of specimens and objects

- casters or dollies with locking casters for deep shelving units (not for narrow shelving)—these allow the shelving units to be easily moved, even when fully loaded, which can help maximize the use of space in a storage area (in effect, they are a inexpensive compact storage design)

- removable restraining bars that are designed to keep items from toppling from shelving units during an earthquake or during any other highly disruptive disaster.

- suspension (*e.g.*, roller-bearing), or Permaslide® or equivalent systems for pull out drawers, shelves, *etc*., avoid friction systems as these rapidly abrade and deposit fine particulates from the paint on collection objects

- Purchase only white or very light-colored storage furniture and storage containers to facilitate housekeeping, pest monitoring, and "crumb" monitoring. It is virtually impossible to inspect for pests against anything other than a white or very light ground. "Crumb" monitoring refers to examination of stored collections for signs of decrepitation such as small particles dislodged from specimens or objects as a result of biological, chemical, or physical deterioration.

Installation of Storage Furniture

Some prudent steps for installation of storage furniture can help ensure that the furniture will protect collections and be durable over time.

- Test all incoming storage cabinets to insure that they are light tight. To test, place a strong, multidimensional light source (a battery-powered lantern designed for camping, or 9-volt flashlights set in various positions) inside a leveled cabinet and close and lock the door. Extinguish sources of room light, and then carefully examine the cabinet for several minutes for signs of light from within. If light can be seen, mark the area with a post-it note and examine it under normal lighting. If the light leak is a result of a flaw in the cabinet from anything other than

a minor problem around the door gasket, contact the manufacturer for repairs or replacement. If there are minor leaks around the door gasket, these can be filled using 3M self-adhesive neoprene foam gasketing material, which is available in various widths at hardware stores. Major problems with door gaskets should be referred to the case manufacturer.

- Test all incoming storage cabinets for offgassing. This includes any powder-coated cabinets, because the coating may indeed offgas and because the cabinets contain many other materials besides the coating. Information on test methods is given below. All storage cabinets should be aired (doors open) for as long as possible before installation of any collection objects.

- Insure that all storage furniture is level (front-to-back and side-to-side) any time furniture is newly installed or moved. Cabinets that are not level will not close properly and therefore provide limited microclimate control, as well as allowing for the ingress of dust and insect pests. Shelving that is not level may result in uneven support for collection objects.

- Keep reasonably wide aisles between rows of cases or shelves in storage areas. At least 36" aisles are needed to accommodate the opening of case doors, removal of large drawers, shelves, or objects, and to accommodate wheelchair access and the use of lift equipment such as stackers or pallet movers.

- Avoid raised decks for compact or mobile storage systems, as these provide a habitat for pests. Mobile storage tracks should be set into concrete that has been carefully leveled to accommodate the tracks, ant then properly cured, sealed with a 2-component, solvent base epoxy, and then and coated with a water-borne epoxy. No carpeting or other flooring should be used over the concrete.

Maintenance of Storage Furniture

- Clean storage furniture annually using a vacuum cleaner. If collections may have been treated with or exposed to hazardous materials, use only a High Efficiency Particulate Air (HEPA) filtered vacuum. HEPA vacuums do not redistribute fine particulates into the air, as do regular vacuum cleaners. HEPA vacuums are available from most companies that produce vacuums today. Heavy duty HEPA vacuums that are still small enough to move around in storage rooms and can be adapted for artifact or storage furniture cleaning are available from Nilfisk.

- Avoid wet cleaning, as this can promote corrosion of metal furniture and can cause temporary increases in the relative humidity in storage rooms. Avoid the use of any chemical cleaner or spray, as these introduce pollutants into the storage environment.

- Routinely clean underneath storage furniture, using a HEPA vacuum. If the furniture has been installed properly, it will be high enough above the floor to permit this type of cleaning. Removal of dust and dirt from below shelving and cabinets will reduce the potential for pest infestations (Williams and McLaren 1990) and protect the furniture from abrasive particulates.

- Immediately repair any damage to the finish on metal storage equipment. Interruptions in the paint surface constitute the site for a corrosion cell. Touch-up kits are available from all major manufacturers of museum cabinets.

- Replace door gaskets on cabinets whenever they appear to be worn or to have lost their elasticity. Major suppliers of museum cabinets can provide replacement gaskets. In addition, self-adhesive gaskets are available from 3M.

Choosing Storage Materials

Although it is important to keep a few *caveats* in mind, there are a number of fairly non-reactive materials that can be used in contact with, or inside a closed environment with specimens and objects. Among the warnings to keep in mind are:

- Modern plastics are synthetic polymers that are often light sensitive, and are especially sensitive to ultraviolet radiation. For example, polyethylene is resistant to all solvents at room temperature, but when exposed to UV radiation, will crack and yellow.

- Modern plastics have temperature ranges at which they function best, that is, at temperatures above or below their optimum ranges, there will be a deterioration of chemical resistance and other properties.

- Additives to synthetic polymers often improve their appearance or their resistance to a specific agent of deterioration while *decreasing* other properties desirable for museum use. For example, a chemical added to make a plastic resistant to ultraviolet radiation may reduce the chemical resistance of the plastic, or may cause the plastic to offgas a reactive compound that could harm collections.

- Some plastics will react with specimens or objects because components of the polymer itself may offgas. Rigid, clear polystyrene offgasses a residual of the monomer from which the polymer is formed. The monomer can interfere with some biochemical analyses of specimens or objects (Baker 1995).

- Some plastics may damage collections if the polymer is exposed to contaminants in the collection environment. When polystyrene (either as a foam or a rigid plastic) is exposed to fumigant residues or other chemicals containing benzene rings, it will begin to dissolve and may adhere to collection materials. This is because the chemical structure of these contaminants is similar to that of the polymer, and "like dissolves like."

- Polymers that contain chlorine may release highly corrosive compounds as they deteriorate, thus many polyvinyl chloride (PVC) polymers, and Saran and other vinylidene chloride polymers are not recommended for use with museum collections.

- Any plastic container, film, or cushioning material that exhibits surface crazing or discoloration, or has an odor, is undergoing a reaction of some kind. Whatever the source or nature of that reaction, the material should be replaced promptly.

- Paper products listed as "acid-free" usually are buffered with alkaline compounds that when in direct contact with objects/specimens, can damage proteins and animal pigments, and may interfere with chemical taxonomy studies in botanical materials. It is important to specify that acid free, pH neutral, non-buffered materials will be used in contact with natural science specimens and most ethnographic objects (Burgess 1995).

Materials that generally are **safe for use with collections** include a variety of modern polymers, paper materials, coated metals, and textiles.

- Polyethylene, such as expanded polyethylene foam; electron-radiation crosslinked, soft polyethylene foam (Volara 2A); high-density molded polyethylene; spun-bonded polyethylene fiber sheeting (Tyvek), and clear polyethylene sheeting, with the following *caveats*:

    - polyethylene foams and sheeting will melt at about 250^{o}F, a temperature considerably below that at which many bird and mammal study skins, untanned or semi-tanned ethnographic materials, feathered or haired objects/ specimens, paper, plant specimens, and many textiles are damaged by heat alone—which means that if the foam or sheeting is in direct contact it will melt and damage the objects or specimens before they would ordinarily be damaged by the heat of a fire

    - polyethylene films develop a static charge in low humidity conditions and can damage friable surfaces, such as the periostracum on many shells or the pigments on many ethnographic objects; fragile parts such as those on some plant specimens; and hair or feathers on any specimen or object

    - polyethylene foams will adhere readily to some small specimens and objects, such as those with fur or with sharp protrusions—a specimen or object can be easily be torn in lifting it from the foam surface

    - expanded polyethylene foams have open pores along cut edges that are an appropriate size for some insects to deposit eggs or for insect larvae to pupate—the edges should be sealed with a hot air gun, or the foam should be cut with a hot knife to seal these openings

- Polyethylene terephthalate film (Mylar®). Unlike other polyethylene films, Mylar® has a very high melting point. It does, however, develop a static charge at humidity levels of about 40% or less.

- Polypropylene, especially high density molded polypropylene, polypropylene foam, and polypropylene films or sheeting (the foams and sheeting may have the same problems as those noted above for polyethylene).

- Clear, rigid polystyrene (clear, hard plastic), as long as it not exposed to solvents and solvent vapors and/or to fumigants, is not used with specimens intended for biochemical analyses, and exhibits no crazing or cracking.

- pH neutral, alpha-cellulose, lignin-free, unbuffered paper products and boards.

- pH neutral, unbuffered, 100% cotton paper products.

- Alkaline-buffered paper products for collections that do not contain proteins or animal pigments, and are not intended for biochemical analyses.

- Well washed, pure cotton fabrics.

- Polyester fiber (non-bonded, high loft, resin-free polyester fiberfill); this should always be separated from direct contact with any collection item that has small protrusions or a friable surface.

- Medium or high density, phenol-formaldehyde-impregnated, exterior grade plywoods that are surface laminated with melamine, or with vapor barrier foil/plastic laminates (see note about aluminum foil laminates, below).

- Borosilicate glassware.

Generally, **materials that should not be used with collections** include:

- Polystyrene, except as noted above, although some polystyrene foams can be useful for short-term shipping and packing.

- Polyvinyl chloride plastics.

- Polyurethane foams and oil-based polyurethane varnishes.

- Synthetic polymers containing unstable plasticizers or other additives

- Alkyd enamel paints.

- Bakelite, a hard, black plastic that decomposes when exposed to alcohol and/or formaldehyde vapor.

- Acidic paper products.

- Alkaline-buffered paper products (in collections containing proteins, animal pigments, or intended for use in some biochemical or chemical taxonomy studies)

- Wood and most wood products (these can be used to construct pallets or dollies if these items are used in well ventilated rooms—not inside closed cabinets or bags—and if the collection materials are not in direct contact with the wood).

- Most uncoated metals (note especially that aluminum metal, and vapor barrier materials made with aluminum foil can be a hazard if used with natural history collections that have been treated with mercury salts or with chlorinated compounds used in pest control treatments—these chemicals react with aluminum).

- Most commercial grade textiles.

- Cotton batting (this is an extremely hygroscopic material that will attract and hold moisture on objects or specimens).

- Natural rubber.

- Commercial grade glassware (usually bi-metallic alkaline glassware); this can leach alkaline constituents into fluids and will gradually deteriorate due to this reaction and to the action of ultraviolet radiation (glassware of this kind should be avoided for type specimens or other important specimens in fluid preservatives).

Tests to Detect Harmful Volatiles

The Canadian Conservation Institute has published a number of tests that can be used to detect volatiles that may be harmful to collections (Tetreault 1999). These can be used to test for volatiles from new cabinets and from samples of various materials. These tests include the pH glycerin (glycerol)/pH test, which is designed to detect a broad range of acid vapors.

1. Dampen a ColorpHast pH test strip (0-7 range) with a solution of 20ml of deionized water mixed with 80g glycerin (use only glycerin from a freshly opened bottle). 1-2 drops of the solution are applied to the pH strip and allowed to absorb into the strip. Excess solution is then, removed with a pipette or by shaking the strip gently. It is important to check the pH of the water and glycerin, before conducting the test. If the strip color indicates a pH below 6 immediately after the solution is the solution (or one of its components) is contaminated and should be replaced.
2. Prepare 6 strips that read above pH 6. Place 3 strips inside the cabinet to be tested and 3 outside the cabinet. After 24 hours, compare the results against the scale on the pH indicator package. If the internal environment of the cabinet gives a reading below that of the ambient air, the cabinet is still offgassing. It should be left open until a new set of tests strips give identical readings for both environments.
3. To conduct the test for materials samples, place samples of the material to be tested in 3 clean glass jars and insert a treated test strip in each jar, ensuring that it does not touch the sample. Cover the jars with glass or metal lids, or aluminum foil. Prepare 3 additional jars in the same way, omitting the samples. After 24 hours, compare the test strips from both sets of jars. There should be no difference in pH. If the pH of the strips in the jars containing the samples is lower than that of the jars without samples, the material is unacceptable for use.

The pH strips are available from laboratory supply companies and companies that sell conservation supplies. Glycerin is available (US Pharmaceutical Grade) at drug stores, and from chemical supply companies.

A test strip designed for use with photographic film can be used to test for offgassing of acetic acid. The strips (A-D Strips, in packages of 250 for about $45) are available from:

Image Permanence Institute (IPI)
Rochester Institute of Technology
70 Lomb Memorial Drive
Rochester NY 14623-5604 USA
T 716.475.2306 F 716.475.7230
Web: www.rit.edu/~661www1

Identification and Evaluation of Plastics

It is always best to be certain that plastics used in collection storage are the types of materials that are safe for use with specimens or objects. It is possible to identify plastic films via a series of reasonably straightforward tests. These are described in a leaflet from the Society for the Preservation of Natural History Collections (Williams *et al*. 1998). Other tests for identification of plastics can be found in Braun (1982) and Morgan (1991).

A test to detect the presence of chlorine in any type of plastics is the Beilstein Test, which is described in the publication by Tétreault (1995) noted above, and discussed in detail in Williams (1993).

The publication by Tétreault (1995) also includes tests to evaluate the chemical resistance of plastics to various vapors, including the vapors that might be released by objects or specimens that have been fumigated with paradichlorobenzene, naphthalene, and dichlorvos (DDVP or Vapona strips).

Evaluation of Paper Products

In general, any paper product that has passed the Photographic Activity Test (PAT) is safe for use with collections (given the exemptions noted above regarding alkaline-buffered papers and boards, most of which will pass the PAT). This test is described in the publication by Tétreault (1995) and in Norris (1995). Manufacturers who supply conservation materials can give museum staff information on whether a paper product has passed the PAT.

Additional tests for paper-based materials are described in American Institute for Conservation Book and Paper Group (1990).

Sources Cited in the Text

American Institute for Conservation, Book and Paper Group. 1990. *Paper Conservation Catalog*. 7th edition. American Institute for Conservation of Historic and Artistic Works, Washington, DC. Available from:

American Institute for Conservation (AIC)
1717 K Street NW, Suite 200
Washington DC 20006 USA
T 202.452.9545 F 202.452.9328
Web: http://aic.stanford.edu
Email: info@aic-faic.org

Baker, Mary. 1995. Synthetic polymers. Pp.305-322 in *Storage of Natural History Collections: A Preventive Conservation Approach* (C. Rose, C. Hawks, and H. Genoways, eds.). Society for the Preservation of Natural History Collections, Iowa City. Available from:

Society for the Preservation of Natural History Collections (SPNHC)
PO Box 797
Washington DC 20044-0797 USA
Web: www.spnhc.org

Braun, Dietrich. 1982. *Simple Methods for Identification of Plastics*. Translated by E. Immergut. Hanser Publishers, distributed in the U.S. by Macmillan Publishing Co., NY. (check local library or booksellers, such as www.amazon.com or www.bibliofind.com or http://abebooks.com).

Burgess, Helen. 1995. Other cellulosic materials. Pp.291-303 in *Storage of Natural History Collections: A Preventive Conservation Approach* (C. Rose, C. Hawks, and H. Genoways, eds.). Society for the Preservation of Natural History Collections, Iowa City. Available from SPNHC at the address above.

Morgan, John. 1991. *Conservation of Plastics: An Introduction*. Plastics Historical Society and The Conservation Unit, Museums and Galleries Commission, London. (check local library or booksellers, such as www.amazon.com or www.bibliofind.com or http://abebooks.com).

Tetreault, Jean. 1999. *Coatings for Display and Storage in Museums*. Technical Bulletin 21. Canadian Conservation Institute, Ottawa. Available from:

Canadian Conservation Institute (CCI)
1030 Innes Road
Ottawa, Ontario K1A 0M5 Canada
T 613.98.3721x250 F 613.998.4721
Web: www.cci-icc.gc.ca
Email: cci_icc/publications@pch.gc.ca

Williams, Scott. 1993. *The Beilstein Test: Screening Organic and Polymeric Materials for the Presence of Chlorine, with Examples of Products Tested*. CCI Notes 17/1. Canadian Conservation Institute, Ottawa. Available from CCI at the address above.

Williams, Scott, Allison Brooks, Stephen Williams, and Rebecca Hinrichs. 1998. *Guide to the Identification of Common Clear Plastic Films.* SPNHC Leaflet No.3. Society for the Preservation of Natural History Collections. The leaflet is available at no charge at the Society's web site: www.spnhc.com.

Williams, Stephen, and Suzanne McLaren. 1990. Modification of storage design to mitigate insect problems. *Collection Forum* 6(1):27-32. Available from SPNHC at the address above.

Sources for Equipment

3M Corporation, Adhesives, Coatings & Sealers Division
223-IN Center Street
St. Paul, MN 55144 USA
(612)733-1110
[self-adhesive, neoprene foam gasket materials; check local hardware stores and builders' supply stores, or call company for information on local suppliers]

Crystallization Systems, Inc.
640 C Broadway
Holbrook, NY 11741 USA
(516)567-0888 (516)567-4007 fax
Email: CSIstorage@aol.com
[specialty storage cases and specialty inserts for cabinets, including screen panels for fragile textiles]

Delta Designs, Ltd.
PO Box 1733
Topeka, KS 66601 USA
(800)656-7426 (785)233-1021 fax
Website: www.deltaltd.com
Email: delta@cjnetworks.com
[museum storage cases; specializes in custom designs]

Spacesaver Corporation
1450 Janesville Avenue
Fort Atkinson, WI 53538 USA
(800)492-3434 (920)563-2702 fax

Website: www.spacesaver.com
Email: ssc@spacesaver.com
[compact storage systems, especially mechanical assist carriages to hold cabinets]

Steel Fixture Manufacturing Company
612 East Seventh Street
Topeka, KS 66601 USA
(800)342-9180
Website: www.steelfixture.com
[museum storage cases; stainless steel tanks]

Madix Store Fixtures
PO Box 177
Goodwater, AL 35072 USA
(800)633-6282
[steel cantilever shelving; steel shelving on carts with casters; steel shelves made of hat channel sections; request information regarding designs with PC01 white finishes]

Nilfisk-Advance America, Inc.
300 Technology Drive
Malvern P 19355
T 800.645.3475
Web: www.pa.nilfisk-advance.com
[HEPA vacuums; check web site or call for information on a local supplier]

Unistrut Corporation
35660 Clinton Street
Wayne, NI 48184 USA
(800)323-7747 (313)721-4040
[metal risers to raise storage cabinets off the floor; P1000 low-carbon steel channel with acrylic enamel coating; P3008 galvanized bolts, washers and nuts; will also supply die-cast aluminum frame supports (TA-4 base, BE-1 head, TA-10 stud) to provide leveling feet]

Viking Metal Cabinet
5321 W 65th Street
Chicago IL 60638 USA
(800)776-7767 (216)397-0295 fax
[replaces Interior Steel and produces steel cabinets with powder coatings and various interior components; Permaslide® coatings for tracks on drawers and pull-out shelves; composite base drawers]

Submitted for publication in the Collections Caretaker in 2000.