

Paper

Found in such items as books, maps, manuscripts, photographs, newspapers, documents, letters, prints, and drawings

Identification and General Information

This discussion is limited to paper made of Western fibers. Papers that are made from Asian fibers and also other paper-like materials, such as tapa, amatl, and papyrus, sometimes referred to as semi-papers because they are not made from a slurry (see below), are not discussed here.

Paper was invented in China approximately two thousand years ago. It is generally believed that it was introduced to the Arab world by the Chinese in the eighth century, carried to Europe by the twelfth century, and spread to other parts of the world, such as North America, a few hundred years after that. Paper was originally made by hand using various similar methods. When it became accepted in Europe and demand increased, especially as a result of the industrial revolution, the papermaking process became mechanized, around 1800. Today most paper is machine-made, although very fine papers are still made by hand by highly skilled craftspeople and artists for special purposes.

Paper has been made from many different fibers over the centuries, depending on what was grown locally, readily available, and easy to use. In Europe and North America, most paper was made initially from cotton and linen cloth rags. The rags were cut up, beaten into a pulp, mixed with water to make a slurry, and then formed into sheets of paper. When the papermaking process became mechanized, there were not enough rags to meet the demand, and alternative fibers were investigated. After some experimentation, wood was found to be a suitable alternative in the early 1840s. Today most of the paper produced in Europe and North America is made from wood.

Wood, however, contains many impurities that accelerate the deterioration of paper by causing harmful acids to form. Modern newsprint, for example, deteriorates very quickly. This deterioration can be seen by its rapid discoloration. The impurities that cause the deterioration can be removed from the wood pulp by chemical means before the paper is made. Wood pulp paper is classified into two types. *Chemical* wood pulp paper has been treated chemically to remove harmful impurities. Some of the most permanent paper that we have today is this type. *Mechanical* or *ground* wood pulp paper has not been treated to remove the impurities and is very impermanent. Other factors that contribute to the deterioration of paper regardless of the fibers from which it is made are the over-bleaching of the fibers to make paper whiter and the use of chemically unstable sizes, such as alum rosin, commonly added to paper so that inks will not feather.

Exact identification of the type of paper used in an item requires chemical or microscopic tests. Often a conservator can look at a sample and make an educated guess as to the type of paper based on its age, condition, and appearance. This level of identification is usually adequate for most purposes.

Basic Care and Storage

In general, the recommendations for care and storage provided in *Basic Care* should be followed. Paper is especially vulnerable, however, to poor storage methods. Haphazard, overcrowded conditions soon result in avoidable damage, such as dirt marks, tears, and creases, while poor-quality storage containers accelerate the deterioration of the items they are intended to protect by transferring acids to them. Because most items made of paper fall into a limited number of specific types, the care and storage of paper are discussed here by type of item.

Books

Boxing is crucial to the preservation of certain books. Those with fragile bindings of special value that should be kept in their present condition should be boxed for protection. Storing a book in a box keeps the binding and pages clean, protects them from light and physical damage, and provides structural support for fragile or damaged bindings. Boxes should be constructed of preservation-quality materials, and they should be custom made to fit the book's dimensions exactly so that the book does not slide in the box and become abraded.

Both drop-spine and phase boxes are acceptable and are available commercially. Drop-spine boxes are preferable because they provide better support and keep books cleaner. Envelopes are sometimes used for the storage of books. These generally do not provide the support books need and should be replaced with boxes. If boxes are too expensive or take up too much space on shelves, books can be wrapped in paper. Never hold damaged books together with rubber bands or string, which can damage bindings. Box them, wrap them in paper, or tie them with a flat undyed cotton, linen, or polyester tape.

In general, maintain good air circulation. Never store books directly against walls but, instead, at least three inches away to facilitate movement of air around the books and to avoid the occurrence of pockets of damp air. This is especially important when bookshelves are positioned against the outside walls of a building.

Keep books upright on shelves rather than allow them to lean to one side or the other, because leaning causes strain on the binding. Bookends help hold books upright. Bookends with smooth surfaces and broad edges are preferred to prevent bindings from being abraded and pages from being torn or creased.

As a rule, do not stack books in piles on shelves. Small, structurally sound books can be

shelved upright. Oversize, heavy, structurally weak, or damaged books can be stored flat rather than upright to give them the overall support they require. If books are stored flat, additional shelves may need to be inserted at narrow intervals to avoid having to stack these books. If it is absolutely necessary to stack books, the stacks should contain only two or three books. When possible, individually box the books that are stacked. Shelves for oversize books need to be wide enough to support the books completely so that they do not protrude into the aisles.

Ideally do not store paper and cloth bindings in direct contact with leather bindings. Acidity and oils in the leather migrate into paper and cloth and hasten their deterioration. Furthermore, degraded powdery leather soils paper and cloth. Again, when possible, box books to avoid these problems. When this is not possible, shelve paper and cloth bindings together, separate from leather bindings. Another alternative to consider is the use of polyester film book jackets or simply the placement of a piece of polyester film between the books.

Remove all acidic inserts, such as bookmarks, scraps of paper, and pressed flowers, from books. If these inserts are important to keep, they can be placed in a small plastic or paper folder or sleeve and returned to the book or stored separately. Removing these inserts will prevent acidity in them from migrating into book pages. Remove paper clips in books as well.

Unbound Flat Paper

Unbound paper items are more vulnerable to damage than books because they do not have the protection of a binding. Single sheets of paper need to be stored in some sort of container to protect them. Traditionally museums place valuable drawings and other works of art on paper in a mat and then store them in frames or boxes. Unless you have immediate plans to display your artworks, frames are not necessary. Matting them and then storing the matted works in a box is a good option. Make all the mats the same size, that of the box, not the artwork, to prevent

movement of the matted art in the box. If you have artworks that vary greatly in size, you may need to choose more than one standard size for the mats and boxes. A lower-cost alternative is to place each artwork in a folder instead of a mat, and then place all the folders in a box. As with mats, the folders should be the size of the box. Using folders will take up less space than mats, so if space is a concern, you may want to select this alternative. Place only one artwork in a folder. If the image on the artwork appears to be smeared, contact a conservator for suggestions on how to store the drawing to prevent further smearing. All mats, folders, and boxes should be made of preservation-quality materials. The boxes should be stored flat.

For other loose paper items, such as documents and letters, keep in mind that only ones of the same general size and type should be stored together. Generally speaking, heavy objects need to be stored separately from lighter ones, as do bulky objects, which cause uneven pressure inside boxes. Because acid migrates from paper of inferior quality to any other paper with which it comes into direct contact, it is important to separate poor-quality paper from that of better quality. Remove news clippings and other obviously inferior-quality papers from direct contact with documents and letters on better-quality paper.

Documents and letters should be unfolded for storage if this can be done without splitting, breaking, or otherwise damaging them. If left folded, these items will eventually tear along fold lines when they are repeatedly unfolded for reading. If unfolding for storage may result in damage, consult a conservator before proceeding. Carefully remove all damaging fasteners such as staples, paper clips, and pins. Damaging fasteners can be replaced, but *only if absolutely necessary*, with non-rusting staples or paper clips. House documents in file folders. Ideally, place no more than ten to fifteen sheets in each folder; the more valuable or fragile the item, the fewer the sheets that should be stored in one folder.

Folders can be kept in document storage boxes. Be sure all folders inside a box are the same size and conform to the size of the box. The boxes can be stored flat or upright. If boxes are stored flat, they should be stacked only two high to facilitate handling. Flat storage will give the documents overall support and will prevent crumbling edges, slumping, and other mechanical damage to which upright storage might subject them. Flat storage, however, causes documents on the bottom of the box to suffer from the weight of those above. Upright storage is preferable when documents and folders are well supported to prevent slumping and edge damage. Spacer boards made out of stable materials can be used to fill out boxes that are not quite full. Care needs to be taken to not overfill boxes because this can cause damage when items are removed, replaced, or reviewed. An alternative to boxing is storage in a file cabinet equipped with hanging racks and hanging folders. If hanging folders made of preservation-quality materials cannot be found, general office hanging folders can be used, as long as the folders within them are made of acceptable materials.

Photographs

It is best for each photograph to have its own enclosure. This reduces damage to the photograph by giving it protection and physical support. Folders, sleeves, and envelopes are common choices. These can be made of either paper or plastic (see below). Because paper enclosures are opaque, the photograph must be removed when it is viewed; clear plastic enclosures have the advantage of allowing researchers to view the image without handling it, thus reducing the possibility of scratching or abrasion. Paper enclosures should be acid- and lignin-free. Plastics suitable for photographic storage are polyester, polypropylene, and polyethylene. Avoid polyvinyl chloride (PVC) at all times. Both paper and plastic enclosures should pass the

Photographic Activity Test (PAT) as specified in ISO 14523:1999 (formerly ANSI IT 9.16-1993) and also meet the standard ISO 18902:2001 (formerly ANSI IT 9.2-1998). These are standards that specify criteria for storage enclosures for photographic materials.

Once photographs have been properly housed in enclosures, they can be stored flat in drop-front boxes. Glass plate negatives are an exception and need to be stored vertically to prevent breakage of plates stored on the bottom of a pile. Horizontal storage of photographs is usually preferable to vertical storage, since it provides overall support and avoids mechanical damage such as bending. Vertical storage, however, may make access to the collection easier and decrease handling. For vertical storage, place photographs in file folders or envelopes that are themselves housed in hanging file folders or document storage boxes. Avoid overcrowding. The use of hanging file folders will prevent photographs from sliding down under each other and will facilitate their handling. Also follow these guidelines if storing photographs in albums. Make sure all materials used in an album pass the standards cited above. Avoid the use of so-called magnetic albums, which employ plastics and adhesives of questionable quality.

House boxes on metal shelves or in metal cabinets. Where possible, store items of similar size together; the mixing of different sizes can cause abrasion and breakage and can increase the risk of misplacing smaller items. Regardless of the size of the photograph, be sure all enclosures within a box are the same size, that of the box. Do not overfill boxes.

Special care needs to be given to the storage of oversize photographic prints mounted on cardboard. This board is often acidic and extremely brittle. Embrittlement of the support can endanger the image itself because the cardboard may break in storage or during handling, damaging the photograph. Such prints must be carefully stored, sometimes in specially made enclosures. Handle them with great care.

Oversize Items

Oversize materials, such as maps and large prints, are best stored flat in the drawers of map cases or in large covered boxes. Place the items in folders, and cut all the folders to fit the size of the drawer or box. Allow adequate room where oversize materials are stored to remove them safely from drawers or shelves, and make sure there is a place to put them down once they are removed.

If oversize items are not brittle or fragile, they can be rolled when flat storage is not possible. It is important to make sure the items are not too brittle or fragile to sustain rolling and unrolling. Depending on their condition, some items need to be rolled individually; others can be rolled in groups of similar-size items, the exact number depending on the size and weight of the paper. A tube several inches longer than the largest item being rolled and at least four inches in diameter (larger diameters are preferable) works well. If the tube is not made of preservation-quality materials, wrap it in neutral or buffered paper or polyester film. Alternatively, the items can be placed in a folder of five-mil polyester film cut several inches larger in both dimensions than the largest item being rolled. The item or items can then be rolled face out onto the tube. If a polyester film folder is used, roll it so that the fold is parallel with the length of the tube. Then wrap the assembly with neutral or buffered paper or polyester film to protect it from abrasions. Tie the wrapped roll loosely with flat linen, cotton, or polyester tape. This assembly can be stored inside a larger tube for added protection if desired. Store tubes horizontally.

Newsprint

Much of the newsprint produced after the mid-nineteenth century is made of mechanical wood pulp, and its long-term preservation is difficult at best. While it is possible to alkalize (deacidify) newsprint to retard its deterioration, this is often not practical because the paper will still continue to deteriorate at a relatively rapid rate. Also, alkalization after newsprint has become

yellow and brittle will not make it white and flexible again. Most news clippings are important because of the information they contain and not because of the value of the clippings themselves. For this reason, photocopying and microfilming are the most practical preservation options for collections of news clippings. Be sure to do all photocopying on preservation-quality paper using an electrostatic copier with heat-fused images. Physically separate news clippings that must be retained from better-quality papers in an enclosure made of polyester film or paper.

Special Pest Concerns

Paper is highly susceptible to mold growth. High levels of relative humidity in combination with still air can lead to mold growth. If, however, you keep the relative humidity below 60 percent and maintain good air circulation, you will probably avoid this problem in most situations.

Insects are another concern, and their presence should be avoided at all costs. Several species will attack paper and in extreme instances can destroy items. Maintaining acceptable levels of relative humidity along with implementing a program of integrated pest management will discourage insects.

Routine Handling

Following a few basic handling guidelines will extend the useful life of items significantly.

Always handle paper with care. It tears and creases easily. Also, it is very susceptible to dirt and marks easily. Be sure to wash your hands before handling paper items so that you do not leave dirty or oily fingerprints behind. These are particularly disfiguring on photographs and drawings and are often difficult, if not impossible, to remove. Use your judgment about wearing gloves. If the gloves do not fit snugly, they may get caught on the edge of paper items and tear them. Also, if you choose to wear gloves, be sure to change them as soon as they become soiled.

Do not pull books off the shelves by the headcap (the top of the binding at the spine), a practice that causes the headcap to fail, tearing the spine of the binding. Instead, books on either side can be pushed in, and the desired book pulled out gently by grasping it on both sides with the thumb and fingers. To minimize chances of dropping books, do not stack them too high when they are moved or carried. Do not stack books of special value at all. If book trucks or carts are used, they should be easy to maneuver. Avoid stacking books high on the truck and having them protrude beyond the edges.

Books are often unnecessarily damaged during photocopying. Photocopy machines with flat copy platens necessitate jamming the binding flat in order to get a good image. Better machines are those with edge platens or other features that allow a book page to be copied with the book open to only 90 degrees instead of 180 degrees. Never press the spine of a book down with your hand or the cover of the copier to ensure a good-quality image.

In general, avoid touching a single sheet of paper, especially a drawing, any more than necessary. Handle it by using its storage enclosure. If it must be turned over, for example, accomplish this by handling only its mat or folder. If an item does not have its own storage enclosure, an acid-free paper folder can be provided. If the item itself must be handled, hold it at the edges, touching no more of it than necessary and avoiding the image if possible. Use two hands. If an item is heavy, oversize, or otherwise difficult to maneuver, two people should handle it.

When an item must be moved from one location to another, support it well. Always use a rigid support larger than the item, made of acid-free corrugated board or similar material, under it. These supports or carrying cards can be cut to the standard sizes of the storage drawers, mats, and other enclosures used in the museum. Remember that certain media on drawings can smear.

Avoid touching or rubbing the image.

Display Issues

In general the suggestions provided in *Display* can be followed. Also, the National Information Standards Organization (NISO) has issued guidelines for displaying library and archival materials. These guidelines are ANSI/NISO Standard Z 39.79-2001. This important standard provides all the basic information you need to safely display your paper items. The standard can be purchased for \$49 from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112, 1-800-854-7179, or online at www.ANSI.org.

Because paper is very susceptible to damage from light, exposure to light is probably the most pressing display concern. Minimize light levels and display times as much as practical, and use substitutes instead of the originals whenever possible. Newsprint, for example, degrades quickly upon exposure to light and will darken. Color photographs, with a few recent exceptions, also are extremely sensitive to light and will fade quickly. Black-and-white photographs are less sensitive, but they also will fade in time. Display a substitute instead of the original if at all possible. Some photographs also are particularly susceptible to pollution. If your display space is in a polluted area, you have another reason to display a substitute rather than the original.

Another concern when using paper items for display is adequate support of items so they do not slip, distort, or suffer structural damage. If loose sheets of paper are displayed vertically on a wall, they need to be well supported in a mat and a glazed frame or in a mat with a glass or acrylic cover. Secure them into the mat in a non-damaging way by such means as hinges, tabs, or straps. Alternatively they can be displayed flat in a case.

Books are best displayed flat, not leaning against a wall vertically. Unless done with great care and expense, vertical display does not provide the physical support needed by a book to

prevent the binding from becoming damaged over time. If a book must be displayed at an angle so that it can be seen, use as low an angle as possible, not exceeding 30° to 45°. Ideally display a book closed, with photocopies of the significant pages displayed beside the book. If the book must be shown open, avoid opening it any farther than necessary to view it, and never open it any farther than the binding allows without force. If the book opens flat without causing stress to the binding or pages and is small and lightweight, it can probably be safely displayed without the aid of a book cradle or other type of book support. Most books, however, need to be displayed on a book cradle that fully supports them when open or with the aid of another type of support, such as blocks or wedges. These bear the weight of the book covers and text block and reduce strain on the hinges and spine of the binding. Do not leave the book open to one place for an extended period of time, because it may become altered structurally and not close properly again. Open it to one place for a limited time only, such as one to three months. If the book must be displayed open for a longer period, turn the pages regularly and as often as possible.

Various types of supports are available from conservation suppliers. Use ones made out of chemically stable, non-damaging materials that are strong enough to support the weight of the book. Inexpensive cradles can be made out of acid-free mat board or polyester film. These types of cradle are best suited for lightweight books but has been used successfully for other sizes of books. If, however, the cradle is positioned at an angle rather than flat, so that the book can be seen better, the cradle needs to be made out of a heavier, more rigid material, such as acrylic, and be fitted with a bottom ledge to support the book. If the book is large and heavy, the cradle also needs a text block support. Although cradles custom-made from acrylic to fit the book when open to a specific location are preferred, these are expensive. Use of mat board and polyester film cradles, adjustable cradles, and other types of book supports are an acceptable, if less than

ideal, alternative.

If necessary, the leaves of an open book can be held in position by narrow (1/2-inch) restraining straps made of a non-damaging transparent material, such as polyethylene or polyester film. Wrap the straps gently around the text and binding and secure them in a non-damaging way with minimal tension. Be sure any adhesives and tapes used to secure the straps never come in contact with the book.

Mounts and Supports

Aside from the book cradles and other types of supports needed for display, paper items do not generally require special mounts and supports. Their greatest need is for storage containers, discussed in *Storage Containers, Supports, and Mounts*. These include phase boxes, drop-spine boxes, mats, frames, document storage boxes, sleeves, and folders.

Cleaning and Minor Repairs

Although removing all dirt from paper is neither necessary nor desirable, some cleaning will often improve the appearance of an item and can remove substances that may eventually harm it. The term *cleaning* refers to a variety of procedures. The simplest of these is surface or dry cleaning, which is done with a soft brush or an erasing compound. The surface cleaning technique described below can be used safely on most book pages, documents, letters, and maps. Use it very cautiously on brittle newsprint, which may tear from even gentle pressure applied during cleaning. Do not use it for photographs. Consult a conservator for advice on how to clean these. Also avoid using it on drawings. These often have graphite or colored pencil, which can smear when cleaned. In general, avoid cleaning pastels, charcoal, watercolors, or other hand-applied coloring that may not be firmly bound to the paper and may be smeared, lifted, or erased

during the cleaning process.

To start, clear a work area that has a large, clean, smooth surface, and place the item to be cleaned on it. Begin cleaning by gently brushing the surface of the item with a soft brush to remove loose dirt and dust. Use up-and-down strokes, and work across the paper. When cleaning books, be sure to brush the dirt out of the gutter or inner margin.

If the dirt is firmly bound to the paper, you may need to use an erasing compound. These come in the form of granules and block erasers. It is probably best to consult a conservator for advice about current brands that are recommended because the compositions of these change periodically. Non-colored vinyl block erasers, such as the Staedtler Mars Plastic eraser and the Sanford Magic Rub eraser, appear at this time to have the least potential for damaging paper. These block erasers can be ground into granules, and they are commercially available in both forms. Test first in an inconspicuous spot to make sure that no damage will occur. Steady the paper with one hand, and test by gently rubbing the cleaning compound over one small area. Once you are certain the image will not be smeared or erased, begin cleaning.

Most conservators clean with granules. To clean with these, sprinkle them over the item to be cleaned. Using your fingers, gently rub the granules over the surface in small circles. Start in the middle and work toward the edges. When cleaning near the edges, do not use a circular motion, but rub from the middle toward the edges using a straight movement. This will help prevent tearing the edges, which are fragile. Brush away granules and loosened dirt frequently. It is essential that all granules be removed from the item following cleaning because they are potentially damaging if left on the paper long-term.

While granules will remove most dirt, erasers in block form may remove even more. Block erasers can abrade soft papers, however, and need to be used with care and only when

necessary. Rub gently in a single direction or in small circles.

Dry cleaning sponges made of vulcanized rubber, which were intended originally for soot removal following a fire, are now being used increasingly for surface cleaning dirt on paper. These sponges are reported to leave no damaging residues on paper, and they appear to be nonabrasive. They are easier to use than granules and block erasers and avoid some of the hazards of these cleaning compounds. You may want to try cleaning with sponges first, especially if you have heavily soiled items. Do not use these on ledger drawings or other items with an image that may smear or lift. Because the sponges tend to degrade upon exposure to light and with age, they need to be stored in an airtight container in the dark. As the surface of the sponge becomes dirty with use, cut off and discard the dirty part.

To clean the outside of books, hold them tightly closed and wipe them with a magnetic wiping cloth. Dry cleaning sponges also work, but they are more awkward to maneuver into the tight spots of a binding unless you cut them to the shape you need. If the books are covered with a heavy layer of dust, vacuuming may be advisable. A soft brush attachment is recommended. The suction of the vacuum may need to be decreased to avoid pulling off loose fragments of deteriorated bindings. Do not use the vacuum directly on books of special or great value. Instead, use a soft-bristled brush to sweep dust from the book into the vacuum nozzle, or use a micro-suction attachment on the vacuum. When cleaning books, it is important to hold them tightly closed so that dirt does not slip between the pages. Clean the top of the book first, which is usually the dirtiest area, followed by the rest of the book. Wipe or brush the book away from the spine to avoid pushing dirt into the endcap or down into the spine of the binding. Clean dust cloths frequently, and never use shelf-cleaning cloths to clean books.

Several cleaning products are available for cleaning bindings; some are specified for

particular types of bindings such as leather, cloth, or paper. There are advantages and disadvantages to the use of these products. Since magnetic wiping cloths and sponges are sufficient for most cleaning tasks, rely on these instead. If you have a particular stain or mark you are trying to remove, contact a conservator for advice.

Tears in paper are a common occurrence, especially if the paper is brittle or the items are used frequently. Never repair tears with self-adhering sticky tape even though the temptation to do so is great. This is because at this time there are no tapes of this type on the market that are of preservation quality. Even though some of the tapes are reputed to be safe and are labeled as archival or of preservation quality, experience shows that these discolor and cause other problems over time, and they should not be used on any item that is intended to last long-term. The same is true of lamination that uses heat or adhesive fusion processes. Safe methods of repairing tears are available. These methods, however, require hand skills that take time to master, as well as the investment in at least a small amount of supplies to get started. In most situations it is not practical to repair tears in-house. An alternative for unbound torn items is to place them in plastic or paper folders or sleeves until the tears can be repaired by a person with these skills. Plastic or paper folders for this kind of storage are available commercially in a variety of sizes. Plastic folders and sleeves have the advantage of allowing an item to be viewed without removing it, which reduces the chance of tearing it further. Most other repairs to paper items are best left to conservators. Do not hesitate to contact them for guidance.