

*re*Collections

Caring for Collections Across Australia

CARING FOR CULTURAL MATERIAL 2

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HERITAGE
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Detail of bark painting, *Lightning Snake Story*, Douglas (Nawurapu) Wununmurra.
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Detail of photograph courtesy of Artlab Australia.

Detail of hand-coloured 19th century children's book. Photograph courtesy of Vicki Humphrey.



HERITAGE
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There are an estimated 41 million objects held in Australian museums, art galleries and historical collections. Collectively they tell the story of our history and our country and contribute to our sense of identity and national pride. Increasing the conservation skills of people who care for these collections is an important factor in protecting this heritage, and is a key goal of the Heritage Collections Council.

reCollections: Caring for Collections Across Australia has been developed with this goal in mind. This set of practical guidebooks is designed by the Council for use principally by non-conservators who are working with Australia's cultural heritage. The guidebooks are also a teacher-friendly resource which can be used in professional development workshops.

Many of Australia's most experienced conservators have been involved in researching, writing and editing **reCollections**, through the Conservation Training Australia consortium, led by Artlab Australia, which first developed the package, and through the Collections Management and Conservation Working Party of the Council.

The Heritage Collections Council's mission is to promote excellence in the management, care and provision of access to Australia's heritage collections so that together, they reflect Australia's cultural and natural diversity. The Council is a collaboration between the Commonwealth, State and Territory governments and the museums sector, and comprises people working in a wide range of cultural heritage institutions across the breadth of urban and regional Australia. **reCollections** is an important component of the Council's National Conservation and Preservation Strategy for Australia's Heritage Collections.

Rob Palfreyman
Chair
Heritage Collections Council

A note to readers

reCollections: Caring for Collections Across Australia

has been written by practicing conservators and is intended to provide a sound guide for the preventive care of cultural items. Active conservation treatment of cultural material should only be undertaken by, or on the advice of, a trained conservator. Before relying on any of the material in this guide, users should check its accuracy, currency, completeness and relevance for their purposes and should obtain appropriate professional advice.

***If in doubt,
consult a
conservator***

To obtain the names of accredited practicing conservators who are in a position to meet your particular conservation requirements contact the **Australian Institute for the Conservation of Cultural Material (Inc.)** a national organisation for conservators and people interested in the preservation of cultural material.

AICCM
GPO Box 1638
Canberra ACT 2601
National Secretary Phone: (02) 6254 8695
<http://home.vicnet.net.au/~conserv/aiccmhc.htm>

Introduction to

reCollections

Caring for Collections Across Australia

Our heritage is represented by a vast array of cultural material, from established national icons holding pride of place in major museums and galleries, to everyday items such as household appliances or newspapers which carry meaning for local communities or families. Yet so often the links to our heritage are tenuous because the objects which represent our culture are in danger of decay. However, there is a lot we can do to protect valued objects and collections and so prolong the life of our cultural heritage. ***reCollections: Caring for Collections Across Australia provides*** practical advice and guidance designed to help the reader care for their heritage.

reCollections explains how to apply preventive conservation techniques to cultural objects and collections. Preventive conservation optimises the environmental conditions in which objects and collections are housed. Controlling light and ultraviolet radiation, humidity and temperature, biological pests, and dust and pollutants helps to prevent damage and decay to cultural material. Preventive conservation also means ensuring that good handling, transportation, storage and display techniques are used at all times. Applying preventive methods to the care of cultural artefacts and collections can prolong and protect their life for current and future generations of Australians.

While ***reCollections*** provides conservation information about the care of cultural objects and collections, it is important to recognise that all except the simplest conservation treatments should be undertaken by trained conservators. Active conservation treatment is a response to the damage of cultural artefacts, a highly skilled field which often involves the use of chemicals and complicated technical procedures. Unless performed with a thorough knowledge of appropriate techniques and with the right equipment and materials, conservation treatments can do more harm than good to the objects being worked upon, and can be hazardous to the people performing the work. Conservation treatments should only be conducted by, or on the explicit advice of, a trained conservator.

To complement the preventive conservation advice contained in the volumes *Damage and Decay* and *Handling, Transportation, Storage and Display*, ***reCollections*** supplies detailed information concerning the care of some of the most common cultural materials. These range from the paper and other materials on which so much of Australia's cultural history may be seen, to special considerations in caring for Aboriginal and Torres Strait Islander cultural artefacts. In addition, modern practices concerning the management of collections and of the people who look after those collections are outlined.

TEXTILES

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Objectives

At the end of this chapter you should:

- have a basic knowledge of the main problems encountered in collections of historic textiles;
- have an understanding of correct handling techniques for historic textiles;
- have an awareness of the range of different types of textiles and have practical knowledge of how to store them, so that damage can be minimised;
- be able to display historic textiles in such a way as to ensure their preservation; and
- have a basic knowledge of, and some practical skills in, labelling and cleaning textiles in the best and safest manner, in order to preserve them.

Introduction

Textiles are found in many collections in museums, galleries and libraries. They are valued for their historic interest, their aesthetic appeal and their cultural significance.

Because of their wide appeal, textiles—particularly historic costume—are often on permanent display in regional museums. They make striking exhibits and are very evocative of times gone by. But our great interest in them can be their greatest enemy.

Many textiles are very familiar, everyday items. For this reason, we don't always realise just how fragile they are and so don't always give them the care that they need. We display them, wash them, wear them, and feel them to enjoy the texture of the fabric; and in doing all of these things we expose the textiles to the risk of damage.

With a greater understanding of how to handle, display and store textiles safely, it is possible to take steps to improve the care of the textiles and to ensure ongoing access to the historic and cultural information and the aesthetic pleasure that they provide.

What do we mean by textiles?

Generally the term textile refers to woven fabrics. In heritage collections, however, the term has a broader meaning and covers materials which are produced by other means, including:

- the interlacing of yarns, such as knitting, lace making and netting;
- other needlework techniques worked through a woven base, such as embroidery and canvas work.

Some examples of textiles that you may find in your collections are:

- costume, uniforms;
- millinery;
- tapestries;
- ecclesiastical textiles;
- carpets and rugs;
- dolls, parasols and fans;



The back view of an 1860s English cotton dress.

Photograph courtesy of Artlab Australia, reproduced with the permission of the History Trust of South Australia.

- patchwork and applique;
- flags and banners;
- quilts;
- teddy bears;
- needlework;



This sampler was produced by a 12-year-old girl in 1841.

Photograph courtesy of Artlab Australia, reproduced with the permission of the History Trust of South Australia

- curtains, upholstery;
- ethnographic textiles;
- samplers;
- non-woven materials such as felt; and sometimes, fur.

What are the most common types of damage?

Textiles are vulnerable to physical damage, and to the damage caused by chemical deterioration of their components.

Physical damage is very obvious and includes problems such as:

- inappropriate repair of damage;
- insect attack;
- damage caused by washing historic textiles in modern washing machines;
- shrinkage;
- tears;
- splits in textiles where they have been folded or creased;
- worn areas; and
- damage resulting from lack of proper support while on display.

Damage due to chemical deterioration includes:

- fading and discolouration because of exposure to UV radiation and high lighting levels;
- weakening of fibres because of chemical reactions initiated by light and UV radiation;
- deterioration because of mould growth—mould digests the materials it grows on;
- damage from pollutants in the storage and display environment; and
- damage caused by perspiration, blood and other stains.

Common causes of damage

All the most common types of damage to textiles are caused by:

- poor handling;
- wearing historic costume;
- poor storage methods;
- inappropriate display methods;
- chemical changes in the textiles themselves;
- chemical changes caused by contact with other materials, such as perspiration and atmospheric pollutants; and
- various combinations of any and all of these.

The following sections will outline practical steps you can take to minimise this type of damage.

The do's and don'ts of handling textiles

Think about how you handle textiles. Handling them with care and commonsense goes a long way to preventing damage.

The most important rule for handling textiles is to keep handling to a minimum.

Whenever possible, wear white cotton gloves when handling textiles. They prevent the transfer of body oil and dirt to the textiles. This is not always practical, so as a compromise make sure your hands are clean: always wash them before handling a textile. This is particularly important with

textiles incorporating metal thread, because acids from the skin tarnish metal.

Remove all jewellery such as rings, bracelets and necklaces, which could catch on the textiles and cause damage.

When you do handle textiles they should always be supported properly. Textiles which appear strong may, in fact, have areas of weakness which are not immediately visible. Regard all historic textiles as fragile.

When handling flat textiles:

- never pick them up by one corner. Always support the weight of the textile evenly;
- carry small textiles on a tray, in a box, or on a board;
- larger textiles should be rolled and carried on the roller, using the part of the roller extending beyond the textile to grip; and
- never try to move a textile by yourself if the size and weight of the textile indicates that you need two people. Carrying large textiles incorrectly can not only damage the textile, but can also put strain on the person carrying it.

When handling a costume, remember that it should never be picked up by the shoulders—always slide your arms under the costume and then lift.

Ideally, costume should be moved in boxes or on a board.

Don't carry items on a hanger without using your arms for additional support.



The correct way to pick up a costume on a hanger.

Photograph courtesy of Artlab Australia

Remember, accessories should always be supported evenly. For example, do not pick up a bag by its handle: use two hands to support it. Accessories should be transported on boards or in boxes. But there are exceptions to this rule. Use your commonsense to decide the most appropriate way to handle them.

The do's and don'ts of labelling textiles

It is often necessary to label individual textiles with an identification number, such as an accession number.

Wherever possible, the number should be written on cotton tape either in pencil or in permanent ink. A reliable brand of permanent ink pen to use is the Nikko Finepoint System Permanent Ink pen. These are available in a number of point sizes. The finer pens are best, such as 0.2mm.

Stitch the cotton tape to the textile with only one or two stitches at each end, using fine, white, cotton thread.

It is helpful to always stitch the number in the same place for each type of textile. This way, you will know exactly where to look for the label and you will avoid excessive handling while searching for the number. For example:

- for flat textiles, always stitch the label on the bottom left-hand corner at the back of the textile; and
- for costume, always stitch the label at the back of the collar on the inside of the garment.

It may not be possible to stitch a label to all items, for example, fans, shoes or hats. Label these items with acid-free cardboard tags with string attached.

Never place adhesive labels directly on textiles—the adhesive will stain the fibres and make them brittle.

Once the items are labelled, store them appropriately. It is very useful to label clearly the outside of all storage boxes and rollers. This allows you to see what item is in each package without having to handle the textile. A small photograph



Accession number label on flat textile.

Photograph courtesy of Artlab Australia

of the textile attached to the outside of the storage system makes identification easy.

A good way to keep your storage area tidy and the collection accessible is to have a shelf list or plan. This shows exactly where each item is stored. If it is kept in the storage areas, it can be used to ensure that items are always returned to the correct place in the store after use.

Historical costumes—why they should not be worn

It is often very tempting to wear an historic costume for festive occasions, especially when celebrating historic events. Some people feel that garments can't be fully appreciated unless they are worn. This is understandable; but the preservation of historic costume demands that the temptation to wear the costume be resisted.

A fabric may appear strong; but when it is strained, even slightly, it can tear or the seam stitching can break. This damage is increased when the garment isn't a good fit on the person wearing it—or if the person does not have the correct undergarments to support the costume. Remember, body shapes have changed and modern undergarments do not necessarily give the right body shape for historical costumes.

The actions of dressing and undressing can cause a lot of damage to fragile items.



The shape of this 1870s dress clearly shows that fashions in body shapes have changed.

Photograph courtesy of Artlab Australia, reproduced with the permission of Burra National Trust

Sitting down or raising your arms in a fragile costume could result in irreparable damage.

Body oils can transfer from the skin to the garment. This can cause disfiguring stains, and the soiling can attract insects.

Food and drink could be spilt on the garment, resulting in unsightly staining. The chemicals in food and drink could also react adversely with the textile itself, or with the dyes in the textile.

The way women move has changed. For example, some dresses were designed so that women could not raise their arms without damaging the dress.

The stress and strain caused by wearing a garment can be immediate and dramatic, or it can contribute to the gradual weakening of the item. Even seemingly minor damage can ruin an historic costume. So it is best to avoid wearing historic costumes from your collection.



Stains can severely mar the appearance of garments.

Photograph courtesy of Artlab Australia, reproduced with the permission of the Art Gallery of South Australia

Storing textiles

Adverse storage conditions affect all items in a collection. The effects are not always dramatically obvious. Changes occur gradually over a long period of time. However, once the changes have occurred they are often irreversible, or require complex and costly treatment to deal with them.

A good storage environment prevents physical damage and helps to slow down chemical deterioration, greatly increasing the life of your textile items.

Ideal storage conditions for textiles

Textiles are considered to be sensitive materials; that is, they are extremely vulnerable to damage when stored or displayed in inappropriate environmental conditions.

Ideally, textiles should be stored in an environment where the temperature is constant and moderate: in the range 18–22°C.

Relative humidity should be constant and in the range of 45–55%. This can be very difficult in extreme climates. If it is not possible to keep the relative humidity within these limits, it is important to avoid rapid fluctuations in relative humidity.

Light should be kept to a minimum. Light is required only when the textiles have to be viewed, for example, when they are being accessioned, treated, or used for research. Information about appropriate lighting levels is given in the section Ideal Conditions for Displaying Textiles.

Protect textiles from pollutants, dust and insects.

Airborne chemicals that most commonly affect textiles include smoke, oil and acids. Smoke causes staining and discolouration, which are extremely difficult to remove. Textiles displayed in a room with a fireplace or where smoking is permitted should be housed in smoke-proof containers such as sealed frames or sealable boxes.

Acids are also given off in small quantities by pest strips and some types of plastic. Consequently, pest strips normally should not be used inside enclosed storage areas.

Practical hints for storing flat textiles

Small flat textiles can be stored flat, either in a box or on covered shelves. Dust covers should be provided for textiles on open shelves.

Always interleave textiles with acid-free tissue, if a number of them are stored one on top of the other.

Take care to not stack too many items on top of each other and place heavier items on the bottom of the stack.

If a textile needs to be folded, the fold needs to be padded—either with crumpled tissue or with a covered Dacron sausage. This is made from a tube of white or unbleached cotton filled with Dacron. Padding is an important precaution because textiles will eventually split along the line of sharp folds or creases.



Textiles stored flat in a metal plan chest. The textiles are padded and protected with acid-free tissue.

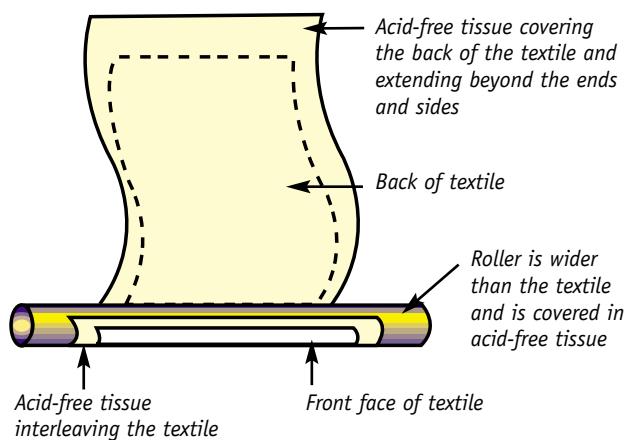
Photograph courtesy of Artlab Australia

Ideally, larger flat textiles should be rolled. When choosing a roller on which to store a flat textile, there are several things to consider.

The diameter of the roller should be as large as possible—to minimise the curvature of the textile when it is on the roll.

The roller should be longer than the textile's width, so that when rolled, the ends of the roll are exposed and the edges of the textile are protected by the projecting ends of the roller.

The roller should be covered with an acid-free material such as acid-free tissue, acid-free paper or Tyvek. This protects the textile from impurities and other damaging chemicals which might be contained in the roller. The tissue also provides a soft surface on which to roll the textile.



Padding and covering a roller.

Photograph courtesy of Artlab Australia

It is important that the textile is clean and dry. A dirty or damp textile is likely to deteriorate in storage; and this may go unnoticed for a long time.

When a textile is rolled, the front side of the textile should face away from the roller.

If the textile has a pile—like velvet—it should be rolled in the direction of the pile, with the pile facing out.

Fringes or tassels should be kept straight in the rolling process. You can do this by sandwiching the fringe or tassels between acid-free tissue before you start rolling.

To prepare the textile for rolling:

- lay the textile out, face-down onto a clean, flat surface. Make sure that the weave of the textile is straight, and check that the weave of the fabric is not warped;
- cover the textile with a layer of acid-free tissue paper. Check that there are no creases in the tissue: these can cause corresponding creases in the textile, and damage it;
- if the textile has areas of padded decoration or the weave is distorted in any way, it will interfere with the rolling process. A piece of Dacron polyester wadding wrapped in acid-free tissue should be placed over the acid-free tissue in the location of the decoration or distortion. The Dacron must be covered, to prevent any of its fibres transferring to the textile or catching on any surface decoration; and
- if you leave approximately 100mm of tissue protruding beyond your textile, you can use this to start the rolling procedure.

When you have finished preparing the textile:

- place the covered roller on the protruding end of the tissue and start rolling. Use a firm pressure so that, as the textile is rolled onto the roller, it remains straight and firm.
- the weave should be kept straight while the textile is being rolled;



Rolling a large textile onto a roller.

Photograph courtesy of Artlab Australia

- once the textile is fully rolled, cover it with another layer of acid-free tissue and/or Tyvek. Secure the cover by tying the ends with cotton tape. It is important to not tie the tape too tightly, because it can distort the edges of the rolled textile;

- very large textiles should also be tied with cotton tape in the centre, to prevent sagging. Again, do not tie the tape too tightly, it might damage the textile; and
- label the textile clearly to identify it in storage.

Preparing historic garments for storage

It is important to ensure that garments are as clean and dry as possible before they are packed away. If the costume is not cleaned, colourless stains may darken with age, and insects such as the clothes moth and carpet beetles will be attracted to organic stains from perspiration and food.

If the garment is strong, it is advisable to have it dry-cleaned.

There are some steps you can take to minimise the risks associated with dry-cleaning historic costume:

Always use a drycleaner who is a member of a professional drycleaner's association.

Be sure to ask for special care if the item is fragile or complex.

Prepare your garments carefully for dry-cleaning, by either covering buttons and hooks with Dacron or by removing them from the garment.

Request that the garment be cleaned on its own.

Ask the drycleaner to place the costume in a bag in the dry-cleaning machine. This gives it support and prevents it rubbing against other items if it is not on its own.

It is better to clean historic costume in fresh solvent—so ask the drycleaners when they are next changing their solvents and schedule your work for that time.

Remember, it is better to leave a garment stained than to damage it greatly during cleaning; so leave fragile items until you have had a chance to seek advice.

CAUTION:

Remember that dry-cleaning machines have a vigorous, mechanical action similar to a tumble drier, and so can damage fragile textiles and costumes. Check with a textiles conservator if you are unsure whether the items you are dry-cleaning are strong enough.

An easy, do-it-yourself padded hanger for costumes

Apart from very heavy or fragile items, many garments can be stored on padded hangers. Padded hangers are used for hanging costume such as shirts, bodices and dresses. Other items such as trousers or skirts need additional support. It is important to remember that by ensuring an even distribution of weight on the hanger, you will be giving the item maximum support while it is hanging in storage.



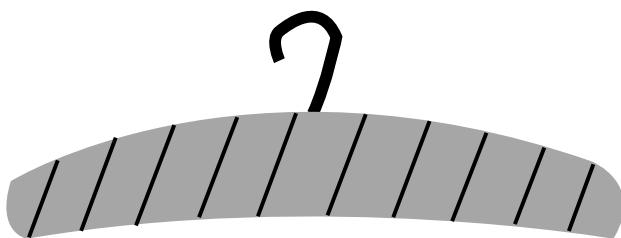
A 19th century velvet and lace bodice hanging on a padded coat-hanger.

Photograph courtesy of Artlab Australia

Padded coat-hangers are quite simple to make—just follow these steps. You will need:

- a coat-hanger—it should be strong and made of either wood or plastic. Wire hangers are not suitable. Make sure that the size of the coat-hanger is appropriate for the garment to be hung. For example, don't use a large coat-hanger for a child's garment. The hanger can be cut down to the appropriate size if necessary;
- fabric—all fabrics used to cover the hanger must be washed before use. White or unbleached fabrics are preferred. Unbleached calico or white/cream, stretch-cotton fabrics are ideal;
- Dacron;
- a needle; and
- thread;
- scissors.

Place layers of Dacron polyester wadding over the hanger, padding it to the same width as the shoulders of the garment. The hanger should be padded to suit the shape of the garment; for example, if the garment has sloping shoulders make the padding to match. The Dacron may need to be hand-stitched to hold it in place.



Once the padding is in place, cover the Dacron with fabric to provide a smooth surface on which to rest the garment. A stretch fabric is generally easier to fit and sew into place.



For additional support, for example, for a dress with a heavy skirt, sew white, cotton tapes to the inside of the waistband, then tie these over the coat-hanger to take the weight of the skirt. Sew at least four tapes onto strong areas of the waistband. If four tapes are not enough to fully support the weight of the skirt, use more. Use a fine needle for sewing and sew through all layers of the waistband.



CAUTION:

Sew tapes only to strong areas of the costume.
Make sure weight is distributed evenly.
Tapes stitched in inappropriate positions
can damage the garment.

Finally, make covers for each garment to protect them from dust. The best materials for making covers for hanging garments are clean, washed cotton, for example, old cotton sheets or calico, and Tyvek.

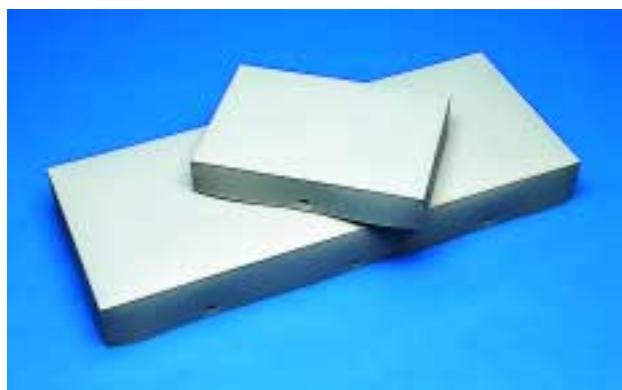
CAUTION:

Do not use plastics and synthetic fabrics as covers. A garment stored in this type of cover can't breathe and may rot. The exception to this rule is Tyvek, which is a specially made polyethylene fabric which can be used because it allows textiles to breathe.

Storing garments in costume boxes

Sometimes hanging storage is not appropriate—either because the garments are too heavy or too fragile to safely carry their own weight, or because you don't have an appropriate storage space.

If hanging storage is not appropriate, the items should be well padded and packed in boxes.



Polypropylene costume boxes from a supplier of conservation materials.

Photograph courtesy of Artlab Australia

Acid-free costume boxes can be bought from conservation suppliers; or you can make your own following the directions below.

If acid-free boxes are not available, normal boxes or drawers can be lined with Tyvek and used for storage. The Tyvek will act as a barrier between the box material and your textiles.

When packing garments in boxes, it is advisable to pad the garments. Crushed, acid-free tissue can be used along all of the folds in the garment and on the side seams, shoulders and sleeves so you will also need enough acid-free tissue paper to pad one average-size garment.

Remember, creases and folds should be well padded, to minimise stress on the fabric. With time, creases develop into splits if not padded adequately.

Take care to not put too many textiles in one box, because the weight may crease the lower textiles. Always put the heaviest costume on the bottom.

Wherever possible, keep all of the parts of one costume together.

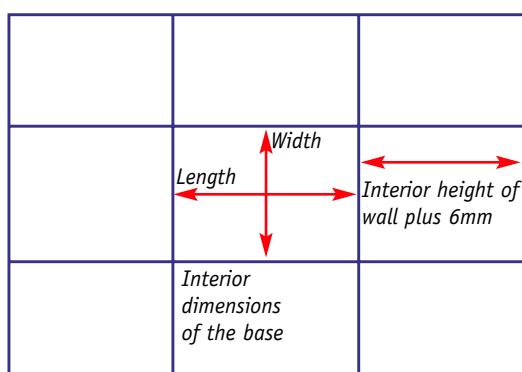
An easy, do-it-yourself costume box

This box is made from 6mm-thick acid-free Foam Cardboard.

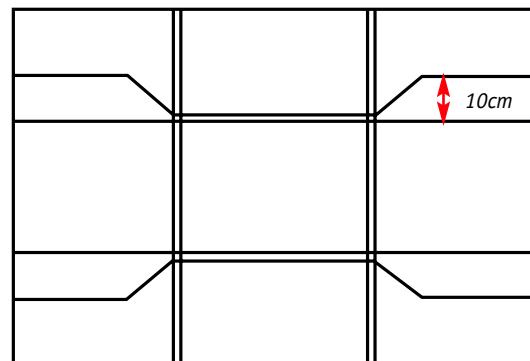
Cut the board into a square or rectangle. Once you have decided on the dimensions of the base, the dimensions of the box can be worked out as shown on the diagram below.

The base of the box should be a little bit larger than the costume, while the height should be sufficient to accommodate the costume and padding.

On the interior surface, draw lines in pencil: 1, 2, 3 and 4 as shown on the diagram.

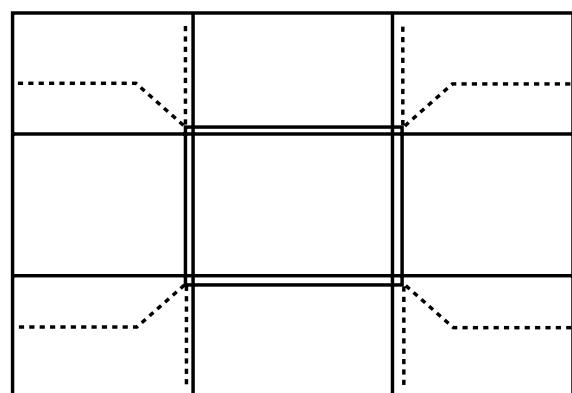


The next step is to draw in additional construction lines, shown in the next diagram.



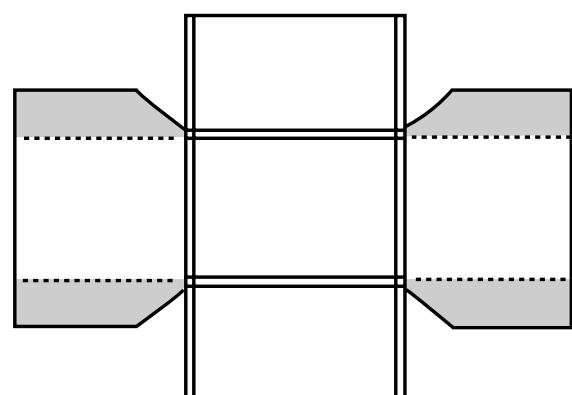
With a utility knife or Stanley knife, cut completely through the Foam Cor board on the dotted lines indicated in the diagram below.

Discard the four corner pieces.

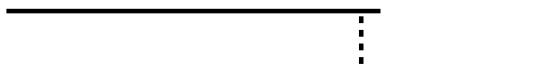


The cut Foam Cor is now ready to be assembled into a box.

Along the dotted lines shown in the diagram below, cut through the upper two layers of the Foam Cor board, being very careful not to cut the bottom layer.



In the stippled areas indicated in the box diagram above, peel off the upper two layers, being careful not to damage the bottom layer. The cross-section of the board will look like this when you have finished:



It is worth practising this with the discarded corner pieces of Foam Cor.

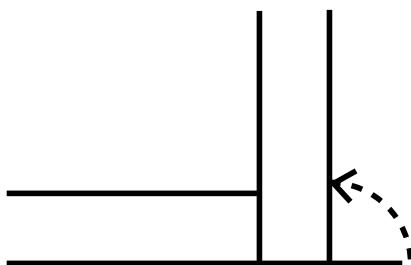
Score the four edges of the base of the box with a Stanley knife between the double lines drawn in pencil on the board; cut half the thickness of the board out between these lines. The board should look like this:



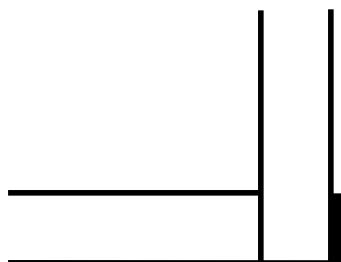
This will allow for a smooth edge when the sides are folded up.

To assemble the box:

- fold the four walls along the scored lines;
- the wall corners should overlap as shown in the diagram below;



- fold the flaps, which were left after you peeled away the top two layers of board, over the adjacent wall and stick them down with acrylic or polyvinyl acetate—PVA—adhesive. The flaps should be stuck securely; make sure that you completely cover the inside of the flap with adhesive and press it onto the wall;



It is wise to stick each flap individually, and weight it while it dries.

The corners and edges of the box can be strengthened by covering them with cotton adhesive tape.

The lid is made in exactly the same way as the box. The lid sits over the top of the box walls, extending down 50mm. The interior dimensions of the lid should be slightly larger than the exterior dimensions of the top of the box. The lid should fit snugly, but not tightly; it should lift off easily without jerking the box.

Storing accessories

It is best to store umbrellas and parasols slightly opened, and gently padded inside with rolled acid-free tissue or Dacron covered in calico or acid-free tissue. Where possible, they should be hung and wrapped in individual calico or cotton covers. If padded umbrellas and parasols are packed in boxes, they should be padded and wrapped individually before storage.



Accessories should be supported properly in storage and for display.

Photograph courtesy of Artlab Australia, reproduced with the permission of the History Trust of South Australia

Store flat accessories, such as scarves and ties either flat or rolled around cardboard tubes. Cover the cardboard tube with a layer of acid-free material before using it to store accessories. Place acid-free material over the textile before rolling it. Once the accessory has been rolled onto the tube for storage, wrap it in another layer of acid-free material, and fasten each end with a length of cotton tape.

Where possible, roll items with fringes or thick edges with the fringe or edge on the outside.

Remember that textiles should be rolled firmly but gently around tubes—to avoid creasing.

The best materials for storing and displaying textiles

Textiles can be adversely affected by other materials in their immediate environment. For example, acids can be a problem for textiles stored in some wooden cabinets. Unsealed wood gives out acidic vapours that build to sufficient concentrations in an enclosed space to cause damage. Sealed wood or metal cabinets are better, because they are less likely to contribute to damage.

Only plastics which are safe and stable, such as polyester and polypropylene, should be used as storage materials. Polyvinyl chloride—PVC—is a commonly available plastic, but avoid using it.

The following list of good and bad materials—from a preservation viewpoint—can help you in selecting your storage and display furniture, or the materials to use when making them yourself.

GOOD	BAD
enamelled metal	chipboard, Custom wood
acid-free board	uncured PVA glue
acid-free paper and tissue	uncured paint
polypropylene	protein based glues, for example, animal glue
Polyester film and felt	cellulose nitrate
Cotton	Polyurethanes
Linen	unsealed wood, especially hardwoods
Acrylic paints and varnishes	PVC
Sealed wood	Wool, if metal is also present

Displaying textiles

When textiles are on display they are perhaps more vulnerable to damage than when they are in storage, particularly from light and UV radiation.

How does light affect textiles?

Light and UV radiation are the greatest enemies of textiles. They cause photochemical deterioration: the colours fade and fabrics become fragile and split readily.



By folding this textile back onto itself you can see the extreme fading caused by exposure to light.

Photograph courtesy of Artlab Australia, reproduced with the permission of the Art Gallery of South Australia

Exposure to light can multiply the adverse affects of poor environmental conditions, and damage caused by light is often accelerated by high relative humidity and temperature.

Textiles produced in the late 19th century need particular care. The aniline dyes which were first manufactured and became popular around this time were very susceptible to fading—especially purples, blues and greens. This is particularly important for many regional museums, because it is often textiles from this period that are on display.

Ideal conditions for displaying textiles

Display textiles in similar conditions to those outlined for storage; however, as light is essential in a display environment there are some differences that must be taken into account.

Textiles are considered sensitive to light, so lighting levels must be set so that they do not damage the collection. The brightness of the light should be less than 50 lux; and the UV content of light should be preferably below 30 $\mu\text{W/lm}$ and no greater than 75 $\mu\text{W/lm}$.

CAUTION:

It is important to remember that all damage caused by photochemical reactions is cumulative and irreversible.

The temperature should be constant and kept in the range of 18–22°C.

Relative humidity should be in the moderate range of 45–55%.

Controlling relative humidity in a display area may be more difficult than in a storage area. Fluctuations are much more likely, because of the varying numbers of people visiting when the display is open followed by no people at times when the display is closed.

Protect textiles from pollutants, dust and insects.

It is also necessary to provide adequate support for costume and textiles while they are on display.

For more information

For more information about adverse environmental effects, please see *Damage and Decay*.

Mounting flat textiles

The following method of mounting a flat textile involves a number of steps, but it is quite simple if the instructions are followed closely. You will need:

- white cotton flannelette. This layer acts as an environmental buffer and as padding for the textile. It is advisable to wash the flannelette in hot water before you use it, so that it shrinks. Shrinkage after you use it on the mount board causes distortion of the board;
- a background, support fabric which has a suitable colour, weave and fibre to harmonise with the textile to be mounted. A general rule for selecting backing fabrics is that they should be made of the same fibre as that being mounted. For example, a silk textile should be mounted on a silk fabric. If you can't use the same fabric, a chemically inert

polyester fabric should be used. Wool and silk are chemically compatible and can be used together;

- acid-free board, such as acid-free Foam Cor, for the base of the mount;
- a Stanley knife or utility knife and metal rule for cutting out the board;
- PVA glue—acid-free PVA is available and should be used if possible;
- a fine needle—a slightly bent needle or a curved needle will be easier to use;
- thread;
- pins; and
- scissors.

Cut the acid-free board to the required size—usually the size of the textile to be mounted plus a border. Borders generally have the same dimensions at the top and sides, with a slightly larger allowance at the bottom edge. The extra allowance at the bottom edge makes the item being mounted look centred on the mount. If this allowance is not made, the item will look as though it is too low on the mount. This is called optical centring.



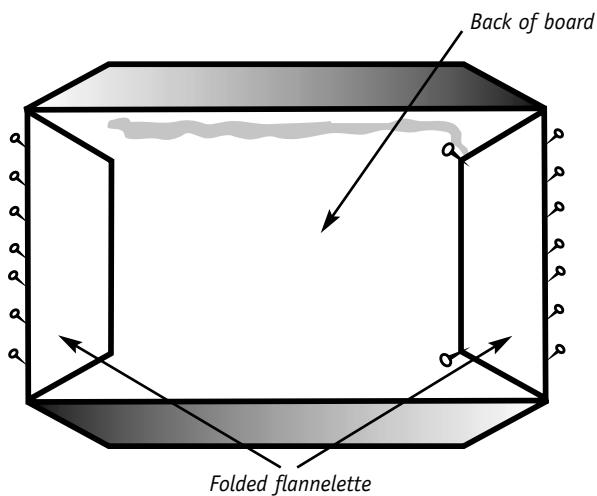
The backing board is cut to size to provide a border around the textile. Note the border is wider at the bottom.

Cover the board with white, cotton flannelette. The fabric should be cut larger than the board, so that it can be folded to the back of the board to be attached firmly.

Pull the flannelette tightly over the board and pin it to the sides of the board. Cut the corners away to allow a flat fold-over.

Check that the grain of the fabric is straight in both directions before fixing it in place.

To fix it in place, glue the fold-overs of fabric to the back of the board using a polyvinyl acetate—PVA—adhesive. Pin the fold-overs in place, to hold them while the glue dries. PVA can be used as long as it dries fully and cures before the mounted textile is framed.



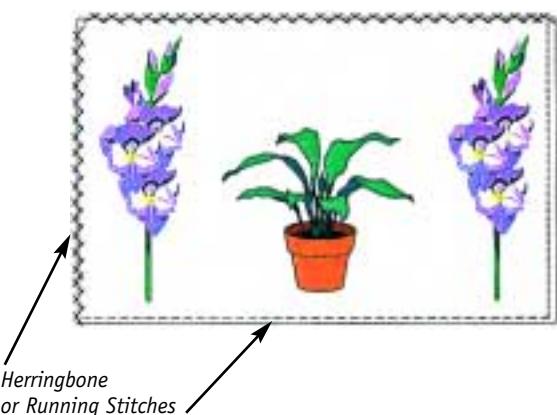
Cut the background support fabric and attach it to the board in the same way as you did with the flannelette. Remember to cut the fabric larger than the board, because it has to overlap on the back of the board.

Once the glue attaching the background fabric has dried, glue another piece of this fabric in place onto the back of the board over the fold-overs. This gives the back of the board a finished appearance and hides the cut edges of the fold-overs.

Once the prepared board is completely dry, lay the textile on the front fabric and stitch it into place. Don't apply tension to the textile when you are stitching it.

Before stitching, ensure that the grain of the textile is aligned with the grain of the backing fabric, otherwise it can look lopsided.

Use herringbone stitches on frayed edges—this will help prevent further fraying. A running stitch can be used on hemmed edges or selvages.



All edges of the textile should be sewn. It ensures that the weight of the textile is distributed evenly.

For larger pieces, grid lines of stitching may be required through the middle of the textiles, to provide extra support. Generally a line of stitching is needed every 200mm.

For more information
For information about the selection of support fabrics and for information about stitches, please see the section *More About Textiles* later in this chapter.

Conservation framing

Having mounted your textile in such a way as to protect it and reduce the stresses placed on it, it is important to frame it correctly. Conservation framing is designed to protect against harmful environmental effects such as light, dust and insect attack.

Framing your textile using the wrong techniques and materials can cause irreparable damage. Conservation materials and techniques may be more expensive than general framing, but it is really worth the investment. The following notes outline the main points to be considered when framing textiles.

It is strongly recommended that frames containing textiles be glazed to provide added protection. Glazing provides a barrier at the front of the frame. The barrier buffers the textile against fluctuations in relative humidity and temperature. It keeps insects, dust and pollutant gases away from the textile, and provides some protection against the harmful effects of light and UV radiation.

The selection of glazing materials is important. Glass can be used, but it does have disadvantages:

- if the glass breaks, it can very easily cut your textile; and
- glass provides only a little protection against the harmful effects of UV radiation.

Plexiglas 231, an acrylic UV-filtering glazing, is much better than glass. It does not break and it gives added protection against UV radiation.

The glazing material should not be in direct contact with the textile because:

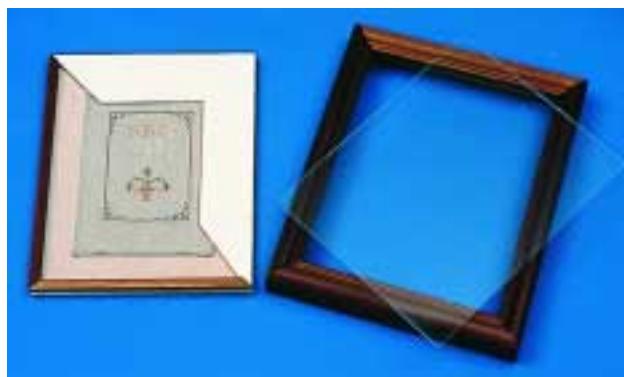
- this can flatten the texture of the textile through pressure; and
- mould can grow on the item, if environmental changes result in condensation forming on the inside of the glazing.

A slip, spacer or window mount should be used to separate the glazing from the mounted item.

The covered, acid-free board on which the textile is mounted should fit into the frame with a couple of millimetres gap in each direction: so that if the board expands, it will not distort.

An acid-free board should be placed on the back of the frame, to seal the frame from dust and insects. It should be attached firmly to the frame and sealed with tape.

The correct mounting and framing of textiles not only protects and prolongs their lives, but can also greatly enhance their appearance.



Components of a conservation framing system. On the right, the frame moulding and glazing; on the left, the mounted textile with a window mount. In this case the window mount is cut away to show the mounting technique.

Photograph courtesy of Artlab Australia

Open hanging methods for flat textiles

It is best for textiles to be fully supported and protected with mounts and frames. But there are types of textiles that are better suited to open display, for example, large flat textiles.

The following open display methods are quite easy and give your textiles adequate support while on display.

Hanging textiles using Velcro

Velcro hook and loop tape can be used very successfully to hang textiles for display. But Velcro can be used to display only some types of textiles. The textiles need to be strong and in good condition.

This method is best suited to fairly thick types of textiles such as tapestries and quilts. It is not suited to fine fabrics like sheer silks or lace.

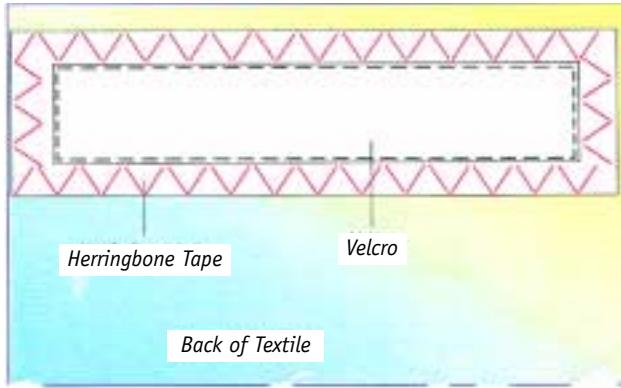
First, machine sew the soft side of the Velcro to herringbone cotton tape; this makes the Velcro easier to hand-sew to the textile and avoids the Velcro being attached directly to items.

Position the Velcro and herringbone tape straight across the top of the textile and hand-sew it to the textile. It is important that the stitching goes through all layers of the textile. If the stitching does not go right through all layers, some layers will bear all the weight and others will eventually sag. The top edge will be damaged and distorted.



Velcro and herringbone tape attached to the back of a textile.

Photograph courtesy of Artlab Australia



CAUTION:

Do not machine sew Velcro to your valued textiles because machine-sewing creates perforations, which can be a line of weakness.

Tack or staple the hard side of the Velcro to a wooden bar of sufficient size and strength to bear the weight of the textile. Make sure there are enough tacks or staples to bear the weight of the item which is to be hung for display. Once this is done, the bar can be hung in position.

Then attach the textile to the bar by aligning the two halves of the Velcro system.

If the textile does not hang straight or flat at first, the Velcro enables you to adjust the top edge and alter the hang of the textile.

Heading cloth

Another method for hanging textiles is to use a heading cloth. This method is suitable only for textiles in very good condition, and is more suited to lightweight fabrics.



This sari is rolled for storage, but in the foreground is a heading cloth which has been attached so it can be hung for display.

Photograph courtesy of Artlab Australia reproduced with the permission of the History Trust of South Australia

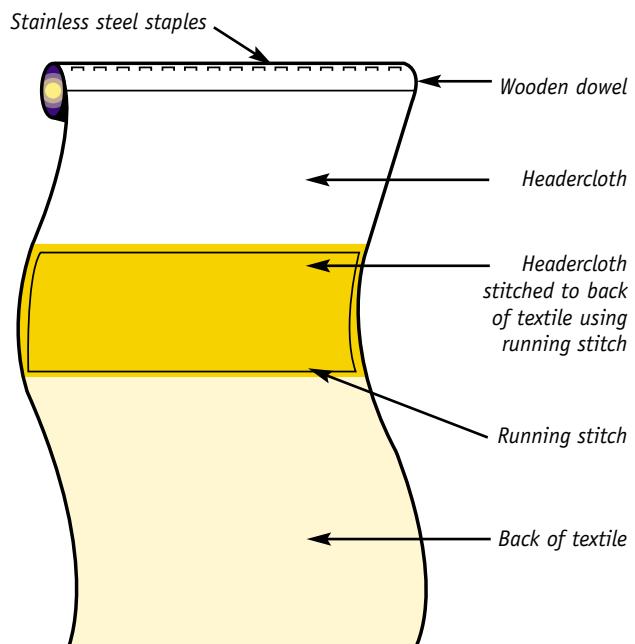
Using running stitch, attach a strip of fabric to the underside of the textile you wish to display. The strip of fabric should extend well under the textile to ensure adequate support, and extend beyond the top of the fabric by at least 500mm.

Use herringbone stitch to attach the heading cloth to the top and sides of the textile if it has frayed edges.

To hang the textile for display, attach it to a round, wooden batten, which must first be sealed with acrylic paint to prevent damaging acids transferring to the textile.

Once the paint is fully dry and cured, the heading cloth is rolled around the batten until the top of the textile is level with the batten. The heading cloth is stapled to the batten using stainless steel staples. See diagram.

The batten can then be attached to the wall with fittings such as threaded eyelets screwed into the ends of the batten.



The back of a textile can be protected using a loose lining. This is particularly important if the wall the textile hangs against is very rough or dusty. A lining is made slightly smaller than the textile, and hangs between it and the wall. It can be attached to the dowel or bar used for hanging the textile.

For more information

For information about stitches, please see the section More About Textiles later in this chapter.

Displaying historic costume

Many people feel that garments cannot be fully appreciated unless they are worn. It is difficult to get a complete picture of the cut of a garment if it is hanging on a coat-hanger. For this reason, garments are regularly placed on mannequins for display, however, the mannequins used are not always appropriate.

A costume needs to be displayed in the correct way: so that it is supported and not vulnerable to physical stress, and so that it communicates accurate information about the fashions and customs of its period.

The most important consideration when displaying a costume on a mannequin is to make sure that the mannequin is the right size and shape for the costume. Each costume has a particular silhouette which provides an accurate representation of fashions of a particular period; and this cannot be seen if the mannequin used is the wrong size or shape.

If you do not have a mannequin of the correct size and shape, it is relatively easy to:

- modify a mannequin to suit a particular garment; and
- provide the correct undergarments for the period.

Modifying an existing mannequin

A mannequin can be modified to suit the garment which you are going to display. If you have a choice, it is best to select a mannequin which is smaller than the garment, and then pad it to fit the garment exactly.

If you have a mannequin which is smaller than the garment, begin by measuring the garment in a number of areas, such as the hips, waist, chest, shoulders, shoulders to waist and inside trouser leg. Careful measuring will ensure that you will not need to keep trying the costume on the mannequin while modifying it. This minimises handling of the garment, which is very important, especially if it is fragile.



The unmodified mannequin.

Photograph courtesy of Artlab Australia



Mannequin padded out and wearing undergarments.

Photograph courtesy of Artlab Australia

If you have a mannequin which is larger than the costume, the mannequin will need to be reduced in size. Electric sanders and saws are useful for this job.

Once the mannequin has been cut down it should be covered as described above. You may have to wrap the mannequin in cotton bandages to smooth over any rough surfaces before padding the mannequin.

Contemporary mannequins are generally not suitable for displaying historic costume because they have the wrong silhouette and inappropriate faces.

Undergarments should be made from white or unbleached fabric. They are particularly important in order to provide the correct support for the garment while on display. If a garment is not supported as intended, stresses will arise along the seams of the fabric and irreparable damage will occur.

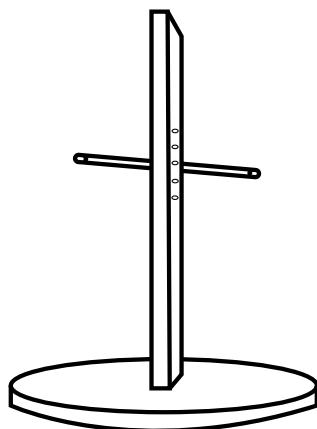


The completed mannequin, with costume.

Photograph courtesy of Artlab Australia, reproduced with the permission of the History Trust of South Australia

The basic stand is made of hardwood 25mm in diameter and approximately one metre long. The hardwood is sunk into a round base approximately 300mm in diameter and 40mm deep. The base may be heavier if necessary.

All wood surfaces must be sealed with a clear Estapol or the like. This slows the migration of acids from the wood.



Drill 5mm holes through the stand at 10mm intervals. This allows for the waistline of the mannequin to be altered to suit a particular costume.

Place a steel pin through the holes to support the upper structure of the mannequin. The stand should be set into the base.

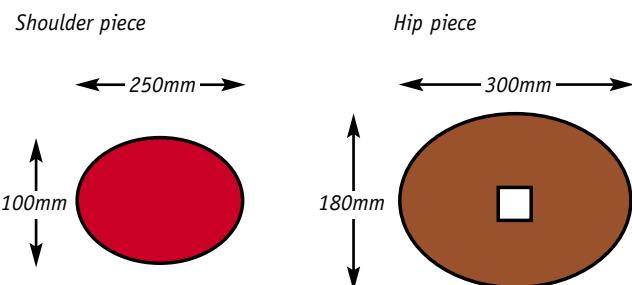
To form the hips and shoulders of the mannequin, cut two oval pieces of plywood to form the hips and shoulders of the mannequin.



An 1860s dress displayed on a mannequin of the correct shape and style.

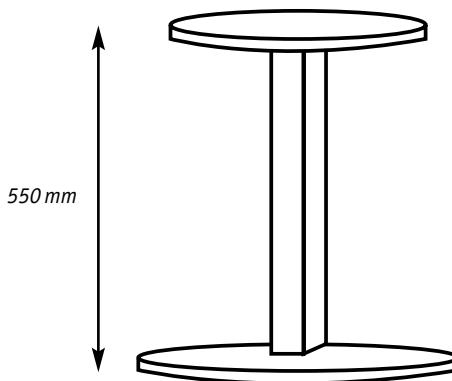
Photograph courtesy of Artlab Australia, reproduced with the permission of the History Trust of South Australia

The following instructions explain how to make a basic mannequin for a dress. The measurements used in these diagrams are a guide only; you will have to modify them to fit individual garments.



Glue the shoulder piece to the top end of a 270mm diameter PVC pipe. This pipe should slide easily over the timber forming the stand of the mannequin.

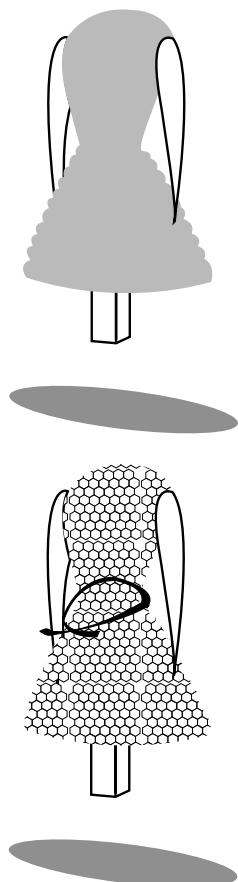
Pass the tube to the bottom of the hip section. Glue in place using Araldite epoxy resin. Paint the stand with acrylic paint to seal the wood and the PVC.



Create the body of the mannequin by wrapping galvanised chicken wire around the frame. This can be attached to the top of the shoulder piece and the bottom of the hip piece.

Arms can be made separately from Dacron covered with fabric. They can be inserted into the sleeves or armholes of the costume first and then attached to the body using Velcro dots. If you do not want an arm shape to protrude from the costume, acid-free tissue can be used to pad out the sleeves.

The waist is made by pulling a piece of string tightly around the cylinder of chicken wire. If you need to change the body shape of the mannequin, you can do so easily by bending the chicken wire.



To pad the mannequin and protect your garments from the wire:

- cover the body of the mannequin with knitted cotton stockinet. Pull the tube of stockinet over the mannequin and attach it to the hip section. Then put Dacron in place to soften the surface of the wire and pad the mannequin to the appropriate shape; and
- stitch the top of the stockinet in place.

If you wish, you can cover the mannequin with a fabric which will enhance the appearance of the costume.

A collar can be made from a piece of fabric-covered cardboard. This will have to be made to fit each individual garment.

You can use a simply constructed mannequin like this for a variety of costumes. The basic framework is there and the size and shape can be modified easily to suit several costumes of approximately the same size.

Cleaning textiles

Textiles can hold a lot of dirt and dust, which can mar the appearance of the items and be damaging as well. You can clean your textiles if they are reasonably robust, but if the textiles appear to be fragile it is advisable to consult a conservator before starting to clean.

The best way to remove dirt and dust from textiles is to use a vacuum brushing technique. This involves lifting dust and grit off the surface with a brush, and vacuuming them away so that they cannot resettle on the surface.

It is important to make sure that the vacuum cleaner has low suction, so that you minimise the risk of damage to the item being cleaned.

There are a number of methods you can use to modify your vacuum cleaner to make it suitable for conservation use.

A product which will attach to any vacuum cleaner is now available commercially. The Micro Vacuum Attachment Kit, made by Schneider Industries Inc., Honolulu, Hawaii 96814, is ideal for conservation use. Another product is a Vacuum Accessory Kit made by Marbig. A variety of micro and mini

vacuum attachments suitable for cleaning some fabrics are on the market. They are designed for cleaning computers.

When vacuuming very fragile objects, it is useful to put a piece of Nylon net over the end of the hose. First attach a rigid pipe to the end of the hose. A piece of net 200mm square can be folded into quarters and attached over the pipe using a rubber band. This prevents fragile materials being sucked into the vacuum cleaner. The rigid pipe makes it easier to control where the hose is placed. The suction of the cleaner can be modified by using extra layers of more closely woven fabric.



Vacuum brushing with netting around the end of the pipe to catch any loose fragments of the textile.

Photograph courtesy of Artlab Australia

There are two methods of surface cleaning with vacuum suction.

Hold the vacuum cleaner hose at least 20mm from the surface of the textile, and use a soft brush to lift the dirt from the surface of the textile. The suction will then pick up the dirt.

Place a piece of net in a round embroidery frame and lay this on the textile. It can then be vacuumed through the net while preventing the suction lifting fibres from the surface.

While surface cleaning, always look out for insect frass—it is often an indication of insect attack—and fragments which have come away from the textile. These fragments should be retrieved and placed in specimen bags, and labelled with the title and accession number of the object, then given to whoever is responsible for the item.

If there is any soiling that cannot be removed from the object with light brushing, do not attempt to remove it because this will damage the surface of the object. Only a trained conservator should attempt removal.

CAUTION:

Washing a textile is an irreversible process.

If the dyes bleed, the fabric shrinks or disintegrates this cannot be reversed.

It is essential that an appropriate washing solution and an appropriate cleaning method are used to prevent damage to the textile.

If you plan to wash or dry-clean textiles, particularly dyed textiles, you should first consult a textiles conservator.

Summary of conditions for storage and display

	Storage	Display
Temperature	18°C–22°C	18°C–22°C
Relative Humidity	45–55%	45–55%
Brightness of the Light	Dark storage preferred.	Less than 50 lux.
UV Content of Light	nil	Less than 30µW/lm, no more than 75µW/lm

Textiles in Australia's climatic zones

The climatic zones outlined below are broad categories—conditions may vary within these categories, depending on the state of repair of your building and whether the building is air conditioned or not.

Arid

This climate is generally very dry, however, in arid areas it is often very hot during the day and very cold at night. This wide fluctuation in temperature is matched by wide fluctuations in relative humidity, for example from 75%–20% in a day.

When caring for textiles in arid areas it is important to note that:

- insects can still survive;
- in very dry conditions, textiles will give out the moisture they contain and will tend to become more brittle; and
- non-fabric components of the textiles may be adversely affected by very dry conditions and consideration should be given to this, even if the textiles themselves are stable.

Remember that even arid areas have periods of higher relative humidity, even though the periods may only be very short.

The system of layers of storage—acid-free material sandwiching the textiles, boxes and rollers in cupboards—is particularly suited to arid areas because of the tendency to get quite marked fluctuations in temperature and relative humidity. Many arid areas are also very dusty and so the layers of storage protect the textiles from dust and grit.

Because of the large temperature fluctuations in arid areas, there is a risk that condensation could form inside frames. It is important to have a spacer in your frames to keep framed textiles out of direct contact with the glazing material, otherwise mould could grow inside the frame.

Note: If your textiles collections have been stored in an arid environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

Temperate

A temperate climate is considered a moderate climate, however, temperate climates tend to have a greater range of temperatures than tropical climates and may include extreme climatic variations.

It is probably easier to achieve the recommended ideal conditions for the storage of textiles in a temperate climate, however, it is unlikely that you will be able to maintain an even environment without the help of sophisticated air conditioning equipment.

The system of layers of storage—acid-free material sandwiching the textiles, boxes, boxes and rollers within cupboards—will be very useful in helping to buffer against the extreme conditions that can occur in a temperate environment.

As for all climatic areas, regular inspections of storage and display areas are important so that developing problems do not go unnoticed.

Note: If your textiles collections have been stored in a temperate environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

Tropical

These climates are characterised by heavy rainfall, high humidity and high temperatures.

When caring for textiles in high humidity conditions it is important to note that:

- insects and moulds thrive and reproduce readily;
- the rate of deterioration due to light and UV radiation increases;
- different components of single objects will take up moisture at different rates and swell by different amounts. For example, a cotton core in a metallic thread will expand and contract in response to fluctuations in relative humidity, but the metal does not change as readily. This causes abrasion to the cotton core thread; and
- gelatine sequins on 19th century costume can swell and become sticky in high relative humidity conditions, and can stick to the underlying fabric.

Remember that in tropical areas, air flow is important and this should be taken into account when designing storage and display systems.

Note: If your textiles collections have been stored in a tropical environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

MORE ABOUT TEXTILES

A note on the use of Tyvek

Tyvek is a very useful storage material for textiles. It will protect your textile from dust and water while allowing air circulation. However, it must be used the right way up. Tyvek is water-resistant from one direction but is penetrable from the other side. This is how it allows the textile to breathe. The smooth side of the Tyvek should be placed in contact with the textile at all times. Tyvek is available in white or with one coloured side. It may be easier to use coloured Tyvek to ensure that you always use it the right way up. Tyvek is available in a range of weights. The weight commonly used in conservation is Type 1443R.

Tyvek can be machine-sewn into storage bags or covers. It can also be machine-washed.



Tyvek used to cover stored garments.
Photograph courtesy of Artlab Australia

Selecting fabrics, threads and stitches for textile conservation

When preparing to mount or hang a textile for display, there are some important principles to remember:

The work you do should be reversible.

You should use only the minimum amount of stitching required to stabilise the textile.

Use the correct techniques and materials to ensure the long-term preservation of your textiles.

As a general rule, always use like with like. For example, a silk textile should be mounted on a silk fabric and stitched with silk thread. If you cannot use the same fibre, always use an inert synthetic fibre such as polyester. Using incompatible materials, such as using silk with cotton, accelerates the degradation of your textile.

Silk and wool are both protein fibres and are therefore compatible. Cotton, linen and other plant fibres are cellulose fibres and are compatible with each other.

Support fabrics

A support fabric is the fabric on which a textile is mounted before framing. As a general rule, always use like with like; that is, a wool fabric should be mounted on wool.

This fabric is often exposed, either forming a border around the textile or showing through areas of damage in the textile. Therefore, it is important that the support fabric is similar in colour and weave to the original textile.

If you cannot buy a fabric of the correct colour, weave and fibre type, you can have fabric dyed by textile conservators experienced in colour matching or by commercial dyers.

Threads

When selecting threads remember to always use like with like, for example, silk with silk or polyester, or cotton with cotton.

As a general rule, the finer the thread the better; but you will have to judge by the appearance of the fabric what denier of thread will be the most appropriate. For example, fine silk will require a fine silk or polyester thread. A woollen tapestry will require a coarser woollen thread.

Stitches

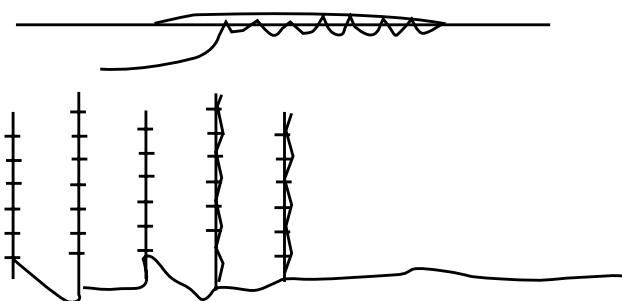
Before stitching your historic textiles, remember:

- to make sure that the needle passes in between the threads in the weave, not through them. If the needle passes through weakened fibres it can cause considerable damage;
- to keep the tension of the stitches fairly loose, so as not to damage the fabric; and
- do not use knots. Start your thread by leaving a tail at the back of your textile and stitch three small stitches in one position to anchor your thread.

The next section describes the main stitches used in textile conservation.

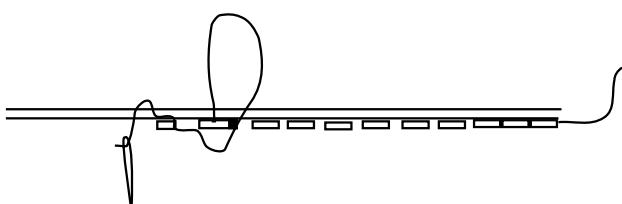
Laid and couched stitching

This is one of the main stitches used in conservation. It is used because it provides maximum support for the fabric with a minimal amount of stitching passing through the textile.



Couching is used to stitch worn areas of the textile to a support fabric underneath it. The textile should never be under tension when being stitched.

Running stitch

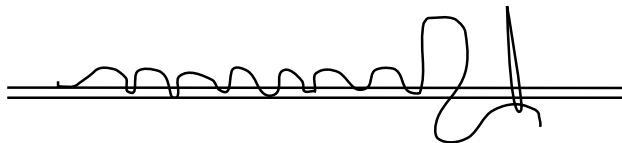


Running stitch is used to join two pieces of fabric together. It is used around the edge of a textile, and is also used when stitching a lining onto a textile in a grid pattern.

It is a good idea to do a back stitch approximately every 50mm: to lock the stitching in place so the textile does not slip along the stitching and so strain.

Stab stitch

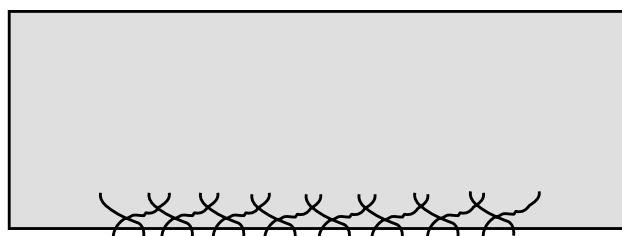
Stab stitch is worked in the same way as running stitch, except the stitch on the surface of the textile is smaller than those underneath.



Herringbone stitch

Herringbone stitch is generally used to stitch textiles with frayed edges. This stitch prevents further fraying of the textile. It is a useful stitch because it spreads the load of the stitching over a greater area of the textile.

The size and spacing of the stitch depends on the type of textile and the extent of the damage.



If you have a problem relating to the storage or display of textiles, contact a conservator. Conservators can offer advice and practical solutions.

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Self-evaluation quiz

Question 1.

Textiles can be damaged by:

- a) being creased—this can lead to splitting of the textiles;
- b) light and UV radiation, causing fading and setting off chemical reactions which weaken the textiles;
- c) mould, insects and pollutants;
- d) perspiration;
- e) all of the above.

Question 2.

When handling textiles:

- a) try to touch as little of them as you can—always pick them up by one part only;
- b) fold them as neatly and as small as possible to make handling easier;
- c) never pick them up by one corner and always support the weight of the textile evenly;
- d) have clean hands.

Question 3.

To label a textile:

- a) write in permanent ink on the corner of the textile, or on the collar of the costume;
- b) write in permanent ink on a sticky label and stick this to the textile;
- c) machine-sew a label to the textile;
- d) write the label onto cotton tape and attach this to the textile with one or two hand-stitches.

Question 4.

Which of the following statements are true?

- a) Historic costume should not be worn if you wish to preserve it.
- b) Body oils and perspiration will not damage textiles.
- c) The stress and strain of wearing a garment can cause a great deal of damage.
- d) Historic costume should be worn on festive occasions especially those involving food and drink.

Question 5.

Small flat textiles:

- a) should be stored in Dacron sausages;
- b) should be stacked one on top of the other;
- c) should always be rolled;
- d) can simply be stored flat, with interleaving if items are to be stacked.

Question 6.

When rolling a large textile for storage:

- a) choose a roller that is longer than the item is wide;
- b) cover the roller with acid-free material to protect the textile;
- c) select a roller with a small diameter so that it does not take up too much space;
- d) fringes and tassels should be kept straight.

Question 7.

When displaying textiles:

- a) be aware that light and UV radiation are the greatest enemies of textiles;
- b) use acid-free materials in the display systems;
- c) ensure that your textiles are well supported;
- d) protect your textiles from fluctuations in relative humidity and temperature, dust, insects and pollutants;
- e) all of the above.

Question 8.

Historic costume can be:

- a) stored on wire coat-hangers;
- b) displayed safely on mannequins if measures are taken to modify the mannequin to the appropriate shape;
- c) worn regularly with the right undergarments;
- d) protected in storage by hanging them on padded hangers and covering them to keep off dust.

Question 9.

To clean textiles:

- a) proceed with caution and use a vacuum brushing technique;
- b) wash them in washing machines;
- c) use the full suction of your vacuum cleaner to ensure you remove all the dirt;
- d) use a carpet beater.

Answers to self-evaluation quiz

Question 1.

Answer: e).

Question 2.

Answer: c) and d).

Question 3.

Answer: d).

Question 4.

Answer: a) and c) are true. b) and d) are false.

Question 5.

Answer: d).

Question 6.

Answer: a), b) and d). c) is not correct: the roller should be as large as possible to maximise the curvature of the textile.

Question 7.

Answer: e).

Question 8.

Answer: b) and d). Wire coat-hangers are not suitable for hanging historic costume. Historic costume should not be worn.

Question 9.

Answer: a).

LEATHER

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Objectives

At the end of this chapter you should:

- know the difference between leather and other skin products such as rawhide, parchment and semi-tanned leather;
- understand the adverse effects that moulds, insects, inappropriate environmental conditions and excessive lubrication can have on leather;
- know the storage and display conditions which are required to minimise the deterioration of leather objects;
- understand the need for careful assessment of leather before attempting any treatment including cleaning;
- know some cleaning processes that can be used on leather and be aware of the limitations of each method;
- know when to lubricate leather objects; and
- be able to prepare and apply lubricants to objects which must remain flexible.

Introduction

Animal skin products have been used since ancient times, and continue to be used. Leather's durability and workability have made it a very important domestic and commercial product.

Leather has been used in the manufacture of an enormous range of objects, including clothing, saddles, boats, thongs, shields, aprons, shoes, upholstery straps and belts, and covers for books. It has been decorated with gold, dyed, moulded and polished.

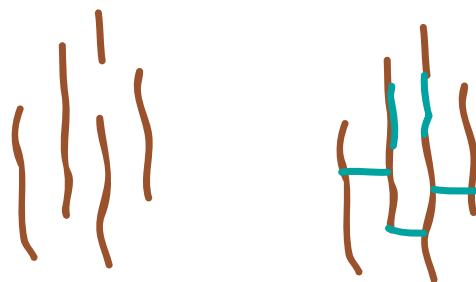
While most museums, galleries and libraries in Australia do not have examples of ancient leather, many have leather objects of some kind. It is important that you have the information you need to properly care for the leather objects in your collections.

What is leather?

Leather is one of a range of manufactured materials which can be made from the skin of any animal.

Long before genuine tanning methods were used to prepare leather, hides and skins were processed in a variety of ways. The different processes were all designed to preserve the skins; and each process produced skin products with different properties. Working oil, grease and even brain matter into raw skins, softening hides by chewing them and smoking skins were some of the processes used. These methods affected both the look and feel of skins and their resistance to deterioration.

Technically, the term 'leather' refers to skin products which have been fully tanned. Tanning is a process which chemically alters skins, making them more durable and more resistant to rotting. It does this by chemically linking relatively small molecules and fibres in the original skins into groups of larger molecules and fibres. Large molecules take longer to break down than smaller ones.



represents the fibres from the original skin
 represents the links that are made during tanning

Some of the other skin-processing methods also link fibres and result in larger molecules; but none of them do it as fully as the various tanning techniques, and none of them produce a material as durable as leather. Other skin products include rawhide, parchment and vellum, and semi-tanned leather.

Leather is made up of tanned collagen—the protein which makes up skin and bones—moisture, oils and fat.

Leather in good condition is naturally acidic: in the range of pH 3–6, with a water content of between 12–20% and a fat content in the range 2–10%.

What are the most common types of damage?

Leather can be damaged in a number of ways. It can be scuffed, worn, torn, scratched and abraded—for example, during cleaning—and over-lubricated—this reduces the moisture content of the leather and it will become hard, brittle and inflexible.

Leather is also adversely affected by inappropriate environmental conditions and by biological pests.

Light and UV radiation affect leather in a number of ways, including:

- providing energy to the chemical breakdown of the collagen that makes up the leather;
- interaction with atmospheric pollutants, producing chemicals that damage leather and other materials associated with it;
- fading of dyes; and
- skin products with hair still attached often suffer hair loss through light-induced damage.

Extremes of relative humidity are damaging to leather. In low relative humidity conditions, leather dries out and can become hard, brittle and cracked. When the relative humidity is over 65%, leather is susceptible to mould attack. Leather is even more attractive to mould if it has been lubricated too much, because mould uses the ingredients of the lubricants as a food source.

Vegetable-tanned leathers, including items of harness, military equipment and bookbindings and upholstery, are susceptible to deterioration known as red rot, caused by pollutants in the atmosphere.

Dust is a major problem for leather objects because it can cause both chemical and mechanical damage. The sharp edges of minute particles are abrasive, and can cause fibre damage if removed by methods other than suction. Dust also attracts fungal spores, and acts as a centre for condensation and subsequent chemical attack.

Moulds, bacteria, rats, termites and many other insects attack leather and the materials incorporated in it.



Mould-damaged shoes.

Photograph courtesy of the Western Australian Museum



The shoes have been treated to kill the mould and then cleaned.

Photograph courtesy of the Western Australian Museum

Leather is often combined with other materials: metal buckles, for example. The interaction of these materials can be damaging.

Many fatty materials incorporated in leather dressings, react with metal components of leather objects, causing them to corrode. Evidence of this corrosion is often seen, for example, the presence of a turquoise, waxy substance on copper fastenings. Metals may have been incorporated into the leather from materials used during the manufacturing process. Deterioration caused by the presence of metals in the leather is hastened when relative humidity is high.

For more information

For more information about adverse environmental effect, please see *Damage and Decay*.

Common causes of damage

The most common types of damage are caused by:

- poor handling;
- poor storage methods;
- inappropriate display methods;
- wear and tear from repeated use;
- chemical changes in the materials which make up the leather objects;
- chemical changes caused by atmospheric pollutants and by chemicals which are in contact with the leather objects; and
- a combination of any or all of these.

Much of the common damage to leather objects can be prevented by care and pre-planning your handling, storage and display.

Storing and displaying leather

Ideal conditions for storing leather

Ideally, objects made from leather, hide and skin should be displayed and stored in a clean, well ventilated environment where temperature is constant and moderate—in the range 18–22°C. If this cannot be maintained, the maximum temperature should be 25°C.

Relative humidity should be kept in the range of 45–55%. In very dry conditions with the relative humidity below 30%, leather dries out and becomes brittle. High humidity, that is, above 65%, encourages mould growth.

Parchment and vellum are very sensitive to changes in relative humidity, and experience considerable dimensional change as they absorb and release moisture.

Leather must be protected from environmental fluctuations and dust and insect attack. Display cases and layers of storage provide this type of protection.

Lighting levels should be kept to a minimum, particularly for dyed leather. The brightness of light on undyed leather should be 150 lux or less; and on dyed leather it should be 50 lux or less. A UV content below 30 µW/lm and no higher than 75 µW/lm is preferred for undyed and dyed leather.

Avoid exposing any leather to bright spotlights or direct sunlight, because these can cause leather to fade, discolour and dry out.

General storage guidelines

Good housekeeping is essential in the care of leather. Vacuum and dust regularly. This helps to minimise mould, insect and rodent attack.

Protect leather objects from dust using Tyvek dust covers, unbuffered acid-free boxes or acid-free tissue.

Check objects regularly to detect mould and insect infestations early.

Leather objects should be fully supported in storage and on display. They should be supported in their desired shape, so that if they harden later there will be no need for reshaping.

Store long leather pieces horizontally to make sure they are supported fully and evenly.

If three-dimensional objects are unable to support their own weight, then they should be supported internally. The form of the support depends on the shape of the object and the weight of leather to be supported. You can support and fill rounded items with unbuffered, acid-free tissue paper, or chemically stable polyethylene or polypropylene foams. You can make supports for other shapes using these foams.

Leather clothing and large objects such as saddles should be fitted on a dummy or a mount made-to-measure. Stable materials, such as the above-mentioned foams, linen, Dacron and most metals can be used in the manufacture of these supports.

Avoid sharp folds or creases in the leather. This helps reduce cracking.

Because leather products are naturally acidic, they should not come into contact with buffered, acid-free materials: these materials are alkaline and potentially damaging to leather.

Storage cupboards and furniture should be made of painted metal—these provide a stable and neutral storage environment for leather objects.

If you have wooden storage and display furniture, it should be sealed and lined with impermeable coatings, for example, clear polyurethane or laminates. This reduces the risk of reactive chemicals from the wood affecting the leather objects or the metal components associated with the objects. Remember, sealants and glues should be fully dry and cured before putting objects into the storage environment.

Standard conservation-quality mounting and framing are usually adequate for the protection of art or documents on parchment.

Treatments

Storing and displaying leather in a well-maintained environment minimises deterioration and the need to treat leather objects. All treatments involve some risk to the object being treated.

Always assess carefully the need for treatment and the type of treatment. If you are in doubt about whether to treat or what treatment to use, ask a conservator for advice.

Use detergents, stain removers and similar chemicals only after talking with a qualified conservator.

Cleaning leather

Even cleaning has the potential to damage leather. For this reason, cleaning should not be considered as an automatic option for leather objects.

Cleaning is recommended for:

- objects which need cleaning to prevent deterioration of the leather, which can be caused by surface deposits and/or mould growth; and
- recently-acquired objects. Before their addition to the collection, they should be inspected and cleaned if necessary. This is essential to reduce the risk of contaminating the rest of the collection.

Before cleaning leather objects, consider:

- the type and condition of the surface to be cleaned;
- the nature of any contaminants or dirt;
- the type of leather; and
- exactly what is to be cleaned.

Dirt or other accretions which have accumulated during an object's useful life may be seen as historic evidence of the object's use. You may not want to clean this evidence away.

What to clean

Surface deposits which may need to be removed by cleaning include:

- dirt, dust and salts;
- fatty spews and gummy spews—materials which migrate to the surface from the lubricants used on leather; and
- mould.

For more information

For more information about fatty spews and gummy spews, please see the section, More About Leather later in this chapter.

To identify crystalline salts, spews and mould you may need to examine the leather surface under magnification:

- the crystalline nature of salts would be clearly evident;
- mould can be identified by the presence of fine, fibrous strands; and
- fatty spews appear greasy, and can be difficult to remove; gummy spews look like resin deposits on the surface of the leather.

Cleaning guidelines

Before cleaning any leather objects, remember to assess the condition of the surface being cleaned. If the object is fragile, cleaning can cause further damage; and it might be better to protect the object from further soiling rather than cleaning it.

It is important to remember that cleaning can stain leather, shift dyes as well as dirt within leather, and remove lubricants from leather. Always make sure that cleaning is necessary before starting.

If cleaning is necessary and the object is able to withstand it, there are a number of techniques you can use.

Vacuum cleaning, with the nozzle just above the leather surface and the power on the lowest setting, is probably the safest cleaning method. It is particularly suited to dusty leather which is in good condition. Place a gauze screen on the end of the nozzle when cleaning. This prevents fragments of leather being lost in the vacuum cleaner. If fragments are being lifted, reduce the suction of the vacuum cleaner.

Brushing with a soft, squirrel hair or camel hair brush is another way of removing surface dirt. Note that even using a soft-bristled brush can damage fragile objects—because dust is abrasive and can scratch a fragile surface. Also, small pieces of damaged leather may be dislodged.

Blowing dirt away with compressed air is appropriate for some objects. Take care that the air stream is not too strong, because it could damage fragile surfaces and dislodge leather fragments. Do this either outside or in a fume cupboard: to prevent dust being redeposited on the object.

Granular erasers can be used to remove more stubborn dirt. Use this method only on surfaces which are in good condition. Remember also that some erasers contain chemicals which can contribute to the deterioration of leather; so it is important that you select your eraser carefully. This is particularly important—it can be difficult to remove all traces of the eraser after cleaning.

For more information

For more information about cleaning with a granular eraser, please see the section More About Leather, later in this chapter.

To remove thick surface deposits such as those occasionally formed by fatty spews, scrape the surface using a soft, wooden spatula. This method should be used only to remove the bulk of the deposit; and care must be taken not to damage the leather surface. Solvents can be used to remove

the remainder of the deposit left after scraping. This method is described below.

Residues or thin films of fatty or gummy spews can be removed using petroleum-based solvents such as white spirit or hexane.

CAUTION:

Before using hexane and white spirit to clean the surface of the leather, test them on an inconspicuous area of the object to check that any surface finish on the leather is not affected by the solvent.

It is necessary to control the application of these solvents, because they can easily spread into the leather and dissolve fats in the body of the skin. The solvents can be applied with a small brush or cotton bud, or a sponge for larger areas. The solvents will soften the fats which you can then remove with a clean, cotton bud or your wooden spatula.

CAUTION:

White spirit and hexane should be used in a well ventilated area. Remember to protect your hands when using these solvents because they will dissolve the oils in your skin, as well as in the leather.

Use a slightly moistened sponge to remove water-soluble dirt from leather objects which are in good condition.

CAUTION:

Use this treatment only where the surface of the object is protected by a water-resistant coating, for example, wax, resin or similar. Water can cause permanent darkening of leather and leave tidemarks in dyed leathers.

Alcohol or alcohol/water mixtures can be used to remove surface salts. Water can stain and damage leather, so keep the water content low. Test the mixture to make sure that it has no effect on the leather surface.

An emulsion cleaner is very effective for removing stubborn dirt. Because this formulation contains some water, test it in an inconspicuous area before applying it on a large scale.



Straitjacket before cleaning.

Photograph courtesy of the Western Australian Museum



Straitjacket after cleaning with emulsion cleaner.

Photograph courtesy of the Western Australian Museum

For more information

A recipe for the emulsion cleaner and instructions for its use in the section More About Leather later in this chapter.

CAUTION:

Do not wet the surface of the leather itself during cleaning. This increases the likelihood of the leather hardening when it dries, and can cause darkening of the leather surface. Use water-based cleaning methods only if the leather surface is water-resistant.

Saddle soap—a note of caution

Anecdotal evidence suggests that, although saddle soap appears to have little detrimental effect on leather objects which are still in use, museum objects which have been cleaned with this soap often seem to be in a worse condition than untreated objects.

Of major concern is the alkaline nature of saddle soaps and the effect that the alkalines can have on leather, which is naturally acidic. If saddle soap is the only available cleaning option, it is important to minimise the amount of moisture used. This reduces the penetration of the soap into the leather and minimises the potentially damaging effects of the soap.

Lubrication of leather

Is it necessary?

The usual answer for museum objects is NO!

The main purpose of applying dressings to leather in museums, galleries and libraries is to prevent the leather hardening if the relative humidity fluctuates widely.

If too much lubricant is applied, the leather repels moisture and eventually becomes hard and brittle—the very effects that the application of the dressing was meant to prevent.

Most mould infestation is caused by the presence of too much lubricant.

Some dressings can also darken leather and cause increased stickiness. A sticky surface collects and holds dust, and is very hard to clean.

Lubricants do not provide protection against acidic pollutants.

Consider these points when deciding whether or not to apply a dressing to leather. If the leather is in its required shape, does not need to flex and is in a relatively stable environment, then lubrication is usually not necessary.

As leathers age, their ability to absorb fats and oils effectively is reduced. The amount of fats and oils needed in archaeological and older leathers is less than in their modern counterparts. Lubricating aged leather only causes more problems.

Dressings should not be used to ‘feed’ leather or as a way of improving its appearance. These approaches inevitably lead to over-lubrication and the development of some of the problems outlined above.

If you want to improve the appearance of a leather object which originally had a polished surface, it is better to use a wax polish. Because this is primarily a surface treatment there should be minimal impact on the leather itself.

When should lubricants be used?

Lubricants are really only necessary if:

- flexibility needs to be restored to an object; and
- the leather is displayed in an environment which experiences repeated and extreme fluctuations in relative humidity.

It is important to realise that museum objects rarely need to be flexible, because they are generally not used. They are usually stored and displayed. If the storage environment is stable, there is little need for lubrication.

To restore flexibility to hardened leather, it is necessary to rehumidify or condition the leather before lubrication. Various procedures may be used (Calnan, 1984). These include:

- sponging the surface with an alcohol solution diluted with water or a water-based moisturiser;
- covering the leather with damp sawdust overnight; and
- placing the leather in a humidity chamber.

For more information

For more information about humidifying leather and constructing a humidity chamber, please see *More About Leather* later in this chapter.

If an object needs to be reshaped then humidification often will be enough.

The next step in restoring flexibility to leather is the actual lubrication itself.

Types of lubricants for leather

The fats and oils which lubricate the leather can be applied either in a water-based emulsion or dissolved in organic solvents. Fats and oils dissolved in an organic solvent are known as solutions or dressings.

Vegetable oils are not used as frequently as fats, because in the long term they are more prone to oxidation which results in the oil yellowing and hardening; this is followed by loss of the lubricating properties.

A water-based emulsion is best if tests show that:

- water does not discolour the surface; and
- the surface absorbs water.

Applying oils in emulsion increases the likelihood of oils remaining evenly distributed throughout the interior of the leather. If an emulsion cannot be applied, use a solvent-based dressing.

For more information

For recipes to make leather lubricants, please see the section *More About Leather* later in this chapter.

Guidelines for the use of lubricants

Only apply lubricants to leather which is:

- deformed—the lubricant is used to make the object more flexible and to assist in reshaping the object;
- extremely dry; or
- cracked due to shrinkage.

CAUTION:

Never apply dressings to objects containing untanned or semi-tanned materials such as hides, parchment and vellum.

Always test the lubricant in an inconspicuous area before use.

When the leather is generally in good shape, but is dry and hard, applying a commercial dressing/wax such as Fredelka is useful.

CAUTION:

Fredelka should not be used on items with metal attachments or decorations because it causes corrosion of metal.

If the dryness is only a surface condition, or if the leather is very thin—for example, book covers and car seats—then a preparation such as British Museum Leather Dressing adequately restores surface-oil content.

Apply it sparingly, using a soft cloth. It can be used on leather with metal attachments or decorations. The beeswax in this dressing forms a thin film on the leather surface which can be polished.

Some surface finishes resist the penetration of oils and fats into the leather, whether you use an emulsion or a dressing. If this happens, it is best to rub an oil emulsion into the flesh side—or underside—of the leather, to encourage penetration.

Although many commercial leather dressings are available, these may not be suitable for museum objects because they are designed for leather objects which are being used. Static museum objects have different needs because flexibility is usually not an important consideration.

Do a careful assessment before applying any treatment to the leather of a book cover. In most cases it is preferable to store the books under the best possible conditions.

For more information

For information about applying dressing to leather book bindings, please see the chapter on Books in *Caring for Cultural Material 1*.

Treatment of attached metal fittings

The metals most commonly used with leather are iron and copper alloys. The fats present in leather accelerate the corrosion of these metals.

A turquoise-blue, waxy material which forms on copper fittings is usually the most visible sign of corrosion.

Due to the intimate contact between the metals and the leather, immersion in chemical baths is usually not an option for the removal of disfiguring corrosion products.

In some circumstances, treatment chemicals may be applied using bentonite paste.

Most of the copper corrosion products can be removed easily using a soft, wooden spatula. Residues can then be removed using cotton buds soaked in leather emulsion cleaner.

To prevent further corrosion, coat the fittings with microcrystalline or Renaissance wax. A corrosion inhibitor, benzotriazole—5%—may be added to the wax if additional protection is needed.

Iron fittings are best treated using sanding or brushing methods to remove surface rust. Applying microcrystalline wax to the cleaned surfaces protects against further corrosion.



Copper corrosion products on studs of a straitjacket.

Photograph courtesy of the Western Australian Museum



Studs after cleaning and coating with Renaissance wax.

Photograph courtesy of the Western Australian Museum

For more information

For more information on using bentonite paste and microcrystalline wax, please see the chapter on Metals later in this volume.

Summary of conditions for storage and display

	Storage	Display
Temperature	Reasonably constant and preferably 18–22°C. 25°C is the maximum	Reasonably constant and preferably 18–22°C. 25°C is the maximum
Relative Humidity	45–55%	45–55%
Brightness of the Light	Dark storage is preferred; but if light is present it should be 150 lux or less. If the leather is dyed, the brightness should be 50 lux or less.	Should be 150 lux or less. If the leather is dyed, the brightness should be 50 lux or less.
UV Content of Light	Dark storage is preferred but if light is present, UV content should be less than 30µW/lm, and no more than 75µW/lm	Less than 30µW/lm, no more than 75µW/lm

Leather in Australia's climatic zones

As leather is affected by changes in temperature and relative humidity, different storage and display strategies may have to be adopted for leather objects in each of Australia's climatic zones.

Leather is physically weakened when it is exposed to frequent cycles of expansion and contraction associated with fluctuations in relative humidity. A combination of high relative humidity and pollutants can cause an accumulation of acids and subsequent chemical attack.

Arid

This climate is generally very dry, however, in arid areas, it is often very hot during the day and very cold at night. This wide fluctuation in temperature is matched by wide fluctuations in relative humidity, for example from 75%–20% in a day.

Leather which is exposed to these conditions is likely to become dry, hard and inflexible. Splitting and cracking are also likely. You can overcome these potential problems by adopting the following practices:

- store leather in cabinets, boxes and wrappers to buffer the objects against fluctuations in environmental conditions and to protect them from dust;
- make sure that any leather object is stored in the shape that the object is meant to have. If the object does then dry out and become inflexible at least the desired shape will be retained;
- ensure that any additional sources of heat are reduced. Exposure to daylight and 'hot' light sources, for example, should be avoided;
- leather objects should be stored and displayed away from external walls, fireplaces and similar sources of heat; and
- portable humidification units may be used during periods of prolonged low relative humidity.

Note: If your collections of leather objects have been stored in an arid environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

Temperate

A temperate climate is considered a moderate climate, however, temperate climates tend to have a greater range of temperatures than tropical climates and may include extreme climatic variations.

Temperate climatic zones are considered to have moderate conditions. It should therefore be easier to maintain conditions reasonably close to those recommended for leather.

Care does have to be taken, however, to overcome the extreme climatic variations which still occur in these areas.

- storage and display in sealed cabinets will usually provide enough buffering capacity to overcome short term variations in relative humidity and temperature;
- wrappers, boxes and cupboards could all be used as layers of storage to provide buffering against changes in the external conditions; and
- regular inspections of the collections should be carried out.

Note: If your collections of leather objects have been stored in a temperate environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

Tropical

These climates are characterised by heavy rainfall, high humidity and high temperatures.

In tropical zones high temperatures and relative humidities pose the greatest risk to leather objects. To minimise damage to leather objects in these areas the following strategies may be adopted:

- place sensitive leather objects in well-sealed cabinets and maintain the relative humidity below 65%.
- use cabinets, boxes and layers of non-buffered acid-free tissue to create buffer zones. This will reduce the impact of relative humidity and temperature fluctuations on leather. This is the “layers of storage” principle;
- portable dehumidification units may be used during periods of extremely high relative humidity;
- if RH control is not possible then ensure you have good air circulation to minimise the risk of mould growth; and
- inspect leather objects regularly and maintain high standards of cleanliness.

Note: If your collections of leather have been stored in a tropical environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

MORE ABOUT LEATHER

Skin

Skin is a complex structure made up of:

- hair;
- sweat glands;
- fat;
- blood vessels; and
- a layer of collagen fibre bundles containing protein. In the corium, or the body of the skin, these fibres are large and loosely-woven. In the protective grain layer, these fibres are finely and tightly-packed.

The grain layer or hair side is the outside surface layer of the skin. The underside of the skin is known as the flesh side.

Collagen

Collagen is probably the most abundant protein in the animal kingdom. It is a major component of skin, tendon, cartilage, and is found in bone and teeth.

Collagen molecules are bonded together to produce fibres. In animal skins there is a structure of fibres held together by crosslinks. This structure accounts for the great strength of collagen and the fact that the fibres are insoluble.

These fibres can be broken down to produce a collagen product that has a very random structure—gelatine.

Untanned skin products

Rawhide

Rawhide is the dried skin of an animal which has had all of the flesh removed. It is usually a very rigid, tough material. Despite its inherent toughness rawhide is in many ways the least durable of the skin products.

It is used in the manufacture of suitcases, and for hammer heads, drum coverings, thongs and lashings.

Parchment and vellum

Parchment and vellum are made by stretching the skin on a frame and drying it. The skin is treated with lime to remove fat and hair, and it is washed and scraped repeatedly.

Parchment and vellum are untanned animal skins. Occasionally, tanning solutions are applied to the surface of the parchment or vellum to improve its surface quality.

Parchment and vellum are usually light-coloured, almost opaque, and smooth. They take ink and colours well. Both were widely used as writing materials before the introduction of paper to the West. They have also been used as bookbinding materials. Translucent parchment and vellums were also produced, and sometimes used as window panes.

The terms parchment and vellum are sometimes used interchangeably. Originally vellums came from calf skins—the name vellum comes from the Latin for calf. Vellums tend to be whiter and of better quality than parchments. Modern parchments are generally thought to be inferior to earlier parchments. Many modern parchments tend to be yellowish in colour, a bit greasy and thin. These parchments are often made from split sheepskins.

Never force curled or distorted parchment to open out or to lie flat—this can cause damage. Humidification and drying under tension can restore the parchment but this should only be done by a conservator.

Semi-tanned leather

Semi-tanned leather—buckskin or buff leather—is produced when skin is stretched and an oil and fat emulsion, usually from the brain of an animal, is rubbed into it. The skin is then manipulated until it is dry, soft and flexible. Often it is smoked in the final stage of treatment.

New, semi-tanned leather is soft, suede-like, extremely flexible and durable.

In earlier times, semi-tanned leather was used for clothing, lining, pouches, gloves, saddle seats, and military uniforms and equipment. The most common modern example is chamois or wash leather.

In museums, galleries and libraries, untanned and semi-tanned skin materials must never be allowed to come into contact with water.

Leather

Skins are tanned to make leather in order to:

- get rid of smaller molecules which will degrade readily, within the skin;
- stop biological degradation—that is, rotting; and
- produce a product that is, flexible, strong and resistant to deterioration.

Skins which are to be tanned go through a number of pre-tanning processes. The skins are:

- cured—dried quickly to achieve a temporary preservation so that they can be transported without rotting;
- soaped—this returns the moisture to the dried skins and removes water-soluble materials;
- unhaired—this loosens hair and fats so that they can be scraped and pulled away. This process produces a plump hide;
- cleaned and the flesh side levelled. During this stage, hair, dirt, grease and remnants of chemicals from previous processes are removed;
- delimed—the unhairing process uses lime which makes the skins very alkaline. This stage of the processing reduces the alkalinity, in preparation for the next treatment stages;
- bated—this process makes the skins soft and flexible. It also cleans the fibre network of the skins and removes some of the smaller and weaker fibres. Traditionally, dung was used in this process;
- drenched—this is similar to bating, but uses weak organic acids. Traditionally, fermented grains were used; and
- pickled—this is the final stage that conditions the skins for tanning.

The next stage in making leather is tanning. The tanning process draws collagen fibres together and creates crosslinks between them. This crosslinking on a molecular and fibre level makes the skin much more resistant to deterioration. Generally, leathers are either vegetable-tanned or mineral-tanned.

Vegetable tanning uses tannins which are present in the barks, woods, leaves and fruits of certain plants. The colour of the leather prior to finishing ranges from pale-brown to a reddish brown, depending on the particular tanning agents used. Vegetable-tanned leathers are particularly suitable for bookbinding.

Mineral processing uses mineral salts to chemically stabilise the skin. In the 1880s, chrome salts were used to make leathers which were hard-wearing, stable and water-resistant. The resilience and open texture of chrome-tanned leathers meant that they could not be embossed. These leathers were unsuitable for some kinds of work, particularly bookbinding.

During investigations into the improved durability of leathers, a number of experiments have been carried out using combined tanning techniques.

Another product which is thought of as a leather is alum-tawed leather. These white leathers were produced using a solution of alum and salt. Leather produced by this process is not a true leather, because it does not have the same chemical stability and resistance to water that fully tanned leather has. Zirconium salts are used to produce a white leather that is washable.

Spews

Fatty spews

Fatty spews are fatty or greasy materials which migrate to the leather surface. The materials which migrate to the surface are either solid fats or products of the acidic breakdown of solid fats.

These fatty materials are often present in lubricants used to soften leather. Neatsfoot oil, unless specified as cold-tempered, contains a considerable amount of fatty materials. Leather dressings containing neatsfoot oil are a potential source of these spews.

Gummy spews

Gummy spews arise when oils—particularly fish oils—used to lubricate leather, degrade to their constituent fatty acids. These substances migrate to the surface of the leather, where they appear as gummy or resinous deposits. They are unpleasant to touch and handle.

Additional cleaning methods

Cleaning using a granular eraser

In this method an eraser—Artgum 211, Faber Castell, for example—is finely grated using a household grater. It is best to use a plastic grater, because metal graters may rust or shed small, metal particles which could damage the leather.

You could also use Draft Clean Powder, a granulated eraser which is available from suppliers of conservation materials.

The eraser grains are spread over the leather, then lightly rotated with the palm of the hand or the flat of the fingers until the entire area has been covered. Because skin contains oils, or your hands could be dirty, wear cotton gloves. If the area you are cleaning is very small or particularly fragile, use a small brush to move the granulated eraser over the surface.

Vacuum clean thoroughly after cleaning to make sure that the eraser crumbs are removed. This is particularly important, as conservators are concerned about the long-term effects of eraser residues on the texture, colour, pH and wettability of the surface.

Emulsion cleaner

Dirt which is particularly resistant to cleaning can be removed using an emulsion cleaner. This formulation is based closely on one described in the literature (Fogle, 1985).

To make this cleaner, you need:

- 20ml of non-ionic detergent, for example, Teric N9, Arkopal N090;

- 2g of carboxymethylcellulose—CMC;
- 1 litre of distilled water; and
- 2 litres of X-4 solvent, hexane.

Mix the non-ionic detergent, CMC, and distilled water vigorously for several minutes before leaving the mixture to stand overnight. This gives the CMC time to swell.

Add 15 parts of this solution to 100 parts of X-4 solvent and shake it vigorously until a creamy emulsion is formed.

This cleaning solution keeps indefinitely, but should be shaken before use.

Before using the cleaner, test it on an inconspicuous area of the object—to make sure that there is no significant effect on the surface coatings on the leather or on the leather itself.

Rub the cleaner onto the surface with a clean cloth, rotating the cloth as it becomes soiled. If the object is very small or delicate, apply the cleaner with cotton buds or some similar soft material. This solution easily removes both fats, oils and water-soluble dirt.

CAUTION:

Before using hexane and white spirit to clean the surface of the leather, test them on an inconspicuous area of the object to check that any surface finish on the leather is not affected by the solvent.

Humidity chamber

A simple humidity chamber can be made using plastic sheeting. The object to be humidified is placed in a plastic tent with a jar containing 50:50 water and alcohol—methylated spirits or ethanol. The alcohol prevents mould formation in the high relative humidity environment created inside the tent. The tent is then sealed with tape.

In addition to being used to condition leather, the raised humidity can also be used to help reshape the leather. As the leather softens it can be reshaped slowly. The time taken for softening

depends primarily on the leather thickness and the presence of surface coatings. The object should be removed from the chamber periodically, and progressively eased into the required shape. It is usually necessary to use padding during this process.

Lubricant formulations

The formulations and application methods described below are those recommended by conservators at the Central Research Laboratory for Art and Science, Holland (Fogle, 1985).

Emulsion lubricant

- 2g of lanolin
- 10g of neatsfoot oil
- 6g of surfactant—Teric N9
- 100ml of distilled water

Warm the first two ingredients together at about 60°C until they melt. Cool the mixture to 20°C and add the surfactant. Mix thoroughly and rapidly. While stirring continuously, add the distilled water bit by bit. When all the water has been added, pour the mixture into a glass cylinder.

Observe the mixture for 10 minutes in the glass cylinder. If it remains stable and does not separate, it is ready for use. This mixture contains no preservatives and does not keep long. Refrigeration extends the life of the mixture.

Paint the cooled emulsion onto the leather using a soft-bristled brush. Allow the leather to dry between coats, if more than one coat is needed to achieve the desired flexibility.

Lubricant solution

- 2g of lanolin
- 8g of neatsfoot oil
- 100ml of Shellsol T—aromatic-free white spirit.

Dissolve the lanolin and neatsfoot oil in the Shellsol T. Paint the solution on the leather using a soft-bristled brush.

Some commercial neatsfoot oil products contain significant quantities of fatty impurities. These impurities will settle out on the surface of leather after dressing to form fatty spews. To remove these from your own neatsfoot oil, refrigerate it then discard the solid upper layer.

British Museum leather dressing

- 200g of lanolin
- 30ml of cedar oil
- 15g of beeswax
- 300ml of X-4 solvent or hexane

To prepare the dressing, the first three ingredients are mixed together and melted by careful heating. The molten mixture is then poured rapidly into the cold X-4 solvent and allowed to cool with stirring. The dressing should be applied sparingly and rubbed well into the leather with clean swabs. After two days the leather may be polished with a soft cloth.

If you have a problem relating to the storage or display of leather objects, contact a conservator. Conservators can offer advice and practical solutions.

For further reading

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Self-evaluation quiz

Question 1.

Of the possible cleaning techniques, which is the safest to use on leather objects?

- a) Brushing with a soft bristle brush.
- b) Swabbing with a slightly moistened sponge.
- c) Vacuum cleaning, with the machine set on low power.
- d) Gently cleaning using a granular eraser.

Question 2.

Lubrication of leather objects in a museum is only necessary if the leather:

- a) is hard and dry;
- b) needs protection against changes in relative humidity;
- c) surface lacks sheen;
- d) needs to be protected against pollutants.

Question 3.

Which of the following statements are true?

- a) Tanning softens leather.
- b) The term leather only refers to skin products

which have been fully tanned.

- c) Leather has no fat in it.
- d) Tanning is a process that chemically alters skins, making them more durable and more resistant to rotting.

Question 4.

Cleaning of leather objects is recommended:

- a) on a regular basis, preferably monthly;
- b) for new objects before they are added to the collection, if they could contaminate other objects;
- c) if the dirt is disfiguring;
- d) before an object is put on display.

Question 5.

Which of the measures listed below will help to minimise mould formation on leather?

- a) Avoid over-lubrication.
- b) Store in the dark.
- c) Maintain good air circulation.
- d) Clean regularly.
- e) Keep relative humidity below 65%.

Question 6.

The major advantage of water-based emulsion lubricants is that:

- a) they promote an even spread of oil through the leather;
- b) they do not darken the leather surface;
- c) they induce greater flexibility than do solvent-based dressings;
- d) they penetrate the leather better than solvent-based dressings.

Question 7.

Which of the following statements about storing leather are correct?

- a) Folds and creases should be avoided.
- b) Buffered acid-free tissue should be used for support.
- c) Long leather pieces should be stored horizontally.
- d) Storage cupboards should be made of painted metal.
- e) Low light levels are best.

Question 8.

In the long term, over-lubrication of leather can cause:

- (i) increased desiccation of the leather;
- (ii) formation of fatty spews;
- (iii) a leather that is too soft;
- (iv) formation of mould under conditions of high RH;
- (v) the attraction of dust to a greasy surface.

Which of the above statements are correct?

- a) All of them.
- b) (i), (ii), (iii) and (iv).
- c) (ii), (iii), (iv) and (v).
- d) (i), (ii), (iv) and (v).

Answers to self-evaluation quiz

Question 1.

Answer: c).

Question 2.

Answer: b).

Question 3.

Answer: b), d).

Question 4.

Answer: b).

Question 5.

Answer: a), c).

Question 6.

Answer: a).

Question 7.

Answer: a), c), d), e). b) is not correct. Buffered tissue should not be used as it is alkaline, while leather is naturally acidic.

Question 8.

Answer: d).

WOOD

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Objectives

At the end of this chapter you should:

- have a basic knowledge of the main problems affecting the condition and longevity of objects made wholly or partially from wood;
- have an awareness of the differences between softwoods and hardwoods, and heartwood and sapwood; and
- be able to protect wooden objects during storage, display and handling.

Introduction

Wood is a material with which we are all familiar. Its extensive everyday use for furniture, walls, flooring, ceilings, structural supports in buildings, cooking utensils and garden tools builds an image of the nature of wood in our minds.

We know that wood is a strong, flexible, versatile and workable material. Items in our homes often withstand rough use or handling over many years and still survive. All these factors can create the impression that wooden artefacts in our collections don't need much care.

This is not the case. We must care for wood as we are for other objects. For wooden objects to maintain their condition and survive without damage, they must be given the right environment and be handled appropriately.

Wooden artefacts found in collections can vary greatly. They include such items as furniture, sculpture, technological and industrial artefacts and archaeological pieces. They can range in size from tiny, intricate carvings to horse-drawn vehicles and whole buildings.

Although at first glance these objects seem to have little in common with each other, the use of wood in their manufacture means that they respond to environmental changes in similar ways. These responses are also associated with the type of wood from which the object is made—the type of tree, the part of the tree from which the wood was originally cut, and the conditions under which the wood was seasoned.

This section gives a brief overview of the nature of wood, and provides basic information about the steps you can take to protect the wooden items in your collections.

An introduction to the anatomy and chemistry of wood

To understand how wood behaves, it helps to have some understanding of the structure of the living tree.

Wood in a living tree is composed of cells—with cell walls made of cellulose—which transport food and waste products through the tree.

As the tree grows, new cell layers are added to its outer circumference, forming seasonal—generally annual—growth rings.

Eventually the older cells in the inner part of the tree produce lignin in the cell walls and die.

This creates an area of wood in the centre of the tree stem which is comparatively dry—it still has bound water—and is free of sap. This is known as heartwood.

The outer, moister portion of the wood is called sapwood.

The differences between the types of cells and their relationship to each other determine the characteristics of particular species of trees, such as their colour, grain and strength.

Many trees also contain other chemicals such as resins and oils which affect the nature and appearance of their wood.

To help with identification, timbers are divided into two distinct groups, which are based on their botanical order:

- softwoods are derived from conifers—gymnosperms. Softwoods have a more uniform structure than hardwoods, but are not necessarily softer; balsa wood, the softest timber, is actually a hardwood; and
- hardwoods are derived from dicotyledons or broad-leaved trees—angiosperms.

There are significant structural differences between softwoods and hardwoods. These allow them to be distinguished from each other by microscopic examination. Every timber species has a characteristic arrangement of cells and tissues which enables it to be specifically identified. The tree structure determines the properties of the resultant timber—for example, strength, degree of shrinkage, durability, resistance to biological attack, porosity and moisture permeability.

The susceptibility of wood to damage from a number of factors depends on the chemical composition of the wood—that is, the percentages of the various components, such as cellulose, lignin and resins. This composition varies, depending on the original species of tree, the part of the tree used and the seasoning process.

When trees are cut for timber, the moisture which was present in the living wood dries out, until the wood reaches its equilibrium moisture content; this is called seasoning.

The equilibrium moisture content—EMC—of a particular piece of wood varies according to the relative humidity of its environment.

If the relative humidity increases wood will absorb water and its EMC will rise. The absorption of water causes wood to swell. If the relative humidity decreases, the wood's EMC drops and it shrinks.

If wood is seasoned too quickly, the sapwood dries and shrinks faster than the inner heartwood—this causes the sapwood to crack.

How much the wood shrinks when it dries depends also on where, within the tree, the wood comes from.

Wood perpendicular to the grain shrinks substantially more, that is, it shrinks across the grain rather than down the length of the grain.

Wood warps when it swells and shrinks at different rates.

What are the most common causes and types of damage?

Rapid fluctuations in relative humidity can result in:

- warping;
- joints in objects pulling apart;

- twisting;
- panels distorting;
- splitting;
- cracking;
- cleavage and loss of paint and other surface layers; and
- veneer can lifting up or popping off.

For more information

For more information about the adverse effects caused by fluctuations in humidity, please see *Damage and Decay*.

Wood is also very susceptible to biological damage. Wood's susceptibility to biological attack from mould, bacteria and insects depends on its moisture content and so can be related to the relative humidity levels of the surrounding environment.

Fungal attack can cause:

- damage to wood fibres;
- structural breakdown of the surface; and
- staining.

Bacterial attack causes slow deterioration of wood, accompanied by a putrid smell. This is most likely to happen when wood is in constant contact with water or mud.

Insects are the most serious pests affecting wooden objects in Australia. Insect attack usually results in structural damage. This damage can be severe.

For more information

For more information about the effects on wood of fungi and insects, please see the chapter on *Biological Pests in Damage and Decay*.

For more information about brown rot, dry rot and soft rot, please see the section *More About Wood* later in this chapter.

Other damage which must be considered includes:

- physical damage caused by falls, knocks and continued use;
- fading and discolouration caused by exposure to light and UV radiation; and
- burning or fire damage.

Common causes of damage

All the most common types of damage are caused by:

- poor handling;
- poor storage methods;
- inappropriate display methods;
- chemical and physical changes in the objects themselves; and
- a combination of any or all of these.

The following sections outline practical steps you can take to minimise this type of damage.

The do's and don'ts of handling wooden objects

Handling wood objects with care and commonsense helps to prevent damage. It is best to handle items as little as possible. It is also important to fully support objects when handling them.

Examine each object carefully to find the strongest, most stable part—and handle it there.

Avoid lifting wooden items by their handles or other weak points such as the backs of chairs, table tops and damaged areas. Lift them by holding the legs, or the lowest, strongest structural member such as under the seat rail of a chair. Pick up and carry furniture, rather than pushing or pulling it. Pushing and pulling furniture puts severe strain on the structure. Secure all drawers and doors before moving furniture, and check for loose decorations and members before moving it.

If objects are painted, avoid touching these areas.

Don't try to carry furniture alone—you risk damaging the furniture and injuring yourself.

Some basic do's and don'ts of repair and cleaning

Repair small pieces which have broken off or become detached, or store the pieces with the object until a conservator can carry out the

repairs. When repairing wooden objects, use only an adhesive which can be removed easily in the future, such as:

- a traditional animal glue which is applied warm; or,
- a conservation-quality, white glue such as Rhoplex AC-33.

White or yellow woodworking adhesives available in hardware stores are not ideal; but they are preferable to epoxy adhesives like Araldite or the superglues because it is virtually impossible to remove these without damaging the underlying wood.

Be aware that the finishes on wood can be affected by the adhesive—so use as little glue as possible near the edges of the break.

If you are unsure about what glue to use, or if the damage is extensive, contact a conservator for help and advice.

Use soft, cotton cloths to gently dust varnished furniture and wooden objects. For wooden objects with more delicate surfaces, for example, those painted or decorated with inlay, gently brush surfaces with a Japanese Hake brush. If the surfaces are flaking or unstable, do not brush them at all.

CAUTION:

Do not use feather dusters because the feathers often get caught in cracks and crevices and can cause the wood to splinter.

Ideal conditions for storing and displaying wooden objects

This section outlines the best long-term storage and display environment for wooden objects. But please note that if an ideal environment cannot be created, the emphasis should be on providing a stable environment.

Ideally, all wooden objects should be stored in an environment where temperature is constant and moderate—in the range of 18–20°C. Changing temperatures affect relative humidity levels; so if temperatures are generally outside this range in your area, it is important to try to keep fluctuations to a minimum and to ensure that they

are gradual. High temperatures can accelerate degradation reactions, and cause wood to dry out and become brittle.

Relative humidity should be constant and in the range of 50–60%. For composite objects, a compromise may have to be reached between a relative humidity that is ideal for the wooden components and the preferred relative humidity for the other component materials, for example, metals.

Wood swells and shrinks with changes in relative humidity. Wooden objects undergo dimensional changes when the relative humidity changes. This is generally a reversible process; but the speed of the process varies—drying takes longer than moisture absorption.

Avoiding rapid or excessive fluctuations in relative humidity is critical. It is better to leave a wooden object in a non-ideal relative humidity environment to which it has acclimatised than to suddenly change the relative humidity.

If relative humidity changes significantly, then swelling or shrinking can cause irreversible damage to a wooden object—this can include warping, twisting, splitting and cracking. Joints can pull apart, and panels distort. Cleavage and loss of paint can occur on painted, wooden items. This phenomenon is the most common and most preventable cause of damage to wooden objects.

Mould grows where relative humidity is continuously above 65%; but relative humidity levels of 60% and less are not favourable to mould growth.

Items which are at risk of drying out too quickly after they have come from moist conditions should be kept in an environment where the relative humidity is in the range of 50–60%. Items which are acclimatised to drier conditions should be kept in an environment where the relative humidity is in the range of 45–55%.

Light should be kept to the minimum necessary for the activity. Wherever possible, items which are not on display should be stored in the dark. If light is not required for viewing while the works are being stored, then there is no need for them to be illuminated. This reduces the risk of materials fading and becoming discoloured.

The brightness of the light should be below 250 lux.

For objects on display, the maximum exposure to light should be 650 kilolux hours in one year.

Ultraviolet radiation should be eliminated completely, because it causes irreversible changes to the appearance and structure of the wood surface and greatly accelerates degradation reactions. Ideally, the UV content of the light should be less than 30 $\mu\text{w/lm}$ and no greater than 75 $\mu\text{w/lm}$.

Avoid exposure to the sun if possible. Research shows that after only three days' exposure to the sun, the lignin is completely broken down in the surface of a piece of wood. This affects both the colour and texture, as well as the strength of the wood, often resulting in wood fibres shedding off the surface.

Protect items from dust and pollutants.

For more information

For more information about adverse environmental effects, please see *Damage and Decay*.

General storage and display guidelines

Give careful consideration to the storage site and the storage system. In situations where you can achieve the ideal conditions, a good storage system in an appropriate storage site will give added protection to your collection. If the available facilities, or the local climate, make it difficult for you to achieve the ideal conditions, then the selection of the storage site and the maintenance of a good storage system are even more critical in preventing damage to the collections.

Wherever possible, the storage and display sites should be in a central area of the building, where they are buffered from the extremes of climatic fluctuations which are experienced near external walls or in basements and attics. Basements should also be avoided, because of the risk of flooding.

The storage site should not contain any water, drain or steam pipes, particularly at ceiling level. If these pipes were to leak, extensive damage could result.

Ventilate storage and display sites. This helps reduce the risk of insect and mould infestation.

Clean and inspect storage and display areas regularly. Thorough, regular cleaning and vigilance help greatly in controlling insects and mould.

Check objects regularly to detect insect infestations early. Signs of infestation include holes and frass—that is, wood powder left by borer insects.

Don't store items in sheds or directly on the floor. Polished surfaces should be protected from moisture.

Cover stored objects with cotton or Tyvek covers. They provide protection from dust and unnecessary exposure to light. These covers also provide some buffering against fluctuations in environmental conditions.

For more information

For more information about Tyvek, please see the chapter on Textiles in *Caring for Cultural Material 2*.

Always give items adequate support, and try to reduce the physical stresses which can cause damage. Ensure that the supports for painted items will not rub against painted areas and cause paint loss.

Small items can be supported on polystyrene-filled, cotton bags. This also allows the items to be well aired, preventing possible cracking through differential drying.

Ensure that light-sensitive items are adequately protected. They can be placed in covered storage boxes, or covered with cotton or Tyvek dust cloths, to reduce their exposure to light.

Rotate exhibitions—so objects are not on display constantly.

Keep light levels low when items are on display, and make sure lights are turned off after hours. Always avoid direct sunlight on your objects. Make sure that the heat produced by the lights does not affect your objects.

Refer to Handling, transportation, storage and display volume for more general information on storing and displaying wood.

Coating wooden objects

Think carefully before deciding to apply a coating to the surface of a wooden object. All coatings require maintenance, and they generally attract dust more readily than unfinished surfaces, increasing housekeeping needs.

Many oils, polishes and waxes have been used over

the years to 'feed' or rejuvenate wooden surfaces. Wood does not need feeding; and products which claim to have this benefit are of dubious value.

It is most important to consider reversibility whenever applying anything to an object.

Oils—for example, linseed oil—applied to wood surfaces can crosslink as they age, becoming more and more difficult to remove, and frequently discolouring or darkening.

For more information

For information on crosslinking, please see the chapter on Common Deterioration Processes in *Damage and Decay*.

If the surface of a wooden object appears dry or patchy, it is better to use a microcrystalline wax polish such as Beckett's Clear Furniture Wax or Renaissance Wax. If necessary, these can be removed using white spirits at a later date.

CAUTION:

Never apply products containing silicone to a wooden object. And avoid colorants. Silicone and colorants are usually found in proprietary furniture cleaners.

Wax objects infrequently—once or twice a year at the most—with wax applied sparingly with a soft cloth. Polished items can be buffed lightly with a clean, soft cloth to maintain shine.

Consider refinishing an object as a last resort only. Remember that original and old finishes are as much a part of the object and its history as the wood from which it was made. It is appropriate that the surfaces of historical wooden objects have patina and look their age.

Many wooden ethnographic objects have very fragile surfaces—for example decorations painted in quite friable pigment. These objects should not be cleaned without the assistance or advice of a conservator. Neither should they be coated to consolidate the surface—such an action would cause considerable damage.

For more information

For information on how to care for ethnographic material see the chapter Aboriginal and Torres Strait Islander Cultural Material in this volume.

Summary of conditions for storage and display

	Storage	Display
Temperature	18–20°C	18–20°C
Relative Humidity	50–60%	50–60%
Brightness of the Light	Dark storage is preferred. but if light is present it should be less than 250 lux.	Should be less than 250 lux.
UV Content of Light	Dark storage is preferred; otherwise, UV content should be less than 30μW/lm and no more than 75μW/lm.	Less than 30μW/lm and no more than 75μW/lm.

Wooden objects in Australia's climatic zones

The climatic zones outlined below are broad categories. Conditions may vary within these categories, depending on the state of repair of your building and whether or not it is air conditioned.

Arid

This climate is generally very dry, however, in arid areas, it is often very hot during the day and very cold at night. This wide fluctuation in temperature is matched by wide fluctuations in relative humidity, for example from 75%–20% in a day.

When caring for wooden objects in arid climates it is important to note:

- these items will tend to give out the water they contain - this can lead to some items becoming dry and brittle;
- wooden objects are particularly susceptible to damage from fluctuations in temperature and relative humidity; and
- as different parts of items release moisture at different rates, warping, dimensional change and flaking of paint can result.

Remember that even arid areas can have periods of higher relative humidity, even though the periods may only be very short.

High humidities will cause swelling and will increase the likelihood of insect and mould attack.

Dust can be a major problem in an arid climate. It is important that steps are taken to protect items from dust in storage and display.

Note: If your collections of wooden objects have been kept in an arid environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

Temperate

A temperate climate is considered a moderate climate, however, temperate climates tend to have a greater range of temperatures than tropical climates and may include extreme climatic variations.

If you are redecorating or designing storage and display areas, consider using materials that will help to buffer these areas against rapid fluctuations and extremes of relative humidity and temperature. This will help to reduce the risk of damage due to the fluctuations and extremes that occur in temperate environments.

The system of layers of storage—boxes, boxes within cupboards and drawers, covering items on shelves, etc—will be very useful in helping to buffer against the extreme conditions that can occur in a temperate environment.

As for all climatic areas regular inspection of storage and display areas, is important so that developing problems do not go unnoticed.

Remember that many of Australia's main cities and major regional centres are in temperate regions. These areas tend to be heavily polluted and this should be taken into account.

Note: If your collections of wooden objects have been kept in a temperate environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

Tropical

These climates are characterised by heavy rainfall, high humidity and high temperatures.

When caring for wooden objects in tropical climates it is important to note that:

- insects and moulds thrive and reproduce readily;
- chemical deterioration reactions generally proceed faster at higher temperatures;
- items that have been in a tropical environment for some time will have a higher moisture content. If they are suddenly moved into a drier environment they are likely to suffer shrinkage and warping; and
- wooden objects are very reactive to changes in relative humidity.

Take steps to ensure that your storage and display spaces have good air flow.

Note: If your collections of wooden objects have been kept in a tropical environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

MORE ABOUT WOOD

Additional notes on fungal attack of wood

Generally fungal attack can occur only when the equilibrium moisture content of the wood is greater than 20% and the temperature is below 40°C. Fungi attack sapwood faster than heartwood.

Some woods are naturally resistant to decay—because their heartwoods contain substances which inhibit fungal attack.

The presence of fungal fruiting bodies on the surface of wood indicates the presence of rot; but in many cases there is no visible sign of fungi. Affected wood can be soft and spongy, or brittle and powdery.

The term 'decay' when used in relation to wood specifically refers to attack by *Basidiomycete* fungi. These are grouped into two types which are particularly destructive to timber in buildings and other artefacts: brown rot and white rot. They are less likely to be a problem for indoor wooden objects.

Brown rot is a term which includes wet rot and dry rot—*Serpula lacrymans*. It attacks softwoods more commonly than hardwoods, destroying the cellulose and leaving the lignin behind. After attack, the wood is typically left stained and brown, with cuboidal cracking of the surface.

Dry rot is extremely destructive because the fungus can grow some distance away from its moisture source, producing long strands which can travel over large areas of masonry to infect new wood.

Dry rot is found only in cooler climates because it can't withstand temperatures greater than 40°C. It is less common in Australia than in Europe, where it causes extensive damage to buildings; but it has been found in Melbourne and Tasmania. If a dry rot outbreak is suspected, it should be dealt with immediately by a conservator experienced in dealing with dry rot.

White rot can destroy both the cellulose and lignin in wood. It is caused mainly by *Ascomycetes* fungi. After attack, the wood is a whitish colour and lighter in weight, with a stringy or fibrous appearance.

Soft rot occurs in wood that is continuously damp or in contact with the ground, for example, building timbers, archaeological wood, marine artefacts, or objects in exterior displays such as outdoor sculpture.

The fungus selectively attacks the cellulose from the outer surface of the wood, causing the surface to soften. After attack, the dried wood has a cracked appearance.

Soft rot can be avoided in wooden objects on outside display by ensuring that they are raised slightly off the ground on plinths or supports, so they are not in direct contact with the soil. Objects should be sheltered where possible, to ensure that water does not lie on their surfaces.

Numerous other fungi and moulds can grow on the surface of—or within—wooden objects, causing staining and possibly structural breakdown of the surface being colonised. These fungi and moulds are more commonly found on indoor objects than are the rots described above. They can cause staining, either by releasing pigments or through the presence of dark, fungal structures.

For more information

For more information about fungi and steps that can be taken to minimise the risk of fungal attack, please see the chapter on Biological Pests, in *Damage and Decay*.

If you have a problem relating to the storage or display of wooden objects, contact a conservator. Conservators can offer advice and practical solutions.

For further reading

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Self-evaluation quiz

Question 1.

Wood is susceptible to damage caused by:

- a) insects;
- b) fungal attack;
- c) fluctuations and extremes of relative humidity;
- d) exposure to light and UV radiation;
- e) none of the above—wood is a durable material.

Question 2.

Which of the following statements are true?

- a) There is no difference between sapwood and heartwood.
- b) Mould grows when the relative humidity is continuously above 65%.
- c) Differences in the amount of swelling and shrinkage within a piece of wood can lead to warping.
- d) The susceptibility of wood to damage from a number of factors depends on the chemical composition of the wood.
- e) None of the above.

Question 3.

When handling objects made from wood it is important to:

- a) examine each object to find the strongest, most stable part, so that you can handle it there;
- b) pick up and carry furniture rather than pushing or pulling it;
- c) fully support objects when handling them;
- d) try to touch them on unpainted areas, if they are painted;
- e) all of the above.

Question 4.

Which of the following statements is true. If you are carrying out repairs to wooden objects:

- a) use Superglue so you can be sure it will stick;
- b) only use an adhesive which can be easily removed in the future;
- c) avoid using epoxy adhesives, because they cannot be removed easily without causing damage;
- d) be aware that the finishes on wood can be affected by the adhesive, so use as little glue as possible near the edges of a break.

Question 5.

What are the ideal recommended conditions for storing wooden objects?

- a) 18–20°C, 50–60% relative humidity, dark storage
- b) 18–20°C, 20–40% relative humidity, dark storage
- c) 24–30°C, 50–60% relative humidity, dark storage
- d) 18–20°C, 50–60% relative humidity, in bright light.

Question 6.

When storing or displaying wooden objects:

- a) protect polished surfaces from moisture;
- b) keep the storage and display sites reasonably ventilated;
- c) always give items adequate support;
- d) ensure that light-sensitive items are adequately protected;
- e) if the ideals for temperature and relative humidity cannot be met or are inappropriate, the emphasis should be on providing a stable environment;
- f) all of the above.

Answers to self-evaluation quiz

Question 1.

Answer: a), b), c) and d).

e) is incorrect. Wood is a durable material, but it is still susceptible to damage and will not be durable unless it is cared for.

Question 2.

Answer: b), c) and d) are true.

Question 3.

Answer: e).

Question 4.

Answer: b), c) and d). a) is not correct. Superglues should be avoided because they cannot be reversed easily without causing damage to the underlying wood.

Question 5.

Answer: a).

Question 6.

Answer: f).

ABORIGINAL AND TORRES STRAIT ISLANDER CULTURAL MATERIAL

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Objectives

At the end of this chapter you should:

- be aware of the range of materials which are used to make Aboriginal and Torres Strait Islander heritage items;
- have a basic knowledge of the most common types of damage encountered in collections of Aboriginal and Torres Strait Islander heritage items;
- have an understanding of the factors that contribute to the deterioration of these items;
- be able to take practical steps to reduce future damage to items in your care;
- know about specific steps you can take to care for particular items, such as bark paintings, and carved and painted objects; and
- know about the national museums' policy on Aboriginal and Torres Strait Islander items.



Photograph courtesy of Karen Coote, Australian Museum

much that you can do to preserve items in your care: through careful and thoughtful handling, storage and display.

This section identifies the main problems you will encounter with Aboriginal and Torres Strait Islander heritage items in your collections, and provides information that will help you to prolong the life of these items. The measures recommended in this section relate to standard museum conservation practice, and do not take into account regional, indigenous conservation methods.

Previous Possessions, New Obligations—a national policy



Photograph courtesy of Karen Coote, Australian Museum

In 1993, the International Year for the World's Indigenous Peoples, the Council of Australian Museum's Association—now Museums Australia—released *Previous Possessions, New Obligations: Policies for Museums in Australia and Aboriginal and Torres Strait Islander Peoples*.

The introduction to this policy document states:

Museums have tended to see their major role as collecting and maintaining objects. But they in fact have obligations to people, most particularly as to how they portray the people and societies whose cultural material and heritage they hold. Increasingly, museums need to strengthen their relationships with the peoples and communities whose material culture forms the basis of their collections. Museums in Australia wish to join with Aboriginal and Torres

Many museum, gallery and library collections include Aboriginal and Torres Strait Islander heritage items. These items can be made from a wide range of materials; and caring for them is not always straightforward.

As with all heritage items, compromise is necessary when trying to find a balance between using and preserving collections. Yet, there is

Strait Islander peoples in collaborative programs to increase understanding amongst all peoples.

Museums Australia's policy encourages all State and Territory museums to work closely with indigenous people to interpret, display and preserve their cultural property. Part of this policy includes the identification and repatriation—to their rightful custodians—of culturally sensitive Aboriginal or Torres Strait Islander material in museums.

Aboriginal and Torres Strait Islander heritage items in collections

This section concentrates on Aboriginal and Torres Strait Islander heritage items that are commonly found in collections, and which are most at risk of deterioration. These include items made from:

- feathers;
- dyed fibres;
- fibres;
- seeds;
- carved wood;
- painted bark;
- painted wood;
- natural pigments;
- natural gums, waxes and resins;
- paintings on canvas;
- printed fabrics; and
- paintings and drawings on paper;

For more information

For more information about the care of paintings, works on paper, fabrics and wooden objects, please see *Caring for Cultural Material 1* and *2*.

What are the most common types and causes of damage?

As with most heritage material which is made mainly from organic materials, Aboriginal and Torres Strait Islander heritage items are vulnerable to physical damage, and to damage caused by chemical deterioration of their components.

Physical damage includes:

- scuffing, abrasion and breaks to objects caused by poor handling and/or inadequate support during storage and display;
- creasing and tearing of works on paper and canvas caused by excessive or careless use;
- splitting and curling of bark paintings due to fluctuations in relative humidity;
- woven plant fibres drying out and becoming brittle in low relative humidity conditions;
- distortion of natural resins and waxes in high temperatures;



Paint is flaking away from this wooden object.

Photograph courtesy of Karen Coote, Australian Museum

- loss of paint because of fluctuations in relative humidity. Fluctuations in relative humidity can cause the paint to flake and become powdery and fall off the surface of bark paintings and carved wooden objects;
- cracking of wooden objects in low relative humidity conditions. Cracking occurs when wood dries out too quickly. This can also lead to a loss of paint from these objects;

- flaking and powdering of paints because of inadequate binder in the paint formulation. The artists make their own paints for use on barks and wooden objects, using natural ochres and mineral pigments bound with glues. Sometimes only a little bit of glue is used, and this can cause the paint to fall off;
- insect attack— insects will attack wood, feathers, seeds, fibres, human hair string, bark, paper and canvas; and



Areas of insect damage can be seen on this object.

Photograph courtesy of Karen Coote, Australian Museum

- soiling caused by deposits of dust. Dust can become permanently attached to objects if components, such as natural resins and waxes, soften due to high temperatures.

Damage due to chemical deterioration includes:

- fading and discolouration of natural pigments, watercolour pigments, felt-tip pen inks and other media caused by exposure to UV radiation and high lighting levels;
- discolouration of paper due to exposure to UV radiation and high lighting levels;
- fading of feathers, woven fibres, printed fabrics, paper and unpainted wooden carvings due to exposure to UV radiation and high lighting levels;
- damage from pollutants;
- natural aging of materials which happens more rapidly when objects are exposed to extreme temperatures and high relative humidity levels; and

- deterioration caused by mould growth. Organic materials are potential food sources for mould. Conditions are very favourable to mould growth when the relative humidity remains constantly above 65%.

For more information

For more information about adverse environmental effects, please see *Damage and Decay*.

Common causes of damage

All the most common types of damage are caused by:

- poor handling;
- poor storage methods;
- inappropriate display methods;
- chemical and physical changes in the objects themselves; or
- a combination of any and all of these.



Photograph courtesy of Karen Coote, Australian Museum

The do's and don'ts of handling Aboriginal and Torres Strait Islander heritage items

Handling Aboriginal and Torres Strait Islander heritage items with care and commonsense will help to prevent damage.

It is best to handle all items as little as possible and to fully support all objects when handling

them. This includes objects made from stone, wood, fibres, feathers, bark, fabric and paper, as well as painted objects and paintings on canvas or other supports.

If objects are painted, try to touch them on unpainted areas where possible. For example, carry barks by holding the edges and decorated carvings in the areas of plain decoration.

If an object is made up of different materials, examine it carefully to find the strongest, most stable part, so that you can handle it there.

Ochre-painted items are particularly vulnerable to pigment loss—take extreme care when handling these works.

Wear gloves to reduce the risk of pigment rubbing off, and the possibility of transferring sweat, grease and grime from uncovered hands.

CAUTION:

Do NOT wear white, cotton gloves when handling objects with flaking or powdery pigment surfaces, for example, Aboriginal bark paintings.

The pigment can be picked up by the cotton gloves. If you must touch pigmented areas, wear clean, close-fitting surgical gloves instead.

Remember, feathers are fragile and should not be handled directly. If you must pick up single feathers, handle them at the rachis, that is, the vein portion.

Storing and displaying Aboriginal and Torres Strait Islander heritage items

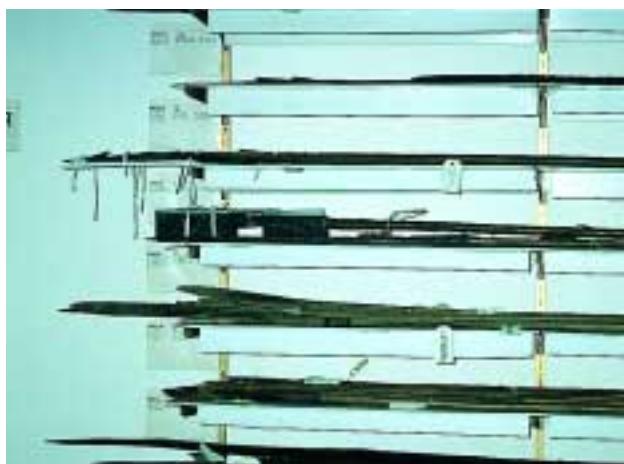
Always remember to be sensitive to the cultural group, and make sure that cultural mores are respected, when handling, storing and displaying cultural heritage material.

For example, with particular Aboriginal community groups, it is appropriate to store items relating to men's business in a separate area to items relating to women's business.

With secret or sacred material, security is important—to make sure that only the appropriate people have access to the items.

Just as there can be appropriate and inappropriate ways to store particular items, it is important to be aware that displaying these items should also be handled sensitively. For example, it may never be appropriate to place some items on general display.

If you are unsure of the appropriate way to handle, store or display any Aboriginal and Torres Strait Islander heritage items in your collection, contact a curator at your State museum for further information or for contacts with the appropriate people to answer your questions.



Spears in storage.

Photograph courtesy of Karen Coote, Australian Museum

Ideal conditions for storage and display

It is important to note that ideal storage conditions cannot always be achieved; nor is it always appropriate to do so, because some items are produced, and used, in extreme climates. For example, if an item has been produced recently, or stored for a considerable time, in a tropical environment, placing it in a so-called ideal environment which is much drier than the conditions it is used to, could cause extensive damage.

This section describes the ideal storage and display environment for most materials. If the ideal environment cannot be achieved, or is inappropriate, the emphasis should be on providing a **stable** environment.

Ideally, store all Aboriginal and Torres Strait Islander heritage items in an environment where temperature is constant and moderate—in the range of 18–22°C. If temperatures are generally outside this range in your area, it is important to keep fluctuations to a minimum and to make sure that they are gradual.

Relative humidity should be constant and below 60%. Minimise fluctuations in relative humidity, and ensure that they are gradual. Fluctuations in relative humidity can cause severe distortion, cracking and splitting, and cause separation of paint layers from the objects.

Mould grows where the relative humidity is continuously above 65%, mould does not grow when relative humidity is stable and below 60%.

Keep items at risk of drying out too quickly after coming from moist conditions, in an environment where the relative humidity is in the range of 55–65%.

Keep items acclimatised to drier conditions in an environment where the relative humidity is in the range of 50–55%.

Light should be kept to the minimum necessary for the activity. Wherever possible, store items that are not on display in the dark. This reduces the risk of fading and discolouration of a range of materials.

It is necessary to have light when items are on display. The brightness of the light should be determined by the sensitivity of the particular materials to light.

For sensitive materials such as feathers, woven fabrics, dyed materials and watercolours on paper, the brightness should be 50 lux or less. For moderately sensitive materials, the brightness of the light should be 250 lux or less.

For all items the UV content of the light should be less than 30 $\mu\text{W/lm}$ and no greater 75 $\mu\text{W/lm}$.

Protect items from dust and pollutants.

For more information

For more information on adverse environmental effects, please see *Damage and Decay*.

General storage and display guidelines

Give careful consideration to the storage site and the storage system. In ideal conditions, a good storage system in an appropriate storage site, gives added protection to your collection. If the available facilities or the local climate make it difficult to achieve the ideal conditions, selecting the storage site and maintaining a good storage

system are even more critical in preventing damage to the collections.

Wherever possible, the storage and display sites should be in a central area of the building, where they are buffered from the extremes of climatic fluctuations which can be experienced near external walls or in basements and attics. The storage site should not contain any water, drain or steam pipes, particularly at ceiling level. Leaking pipes can cause a lot of damage. Basements should also be avoided, because of the risk of flooding.

The storage and display sites should be well-ventilated. This helps reduce the risk of insect and mould infestation.

Inspect and clean storage and display areas regularly. Thorough and regular cleaning helps greatly in controlling insects and mould. To detect insect infestations early, check objects regularly for signs of infestation—holes and frass, that is, wood powder left by boring insects.

Don't store items in sheds, or directly on the floor.

Cover stored objects with cotton or Tyvek covers. They provide protection from dust and unnecessary exposure to light. These covers also provide some buffering against fluctuations in environmental conditions.

For more information

For more information about Tyvek, please see the chapter on Textiles in this volume.

Always give items adequate support and try to reduce the physical stresses that can cause damage.



Spear throwers supported and shelved in storage.

Photograph courtesy of Karen Coote, Australian Museum



Hafted axes—note the supports for each item.
Photograph courtesy of Karen Coote, Australian Museum

Bark paintings should be stored flat, and any curved or warped areas supported with polystyrene-filled, cotton bags or something similar. This gives the bark the greatest overall support.

Ideally, place barks in drawers such as plan cabinets: to protect them from dust and from fluctuations and extremes in relative humidity and temperature. If suitable drawers are not available, store bark paintings on flat shelving, with support for warped or curved areas as described above.

You can consider placing each bark painting on a flat board, for example, acid-free Foam Cor, mount board or in a box, so that you can lift the item without touching the bark itself. This is particularly helpful when it is necessary to move items in storage or to have the bark painting available for study purposes.

Woven material, such as pandanus, bark string bags and baskets, should be well supported on the inside with Dacron-filled cotton bags. This helps to maintain their shape, and reduces the risk of splitting along the creases, which can occur if they are stored flat. It is wise to support them on the outside with filled, cotton bags as well.

Design similar support systems for items that are on display, especially for long-term display.



This woven bag is padded to help it maintain its shape.

Photograph courtesy of Karen Coote, Australian Museum



The support system on the right is designed to prevent distortion of the dance hat on the left.

Photograph courtesy of Karen Coote, Australian Museum



The hat mounted on its support ready for storage or display.

Photograph courtesy of Karen Coote, Australian Museum

Objects made with feathers and/or seeds are prone to light and insect attack. It is better to store them in large, dry, plastic containers with lids in a storage system specifically made to fit the container. As well as protecting against light damage and insect attack, this stops the items being squashed.

Always give carved and painted items adequate support—using systems that will not rub against painted areas and cause paint loss.

Store and display carved and painted items, such as Pukumani poles from the Tiwi Islands, so that their weight is supported and there is no friction on painted surfaces, which could lead to losses.



Pukumani poles supported in a specially designed storage system.

Photograph courtesy of Karen Coote, Australian Museum

Smaller items can be supported on polystyrene-filled cotton bags, where the paint can be protected and the carving is well-aired, preventing possible cracking through preferential drying.

Painted bags, for example, decorated bark baskets or painted pandanus bags, can be stored inverted to give uniform support over the unpainted surface, or on doughnut-shaped, padded cushions which hold them upright and touch only unpainted areas of the objects.

Make sure that light-sensitive items are adequately protected.

Store light-sensitive material—such as the pandanus and bark string bags and baskets—away from strong light, because the vegetable dyes fade readily. They can be placed in covered storage

boxes, or covered with cotton or Tyvek dust cloths to reduce their exposure to light.

Rotate the exhibitions, so objects are not constantly on display.

Keep light levels low when items are on display, and make sure lights are turned off after hours. Make sure also that heat produced by the lights does not affect your objects.

Always avoid direct sunlight on your objects.

Care of bark paintings

The bark most commonly used for paintings is called Stringybark—*Eucalyptus tetrodonta*. The pigments used in the paintings are natural red and yellow ochres as well as white gypsum and charcoal. Since the 1960s these pigments have been mixed with water and varying quantities of PVA glue, generally the brand name Aquadhere. Earlier, artists used vegetable binders with the pigments, including orchid juice, the sap of certain leaves and trees and turtle egg yolk.

Problems encountered with bark paintings

Loss of paint

Possible Causes

- Poor storage conditions.
- Poor mounting systems.
- Too little binder in the paint.
- Paint applied over unbound pigment.
- Environmental fluctuations cause movement of barks, causing paint to flake.
- Some paints shrinking more than others as the paint dries.

Preventive Action

- Store bark paintings flat, painted side up, and in a stable, dust-free environment.
- Support barks so that they are protected against vibration.
- Avoid stacking objects one against the other.

- Seek the advice of a conservator.
- In communities where the artist is available to retouch his or her work, take great care to make sure only the damaged area is treated and pigment colours are matched.

CAUTION:

It is unwise to spray commercial fixatives onto flaking or powdery areas, because the fixatives often yellow in time, and the pressure of the spray can blow flakes from the objects.

Mould growth

Possible Causes

- Relative humidity above 65%. The main storage room may be at a low relative humidity; but pockets of higher relative humidity can occur, especially in badly ventilated corners and drawers.
- Mould can grow unseen on the back of a bark where the relative humidity is higher because of poor storage conditions. The mould can then grow through fine cracks in the bark to the painted surface.

Preventive Action

- Store or exhibit in a well-aired environment with relative humidity below 65% and preferably below 60%.

Splitting and curling

Possible causes

- Rapid fluctuations in relative humidity—fibres absorb and lose water, which causes barks to expand and shrink.

Preventive action

- Store the bark horizontally and well supported in a stable environment.
- Avoid placing the bark near heaters, air conditioning outlets or open windows. The environment is not likely to be stable in these areas.
- The most stable areas are normally the inner rooms of a building.
- In time, the bark may relax into a flatter position.

Warping

Possible causes

- Normally because of uneven pressure on the bark. It can occur over a long time, and can eventually cause splitting and loss of pigments.
- Can be the result of poor mounting systems, which allow some areas of the bark to move in response to environmental fluctuations while others are kept immobile.

Preventive action

- Remove any uneven pressure from the back or front of the bark.
- Remove, or get a conservator to remove, any glued bars of wood from the back of the bark.
- If you wish to display your bark painting, mount it in such a way that it is supported without being subjected to uneven pressures.

Care of items made from fibres

Vegetable fibres are used for the manufacture of a range of woven objects. In the north of Australia, the Pandanus Palm—*Pandanus spiralis*—and the Sand Palm—*Livistonia humilis*—are used extensively for basket making. Fibrous grasses of the genus Cyperus are used also.

Bush string is made from a range of species—including the Yellow-flowered and Red-flowered Kurrajong—*Brachychiton diversifolius* and *Brachychiton paradoxum* respectively—the Banyan Tree—*Ficus virens*—and Beach Hibiscus—*Hibiscus tiliaceus*. Bush string is used to make bags and ornaments.

In recent years, Aboriginal people have developed a range of vegetable-dye recipes for colouring their vegetable fibres; and in some regions the purple dye of the Murex shellfish is also used.



Fibre items and bark paintings on display

Photograph courtesy of Karen Coote, Australian Museum

Objects are also made from human-hair string, and some are decorated with the feathers from a variety of birds.

Problems encountered with items made from fibres

Insect attack

Insect attack can be avoided by:

- storing objects in sealed containers to prevent infestation;
- placing these items indoors for exhibition, preferably in sealed showcases;
- checking objects constantly for insect attack; and
- fumigating or freezing items that are being attacked by insects.

For more information

For more information on controlling insects, please see the chapter on Biological Pests in *Damage and Decay*.

Damage through exposure to light and UV radiation

Light and UV radiation damage can be avoided by:

- storing objects in containers or boxes with lids, or under cotton or Tyvek covers;
- rotating items on exhibition, so that individual items are not exposed for long periods;

- keeping light levels low when items are on display, and turning lights off when they are not needed for viewing; and
- using low UV-emitting light sources, and avoiding sunlight.



Fibre items stored in plan chest drawers.

Photograph courtesy of Karen Coote, Australian Museum

For more information

For information about reducing UV radiation from storage and display areas, please see the chapter on light and UV radiation in *Damage and Decay*.

Care of wooden objects

In the Top End, many wooden objects—particularly carvings—are made from the soft wood of the Beach Hibiscus—*Hibiscus tiliaceus*—the Kapok Tree—*Bombax ceiba*—Shitwood—*Cyrtocarpus americans*—the Milkwood—*Alstonia actinophylla*—acacias and eucalyptus woods.

Burial poles and weaponry on Melville and Bathurst Islands are commonly made from Ironwood—*Erythrophleum chlorostachys*—or Bloodwood—*Eucalyptus nesophila*.

Most items are made from freshly cut timber, that has been dried for several days, though this varies according to the maker. On Melville and Bathurst Islands, burial poles are made, where possible, from fallen logs which are already cured through a long drying out period.

In arid central Australia, the most common wood used for making weapons and carvings is Mulga wood—*Acacia aaneura*. Other commonly used

timbers for making artefacts are Bloodwood—*Eucalyptus opaca*—Desert Kurrajong—*Brachyítón gregorii*, and Sandhill Wattle—*Acacia dictyophleba*.



A canoe in storage.

Photograph courtesy of Karen Coote, Australian Museum

Problems encountered with wooden objects

Insect attack

Possible causes

- Softer woods are prone to insect infestation.
- Usually the infestation occurs before the tree is cut down, and insects emerge from the object because the conditions—relative humidity and temperature—are favourable for continuing their life cycle.
- Insect infestation shows itself by the typical frass and exit holes in the wood. The size and shape of the hole can tell an expert what insect has emerged.

Preventive action

Freeze the object:

- place the affected object in a plastic bag;
- remove as much air from the bag as you can. This reduces the amount of moisture which would otherwise be absorbed by the object or condense inside the bag;
- close the bag with a heat-sealer or waterproof tape;
- place the object, in its bag, in a freezer for 48 hours at -20°C; and

- then remove the object from the freezer and allow it to thaw.

Wood, leather, feathers, fibre and textiles can all be treated this way. This process kills insects at all stages of their life cycles.

Cracking

Possible causes

- Aboriginal wooden objects have often been cut and carved before the wood has had time to cure or season. This leads to preferential loss of water from particular areas of the wood as they dry out in the natural atmosphere.

Preventive action

- Place the object in a wetter environment, up to 60%RH. This slows down the drying rate and helps to reduce cracking.

Flaking paint

Possible causes

- Too little binding medium in the paint.
- Paint applied over unbound pigment.
- Environmental fluctuations causing movement of the wood, leading to flaking of the paint.
- Preferential shrinkage of some paints over others as the paint is drying.

Preventive action

- Wooden objects with flaking paint can be stored by supporting them on sand-bags, so that the painted areas are not under any pressure.

CAUTION:

Do not try to treat painted wooden objects without a conservator's help. Using the wrong adhesive and/or application technique can cause problems, including further flaking and the yellowing of the paint area over time. It is unwise to spray commercial fixatives onto the flaking or powdery area, because the fixatives often yellow in time, and the pressure of the spray can blow flakes from the objects.

Natural adhesives and cements

Wax, gums and resins are frequently used:

- as adhesives for mounting stone spear or axe heads;
- for mending broken artefacts;
- as caulking for containers;
- for modelling small figures; and
- for making ornaments and ceremonial items.

In the desert the most common adhesive is resin from the Spinifex bush—*Triodia sp.*—other types include gums from the Desert Grass Tree—*Xanthorrhoea thorntonii*—the Mulga—*Acacia aneura*—and the Ghost Gum—*Eucalyptus papuanus*.

In the tropical north, the wax made by native bees is the most commonly used sealant and adhesive; it is used for making small modelled figures and ornaments as well. Sometimes the gum from the Ironwood tree is also used as a cement.

Problems encountered with natural adhesives and cements

Distortion and slumping

Possible causes

- These substances change as the temperature and humidity fluctuate.

Preventive action

- Keep items with these types of materials out of direct sunlight and away from heat.

Paint media on canvas and paper

Artists' paints can include combinations of acrylics, natural gums and natural pigments.

Problems encountered with paint media on canvas and paper.

Flaking and powdering of paints

Possible causes

- Fluctuations in relative humidity.
- Too little binding medium in the paint.
- Inadequate support of the paper or canvas, allowing them to flex.

Preventive action

- Store works on paper and canvas in a stable environment.
- Use correct mounting techniques for works on paper to ensure that they are fully protected.
- Use appropriate storage, handling and display techniques for stretched and unstretched paintings on canvas.

For more information

For more information about storage and display of works on paper and or painting,
see *Caring for Cultural Material 1*.

Aboriginal and Torres Strait Islander heritage items in Australia's climatic zones

The climatic zones outlined below are broad categories. Conditions may vary within these categories, depending on the state of repair of your building and whether the building is air conditioned.

Arid

This climate is generally very dry, however, in arid areas, it is often very hot during the day and very cold at night. This wide fluctuation in temperature is matched by wide fluctuations in relative humidity, for example from 75%–20% in a day.

When caring for Aboriginal and Torres Strait Islander heritage items in arid climates it is important to note:

- many of the materials that make up these items will tend to give out the water they contain—this can lead to some items, and some components of items, becoming dry and brittle; and
- the composite nature of many Aboriginal and Torres Strait Islander heritage items means that they are particularly susceptible to damage from fluctuations in temperature and relative humidity. As different materials release moisture at different rates, warping, dimensional change and flaking of paints can result.

Remember that even arid areas can have periods of higher relative humidity, even though the periods may only be very short. High humidities will cause swelling of some materials, and will increase the likelihood of insect and mould attack.

Dust can be a major problem in an arid climate. It is important that steps are taken to protect items from dust in storage and display.

Note: If your collections of Aboriginal and Torres Strait Islander heritage items have been kept in an arid environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

Temperate

A temperate climate is considered a moderate climate, however, temperate climates tend to have a greater range of temperatures than tropical climates and may include extreme climatic variations.

If you are redecorating or designing storage and display areas, consider using materials that will help to buffer these areas against rapid fluctuations and extremes of relative humidity and temperature. This will help to reduce the risk of damage due to the fluctuations and extremes that occur in temperate environments.

The system of layers of storage—boxes, boxes within cupboards and drawers, covering items on shelves, etc—will be very useful in helping to buffer against the extreme conditions that can occur in a temperate environment.

As for all climatic areas regular inspection of storage and display areas is important so that developing problems do not go unnoticed.

Remember that many of Australia's main cities and major regional centres are in temperate regions. These areas tend to be heavily polluted and this should be taken into account.

Note: If your collections of Aboriginal and Torres Strait Islander heritage items have been kept in a temperate environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

Tropical

These climates are characterised by heavy rainfall, high humidity and high temperatures.

When caring for Aboriginal and Torres Strait Islander heritage items in tropical climates it is important to note that:

- insects and moulds thrive and reproduce readily;
- chemical deterioration reactions generally proceed faster at higher temperatures;
- materials that have been in a tropical environment for some time will have a high moisture content. If they are suddenly moved into a drier environment they are likely to suffer shrinkage and warping;
- many of the materials used in making Aboriginal and Torres Strait Islander heritage items are very reactive to changes in relative humidity; and
- composite works will be particularly vulnerable.

Take steps to ensure that your storage and display spaces have good air flow.

Note: If your collections of Aboriginal and Torres Strait Islander heritage items have been kept in a tropical environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal condition. This could do more harm than good. The emphasis should be on long term stability.

MORE ABOUT ABORIGINAL AND TORRES STRAIT ISLANDER HERITAGE ITEMS

Additional information on *Previous Possessions, New Obligations—a national policy*

The following principles and detailed policy statements about preservation are taken directly from *Previous Possessions, New Obligations: Policies for Museums in Australia and Aboriginal and Torres Strait Islander Peoples*.

Management and collections

2. Aboriginal and Torres Strait Islander involvement in management of collections and information, and their use in the public programs and communication of museums, including exhibitions, education and publications, is essential.

Assistance to Aboriginal and Torres Strait Islander communities

8. Museums must assist Aboriginal and Torres Strait Islander community groups in the care and

preservation of objects. Conservation practice must adapt to cultural requirements, most particularly in respect of secret/sacred items.

Human remains

Return

1.5 All requests for the return of Aboriginal and Torres Strait Islander remains will be promptly and sensitively dealt with by the Museum.

Storage, access and display

1.7 Human remains, if retained by the museum, will be properly stored in an area separate from other parts of the collections and treated with respect at all times.

Secret/sacred material

Custodianships and access

2.5 Secret/sacred material shall be kept in a manner consistent with its sensitive nature and separately from other collections.

2.6 Traditional custodians will be consulted on the method of storage and preservation of secret/sacred material.

Display

2.8 Secret/sacred material shall not be displayed to the public except with the specific permission of the traditional custodians or their descendants.

Return

2.10 Secret/sacred material will be considered for return to the traditional custodians when requested by them in accordance with procedures which involve establishing that those requesting return are the rightful custodians according to Aboriginal and Torres Strait Islander custom and have regard to the highly sensitive nature of the material.

Collections in general

Acquisition, ownership, access and return

3.1 Acquisition, conservation, disposal and access to collections, including use in public programs, will take into account, or incorporate as appropriate, the views of the Aboriginal and Torres Strait Islander community of whose cultural traditions the items form part.

3.3 Museums will lend cultural material from their collections to museums and other appropriate venues, especially local Aboriginal and Torres Strait Islander keeping places, subject to appropriate conditions concerning conservation and security of the items.

Staffing, training and financial support

Employment

5.1 Museums will actively promote the employment of Aboriginal and Torres Strait Islander people in activities concerning Aboriginal and Torres Strait Islander cultures and heritage including collections management, research and conservation, public programs and administration.

Mould on objects

Mould can be very damaging to a wide range of Aboriginal objects. It is disfiguring, can stain and obscure the surface, or even penetrate through the whole structure of an object.

Mould grows where the relative humidity is continuously above 65%, where there is stagnant air, and in dusty and acidic environments. Mould particularly affects wood-based objects which have not been thoroughly dried or seasoned before use.

CAUTION:

Remember that mould is dangerous to your health—always wear a dust-mask when dealing with mould growth.

Preventive action

It is important to seek the advice of a conservator before undertaking any action on a cultural object. In the case of bark paintings, it is particularly important if:

- painted surfaces are crumbly or powdery, and brushing the mould removes the paint; and
- the mould growth is ingrained into the surface of the object and the bloom is still visible.

As a preventive measure, spray the back of a bark painting or the unpainted areas of objects with Glen 10 or Glen 20. The object can then be moved to a drier and environmentally more stable area of the building.

CAUTION:

Do not use Glen 10 or Glen 20 on acrylic paints.

Do building repairs, where necessary—to maintain the relative humidity below 65%.

Keep air circulating by using oscillating fans, which are more effective than ceiling fans.

Avoid placing objects in corners of rooms where there is minimal air circulation.

Inspect regularly for any signs of mould growth.

Maintain a clean room by vacuuming to prevent dust accumulation.

Avoid eating inside the room—foodstuffs are nutrients for mould as well as insects.

If you have a persistent mould problem, you may have to disinfect the room before your housekeeping efforts become effective. This means

washing down the walls with a product such as Exit Mould, and disinfecting, clean surfaces with a Glen 20 or Glen 10 spray; Glen products have a residual effect for up to 3 months.

It is important to document the condition of the object before treating it. This can be a written description with an accompanying photograph. By examining the item thoroughly you will better understand the extent of the problem. For example, it is often found that mould grows initially from the back of a bark painting, where a hot, wet microclimate has developed, and the mould on the front is symptomatic of the greater problem on the back.

The method you use to clean mould from an object depends on the state of the mould. The treatment described below dries out and removes a light dusting of mould.

Place the mouldy item in a well-aired, stable atmosphere with relative humidity of 50–60%. This dries the mould so that it can be removed.

Drying the mould does not kill it. Unless it is removed outdoors or in a well-ventilated area away from the rest of the collection, the spores can spread, be deposited on other items and infect the rest of the collection.

Do not over-dry the environment. A significant drop in relative humidity can cause objects to warp, curl and crack. For example, don't place infected items in direct sunlight because this could cause them to split or warp.

Dried mould can be brushed off outside using a medium/stiff brush.

CAUTION:

It is important to test-clean an area first to ensure there will be no loss of paint during cleaning.

Where the mould has progressed to a thick growth and is damp to the touch, it is safer to remove it through a wet-cleaning process. This is particularly true for carved and painted wood sculptures where the paint is stable.

- Mix 7 parts industrial methylated spirits to 3 parts water in a small glass jar.
- Before you begin cleaning, test an inconspicuous area using a cotton swab.

- If there is no smudging of paint or colour loss, clean off the mould with damp swabs.
- Change swabs regularly.
- An alternative method is to dip a brush into the solution, brush the affected area with it, then remove mould residue with lint-free paper or fabric.
- Allow the object to air-dry naturally.

If there are any problems, consult a conservator. It is also wise to see a conservator if the painted surfaces are friable and brushing the mould removes paint or if the mould growth is ingrained in the surface of the object and the bloom is still visible.

Mounting bark paintings

The system suggested below is described in Coote, 1995.

This method is straightforward, but requires you to contour the mount to the shape of the bark. If you are not confident doing this work, ask a conservator for help, or work through it with your local framer.

Problems which can occur with inappropriate mounting systems

Bark is subject to movement when it is placed in environments that are not controlled. This movement can happen over a short or long period of time, depending on the speed and extent of environmental changes. If a bark painting is constrained, or mounted in the wrong way, a great deal of damage can occur during this movement. In addition, if the paint is not held strongly onto the bark surface, it is more likely to flake off when the bark moves.

If a bark painting is fixed top and bottom, it tends to develop a twist.

If a wood backing has been glued in spots to the back of the bark then hung, it may develop a central warp over time.

If strips of wood are glued to the bark, it can develop a warp just below the adhesive line, which can progress into splitting or pulling away from the bark during natural movement.

In the past, barks were nailed, screwed or wired through from the front, and held onto a hard board at the back. This is now considered unethical: in the same way that any painted surface by an artist should be respected in its entirety. In addition, those areas which are unconstrained can move, split and warp as the environment changes, while the constrained areas cannot move. This can result in more damage than occurs when the whole bark is unconstrained.

A bark larger than about 750mm in length which is leant unsupported on an angle against a wall develops a curve, indicating that it cannot readily support its own weight.

A mounting system for bark paintings

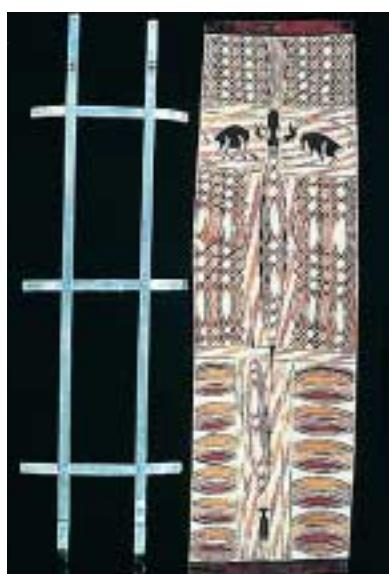
The best mount fully supports the bark and its contours, using a reversible system that does not employ adhesive contact with the bark. This system has great advantages when used in uncontrolled environments.

The system uses a padded, riveted, aluminium framework, designed to conform to the significant contours of the bark painting.

Aluminium strips of 1.6mm and 3mm thick and 200mm wide are used.

The bark is held in place at the base by appropriately coloured polyethylene-coated aluminium feet.

Strong, durable, polycarbonate clips hold the bark in place at the top and sides.



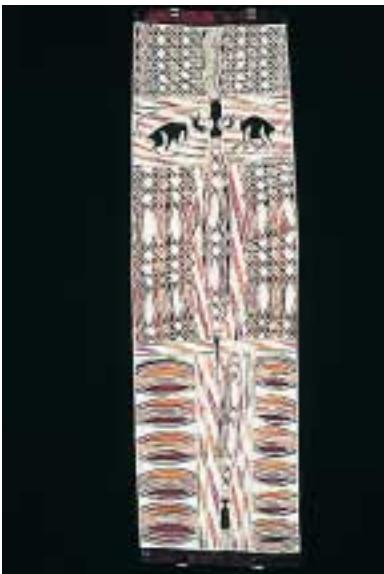
A bark painting and its aluminium mount.

Photograph courtesy of Karen Coote, Australian Museum



The back of the bark painting showing the mount in place.

Photograph courtesy of Karen Coote, Australian Museum



The mounted bark ready for display.

Photograph courtesy of Karen Coote, Australian Museum

When you are constructing the mount it is important to constantly check the mount against the bark, because small movements during construction can cause problems and frustration in the final alignment.

The method

Assess the bark painting to determine how many horizontal and vertical support struts are needed, and the approximate placement of the clips and base feet.

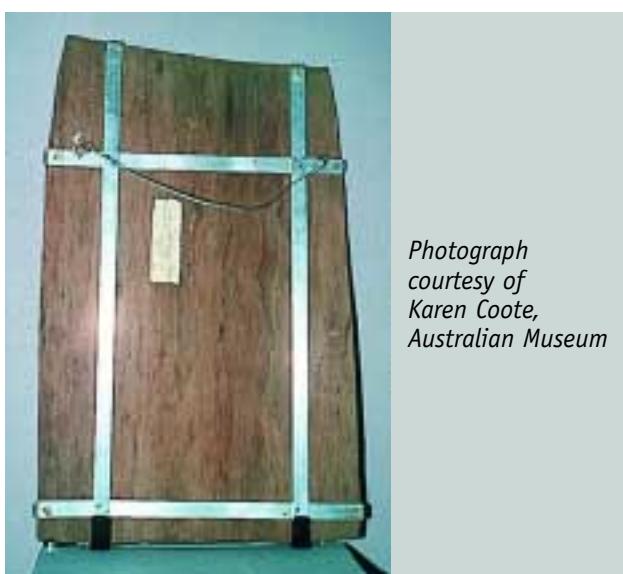
A bark approximately 1100mm x 450mm needs two struts of 3mm gauge aluminium following the longitudinal direction of the bark, and three struts of the 1.6mm gauge following the radial direction of the bark.

You may have to compromise between the best structural support for the bark and the aesthetic

placement of a clip over an important image on the painting.

After you have determined where the clips should be placed, mark the positions with chalk on the back of the painting.

Then place the bark painted-side down on a supporting bed of sand or Dacron-filled bags, so that all the contours of the bark are fully supported. Only proceed to this step if you are confident that the paint is well attached to the bark surface.



At this stage, the placement of the aluminium strips can be mapped out precisely.

The 3mm-thick lengths are cut with a hacksaw to the exact length of the bark.

If the bark is overly convex or concave, you will need to make some allowance in the length, to be able to slightly bend the aluminium to conform to the shape.

File and smooth the aluminium at the ends—to prevent any damage to the bark.

The 1.6mm-thick lengths for the radial—or horizontal—strips need to be cut about 100mm over each end. This gives adequate allowance for the shaping of the aluminium to the contours of the bark in this direction.

These radial strips are then moulded by hand to the shape of the bark.

It is recommended that shaping of each strip starts from the centre and works to the sides.

Once the shape conforms well to the bark contours with allowance in the length of the strips for any curving at the edges, the strips are cut to the correct length, filed and rounded to prevent damage to the bark.

The 1.6mm aluminium can be bent readily using thumb, finger and hand pressure. Practice speeds the process and the using a vice and a pair of pliers can help. Experience shows that hand and finger pressure is often all that is required, because tools can create too sharp a bend, preventing smooth contours being formed.

When you have finished shaping the strips, lay them in place over the back of the bark, with the 1.6mm contoured strips in direct contact with the bark.

Then mark the aluminium with a fine, felt-tipped marking pen: to help in placing the drilled holes for the rivets, which will attach the aluminium strips together and attach the D-rings to the mount.

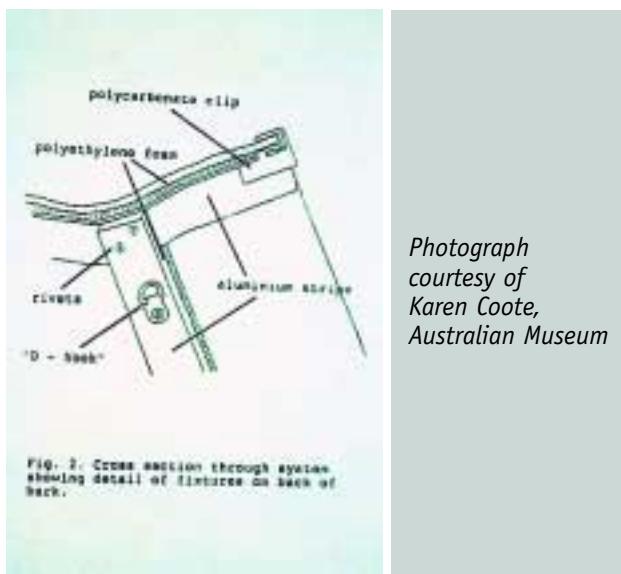
CAUTION:

Do not drill the holes while the aluminium strapping is resting on the bark. For drilling, place the aluminium strapping on a surface away from the bark. Otherwise you could damage the bark.

Use a rivet gun and steel-stemmed, aluminium rivets to rivet the aluminium strips together. The recommended rivet size is 10mm long with rivet diameter 3.2mm.

To prevent any distortion or movement of the system when in place, it is useful to make a double rivet at one joint. This double rivet can be put into place after all other riveting has been done and final alterations made, to ensure a good fit to the bark.

The D-rings, which are used to hang the painting, can be riveted at this stage. They are always attached to the heavier, 3mm-thick aluminium, as these are the weight-bearing struts of the system.



Mount system with D-rings and polycarbonate clips in place.

Photograph courtesy of Karen Coote, Australian Museum

When the system sits snugly over the bark, holes for the polycarbonate clips can be marked and drilled along the top and sides. Remove the mount from the bark during drilling.

Depending on the weight of the bark, the finer or heavier gauge aluminium can be used to construct the feet. A length of aluminium, approximately

120mm, is cut to bend a U foot, on average, 8mm internal width and a foot 10mm front.

The length of the back depends on the needs of the joint, but would measure at least 40mm, to enable two rivets to join the foot to the base and ensure a strong joint.

An appropriately coloured, powdered, low-density, polyethylene material—LDPE—can be heat-sealed onto the feet: to give a durable, aesthetically pleasing support. Alternatively, they can be covered with a coloured fabric—or painted after the application of an etch prime paint. The feet are thus coloured and double-riveted to the base of the system.

Thin strips of polyethylene foam—1–3mm—are cut and glued to the inside of the aluminium system. These will be in direct contact with the bark.

The foam can be glued with a hot-melt glue applied with a glue gun.

It is important to create a fairly firm sandwich of the bark/foam/aluminium system; and different thicknesses of the foam may be needed.

When the system is ready, it can be attached to the bark by slipping the bark into the feet and clipping it into place with the polycarbonate clips.

If the system is loose at the clips, they can be glued to the aluminium struts with hot-melt glue; or extra polyethylene foam can be added to the sandwich.

The final steps are:

- removal of the pen markings with ethanol;
- attachment of picture wire to the D-rings; and
- hanging the bark in place.

An alternative display system

For display purposes, a bark painting can be exhibited by leaning it against the wall, with the bottom of the bark resting on a narrow shelf. A padded L-shaped bracket can be drilled into the wall at the top centre of the bark, to secure the bark so that it cannot fall off the shelf.

If you have a problem related to the care of Aboriginal and Torres Strait Islander heritage items, contact a conservator. Conservators can offer advice and practical solutions.

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Self-evaluation quiz

Question 1.

Which of the types of damage to Aboriginal and Torres Strait Islander heritage items listed below are caused directly by extremes or fluctuations in relative humidity?

- a) Splitting and curling of bark paintings.
- b) Creasing and tearing of works on paper.
- c) Cracking of wood.
- d) Dimensional change leading to paint loss.
- e) None of the above.

Question 2.

Which of the following statements are true?

- a) Items that are at risk of drying out too quickly should be stored at 65%RH or above.
- b) Mould grows when the relative humidity is continuously above 65%.
- c) Fluctuations in relative humidity don't matter because they will not result in damage.
- d) Items that are acclimatised to drier conditions should be kept in an environment where the relative humidity is in the range of 45–55%.

Question 3.

Which of the following factors should you take into account when considering the display of Aboriginal and Torres Strait Islander heritage items?

- a) Whether the materials are sensitive to damage from light and/or UV radiation.
- b) Whether the display of particular items is culturally appropriate.
- c) Whether the items are likely to fade or discolour.
- d) Whether you are able to rotate light-sensitive exhibits, to reduce the display-time per item.
- e) All of the above.

Question 4.

What would you look for if you find fine wood powder on the floor near an object?

- a) Light damage.
- b) Mould growth.
- c) Insect infestation.
- d) Unsupported objects.

Question 5.

Which of the following statements is false?

- a) If an item has been stored for a considerable time in a tropical environment it should be placed in a much drier environment as soon as possible to prolong its life.
- b) Covering objects in storage protects them from dust and unnecessary exposure to light.
- c) Bark paintings should be stored flat, and any curved or warped areas supported with polystyrene-filled cotton bags or something similar.
- d) Woven material such as pandanus, bark string bags and baskets should be well supported on the inside with Dacron-filled, cotton bags.

**Answers to
self-evaluation quiz**

Question 1.

Answer: a), c) and d).

Question 2.

Answer: b) and d) are true. a) is not true. Items that are at risk of drying out too quickly after they have come from moist conditions should be kept in an environment where the relative humidity is in the range of 50–60%. If the relative humidity is above 65%, mould growth is highly likely. c) is not true. Fluctuations in relative humidity can cause extensive damage in a range of materials.

Question 3.

Answer: e).

Question 4.

Answer: c).

Question 5.

Answer: a) is false. If an item has been recently produced, or stored for a considerable time in a tropical environment, placing it in a much drier environment without allowing it to acclimatise gradually could cause extensive damage.

METALS

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Objectives

At the end of this chapter you should:

- have a basic knowledge of the nature of metals;
- have a basic understanding of what causes metals to corrode;
- be able to take steps to minimise the corrosion of metals in your collections;
- be able to determine whether corrosion is active or passive;
- be aware of when and where not to apply chemical treatments to metals;
- know the correct treatments for particular types of metal; and
- be able to determine when it is necessary to seek professional assistance.

Introduction

Metals have played a significant part in human and technological development. This is reflected in the fact that two major periods in human history have been named after metals: the Bronze Age and the Iron Age.

Metals have been used—either in pure form or combined with other metals—to produce an enormous variety of objects, including weapons, tools, machinery, decorative art objects and jewellery. Because of the huge range of uses for metals, objects containing metal, or fully made from metals, are all around us. They make up a large part of many collections housed in museums, galleries and even some libraries.

But despite their apparent solidity, metals do corrode and can be vulnerable to physical damage. It is important that those responsible for the care of metal and metal-containing objects are able to recognise problems when they see them, and take steps to halt them.

Metal objects in collections

An enormous range of objects in collections are either made of metal or have metal components. Among them are:

- weaponry;
- sculpture;
- clocks and watches;
- jugs;
- metal thread;
- armour;
- signs;
- coins;
- plates;
- cutlery;
- buttons;
- teapots;
- pots and pans;
- tools;
- zips, hooks and eyes;
- aeroplanes;
- backings on mirrors;
- photographs;
- automobiles;
- boats;
- badges and regalia;
- hammers;
- agricultural machinery;
- scythes;
- sewing machines;
- traps;
- electrical equipment;
- jewellery;
- scientific instruments;
- buckles;
- military machinery;
- rigging for boats;
- screws and bolts;
- coatings on CDs; and
- fittings on saddles.

Common metals

The metal objects in your collections will be made from a range of different metals, including:

- cast iron;
- pewter;
- wrought iron;
- lead;
- bronze;
- tin;
- brass;
- aluminium;
- sterling silver;
- gold;

- Britannia metal;
- Sheffield plate;
- steel;
- electroplated nickel silver.
- galvanised iron;
- stainless steel;
- zinc; and

The nature of metals

The atoms which make up metals are bonded in a way that is peculiar to metals. A metal becomes a solid at a certain temperature; and the atoms of the metal settle into a characteristic, well ordered configuration. In this configuration the atoms are fixed rigidly in relation to each other. The configuration is called a crystal lattice or a crystal.

Some of the basic qualities of metals include the following:

- they are good conductors of heat and electricity;
- high reflectivity when their surfaces are smooth;
- usually good ductility, that is, they are capable of being drawn out into wire or threads;
- good malleability, that is, they can be extended or shaped by hammering or by pressure with rollers; and
- mechanical strength.

Alloys

For centuries, the properties of metals—such as their appearance, strength, malleability and chemical reactivity—have been altered by combining them. These combinations are called alloys. For example, iron combined with carbon produces alloys such as cast iron and steel; whereas the alloying of chromium and nickel with iron forms stainless steel.

Similarly, copper can be combined with zinc, to form brass; and with tin, to form bronze.

Patina

The patina is a film of metal corrosion products which forms on the surface of an object as a result of:

- exposure to the elements; and
- deliberate steps taken to produce this effect. For example, sculptors often apply chemicals to the surface of a work, to produce a certain visual effect with the corrosion products.

Before any decision is made to remove this layer of corrosion products from an object, the nature of the object and its history must be considered very carefully. For instance, under no circumstances should the patina be removed from an ancient bronze sculpture, whereas a Victorian-era silver candelabra would have been highly polished and so should be cleaned of accumulated tarnish.



Examples of copper alloy Japanese sword handles, where the patina is an integral part of the object.

Photograph courtesy of the Western Australian Museum

What are the most common types of damage?

Metals are vulnerable to physical damage and to chemical deterioration.

Physical damage includes:

- dents;
- wear of machine parts through repeated operation;
- wear of metal surfaces through excess polishing; and
- scratches. On highly polished surfaces scratches can be distracting and mar the appearance of the object; and on finely machined surfaces, for example in machinery, scratches can adversely effect the operation of the machine.

Chemical deterioration in metals is called corrosion. Physical damage to metal objects can leave them vulnerable to corrosion. For example, a scratch in tin plate leads to corrosion of the base metal.

Corrosion

The tarnishing or corrosion of metals will be your major problem if you are responsible for the care of metal items.



Bullets showing copper and lead alloy corrosion products.

Photograph courtesy of the Western Australian Museum



Corroded rifle

Photograph courtesy of the Western Australian Museum

Gold, silver and copper are the only metals that are stable enough to be found in their natural metallic state. All other metals are more stable when combined with other elements, to form oxides, sulphides, chlorides, carbonates or mixtures of these.

There is a natural tendency for most pure metals to return to their more stable, corroded states.

Because of this, metal objects need to be protected from environmental conditions and pollutants which encourage corrosion.

In some cases—as the metal corrodes—the oxide film that forms acts as an insulating barrier, which slows the rate of corrosion to an acceptable level. Copper and aluminium are two metals in which oxide coatings form protective layers—called passivating layers. When iron corrodes, however, it does not usually form a protective film. Iron continues to corrode until no metal is left, unless some other protective coating is applied to protect it from the elements.

It is important to note also that corrosion builds up on top of the metal surface, and is often much thicker than the original metal. You may find that when you come to treat an object there is little or no original metal remaining; and removing the corrosion products could mean ending up with a much reduced object or none at all.

Causes of corrosion

Moisture and oxygen are required for metals to corrode.

Chloride ions, which are found in common salt—sodium chloride—can speed up the corrosion rate, and are also capable of penetrating protective oxide layers.

Fats, oils and sweat can also enhance corrosion.

Acids formed when air pollutants combine with moisture will attack metals. Outdoor monuments and sculptures are particularly vulnerable to this type of attack.

Relatively unreactive metals, such as copper and silver, can suffer significant corrosion if sulphide-containing materials are in the same environment as the metal.

These sulphide pollutants are usually associated with the breakdown of plant matter, and the decomposition of sulphur-containing proteins such as wool. A common pollutant is carbonyl sulphide—COS.

Dust absorbs moisture readily. So areas with a build-up of dust can have quite high local humidity—higher than the surrounding environment. Dust will absorb pollutants and other reactive materials as well.

Corrosion also occurs if dissimilar alloys and metals come into contact with each other. This type of corrosion is called galvanic corrosion.

Under these circumstances, the more reactive metal or alloy corrodes while the less reactive metal is protected. For example, if iron and copper were in direct physical contact in the presence of moisture and oxygen, then the iron would selectively corrode while simultaneously protecting the copper.

This problem can be overcome by avoiding direct contact between dissimilar metals. This will not be simple if the metals are components of the same object.

The oxide film which forms on particular metals acts as an insulating barrier or passivating layer barrier, slowing the rate of corrosion to an acceptable level. This type of passivation occurs with copper and aluminium.

When looking at the way in which artefacts have corroded and when deciding on management strategies, it is important to ask these basic questions: is it necessary to treat an object? or can the causes of deterioration be controlled?

For more information

For more information on the effects of humidity, dust and pollutants, please refer to *Damage and Decay*.

For more information on how chloride ions, fats, oils and sweat can speed up corrosion, and on the effects of acids and sulphide pollutants, please see the section More About Metals, later in this chapter.

- chemical interaction between the metals and other materials, including other metals; or
- a combination of any of the above factors.

The following sections outline general storage and display principles for metals, as well as giving details of the problems, care and treatment of specific metals.

Handling, storage and display guidelines

When you are handling metal objects, particularly ones with polished surfaces, always wear clean cotton gloves or surgical gloves. This prevents the transfer of sweat and fats from the skin to the metal object, and helps reduce the risk of corrosion.

Always give your objects adequate support, and remember that metals can weaken over time.

Don't lift metal objects by their handles. The joint between the handle and the object could be weak.

When displaying a hinged object open, take care to support it—so that the hinges are not carrying the weight of a part or all of the object.

Because some of the major contributors to the deterioration of metals are oxygen, water and airborne pollutants, it is important to provide an environment which offers protection against these factors. This action can prolong the life of your metal objects.

Simple steps can greatly improve the longevity of objects. Steps such as:

- wrapping objects in unbuffered, acid-free tissue;
- placing them in acid-free boxes; and
- storing them on painted—preferably baked enamel—metal shelving.

CAUTION:

Avoid chipboard or wood cabinets. These materials give off formaldehyde and organic acid vapours, which can accelerate corrosion.

If you have no choice about the type of shelving and you must use wooden shelves, we recommend you take the following steps:

- coat wood with an epoxy or polyurethane finish to seal the wood;
- paint chipboard with a solution of 400g of urea in 1 litre of water; and
- allow time for proper drying and curing.

Do not seal objects in plastic bags, because the bags seal in moisture as well. This raises the relative humidity inside the bag, providing a microclimate which is favourable to corrosion.

CAUTION:

Avoid polyvinyl chloride—PVC—bags. They can give off hydrogen chloride, an acidic gas which will corrode most metals.

If you want to use plastic bags for storage, make sure you select polyethylene bags, and punch holes in the bag.

Store and display metal objects in environments where:

- the temperature is stable—remember that fluctuations in temperature can cause the relative humidity to fluctuate;
- relative humidity is less than 45%.
- lighting levels are kept below 300 lux. Lighting levels should be lower if the objects are coated, because the light can adversely affect the coating; and
- UV content is below 75 $\mu\text{W}/\text{lm}$.

For more information

For information about adverse environmental effects, please refer to *Damage and Decay*.

Corrosion can be stopped by removing oxygen or water from the local storage environment.

Reasonably small, particularly vulnerable objects can be placed in a container with silica gel or an oxygen scavenger. Removing only one element of the corrosion equation, effectively halts corrosion—including bronze disease.

Guidelines for outdoor objects

If you are trying to prevent corrosion in an outdoor object:

- bring the piece inside, or build a roof over it, if it is appropriate and possible. In most cases this won't be possible;
- look for areas where water can pool, and improve the drainage in these areas or remove water after rain;
- don't allow objects to sit directly on grass—raise them on a plinth;
- don't allow the object to sit in water;
- don't water the object when you are watering the garden—unlike the plants, it won't grow; and
- clean off bird excrement immediately—it is corrosive and will quickly etch the surface.

Metals in Australia's climatic zones

When considering the conservation needs of metals, the environmental conditions associated with the various climatic regions as well as those of the coastal areas must be taken into account. The moisture, salt and pollutant levels of the storage environment will have the greatest impact on the rates of corrosion, of metals. Metals corrode less in dry zones than in areas that have higher average relative humidity.

Metal objects housed in coastal regions are at great risk of corrosion, if steps are not taken to minimise the impact of salt-laden air.

Arid

This climate is generally very dry, however, in arid areas, it is often very hot during the day and very cold at night. This wide fluctuation in temperature is matched by wide fluctuations in relative humidity, for example from 75%–20% in a day.

Steps that can be taken include:

- storing metals in cabinets, boxes and wrappers to buffer the objects against short-term upward swings in relative humidity. Protection against dust is also achieved in this way.
- using insulation and sensible house-keeping practices which minimise the differences between internal day and evening temperatures. The corresponding fluctuations in relative humidity should be minimised.

Note: If your collections of metal objects have been stored in an arid environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

Temperate

A temperate climate is considered a moderate climate, however, temperate climates tend to have a greater range of temperatures than tropical climates and may include extreme climatic variations.

Steps must still be taken to overcome the extreme climatic variations which occur in these areas.

High relative humidity conditions can be counteracted by:

- displaying metal objects in sealed cabinets to overcome short term variations in relative humidity and temperature;
- store metal objects in cupboards, boxes and wrappers to buffer against variations in external conditions; and
- protect metals by coating them with water repellents such as CRC, WD-40 or waxes. Consult a conservator before doing this.

Note: If your collections of metal objects have been stored in a temperate environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

Tropical

These climates are characterised by heavy rainfall, high humidity and high temperatures.

To counteract the problems associated with high relative humidity and generally high temperatures that characterise these regions the following strategies can be adopted:

- place sensitive metals in well-sealed cabinets and maintain the relative humidity at a level below 45%;
- use cabinets, boxes and layers of acid free tissue to create buffer zones which will reduce the impact of high relative humidity and temperature on metals;
- use portable dehumidification units during periods of high relative humidity; and
- inspect metal objects regularly and maintain high standards of cleanliness.

Note: If your collections of metal objects have been stored in a tropical environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

Coastal Regions

Coastal regions generally have more moderate climates than inland areas but they also have high levels of wind-borne salt. Consideration must be given to counteracting the corrosive effects of salty air.

Steps which can be taken include:

- storing and displaying metals in sealed cabinets to buffer against environmental changes and to exclude dust and salty air; and
- putting multi-metal vapour phase inhibitors, such as Senson, in sealed storage and display areas.
- sealing buildings to minimise air exchange with the external, salt-rich air, by keeping doors and windows closed, eliminating drafts and using airlock doors.
- maintain relative humidity below 45% in storage and display areas.
- treat metals with moisture agents—waxes are recommended—and corrosion inhibitors.

Care of particular metals

In this section, information is given about a range of metals. The information includes:

- a description of the metal and its alloys where applicable;
- the signs and main agents of corrosion of that metal and its alloys;
- methods of cleaning the metal;
- storage and display methods for each metal; and
- protective coatings that can be applied to objects made from that particular metal.

It is important to note that, while some of the

methods for cleaning the metals are quite straightforward, others involve the measuring, mixing and application of reactive chemicals. It is strongly recommended that:

- you contact a conservator and discuss the risks involved in treating metal objects before you proceed;
- you do not treat an object unless you feel confident about carrying out the treatment;
- you do not treat an item if you are unsure about the type of metal with which you are dealing. A conservator can help you with this. It is also possible to carry out spot-tests to identify your metals;
- if possible, you practise the treatment on another piece of the same metal; and

- you attend a training workshop on the treatment of metals before attempting some of the more complex treatments.

For more information

Spot-tests to identify metals are described in the section More About Metals later in this chapter.

It is extremely important that you are aware that some of the chemicals used in these treatments can also affect you.

CAUTION:

Thiourea is poisonous, is a suspected carcinogen and causes goitre.

Acetone can cause headaches, depression, nausea and dizziness when inhaled.

Industrial methylated spirits—IMS—is a mixture of ethanol and methanol and should be used with care. Ethanol can cause headaches, dizziness and nausea, and methanol is toxic and can cause blindness.

Ammonia can cause severe irritation to the skin and eyes, breathing difficulties, nausea and vomiting.

Disodium ethylenediamine tetraacetic acid EDTA—can be mildly toxic, and can affect unborn babies.

Citric acid is moderately toxic and irritating.

Petroleum spirit is flammable; it removes fats from the skin, and should be used with care.

Sodium carbonate can cause skin irritation and ulcers. If it is swallowed, it causes nausea, vomiting and diarrhoea.

If it touches skin, **sodium hydroxide** causes deep skin burns. If inhaled, it irritates the respiratory tract. If ingested, it can cause burning pain, diarrhoea swelling of the larynx and suffocation.

Silica gel in its granulated form can cause silicosis.

Protect yourself when working with these chemicals—wear gloves and masks. If you buy any chemicals to mix up your own cleaning solutions, ask for safety data sheets as well, and make sure that you store the chemicals safely.

You must also remember to take care when disposing of these chemicals—some of them cannot be flushed down the sink.

Silver

Silver's lustrous appearance and relatively low natural abundance, its corrosion resistance and ability to be easily worked have made it a prized metal. Silver is often used for coins, jewellery and cutlery.

Most silver items found in Australia will be either sterling silver or plated silver.

Sterling silver

Sterling silver is the standard alloy used in jewellery and cutlery. It is made up of 92.5% silver and 7.5% copper. The addition of copper to silver increases hardness of the alloy, without any significant loss of lustre or colour.

Plated silver

The two common forms of plated silver are Sheffield plate and silver plate/electroplate.

Sheffield plate is made by fusion-bonding—sweating sterling silver to both sides of a copper or brass sheet; it is then worked to produce the desired object.

Silver plate or electroplate is formed when a thin layer of pure or sterling silver is deposited electrolytically on the surface of a base metal. Common base metals include copper, brass, nickel silver—an alloy of copper, zinc and nickel—and Britannia metal—a tin alloy with 5–10% antimony.

Electroplated materials are often stamped EPNS for electroplated nickel or silver, or EPBM for electroplated Britannia metal.

As commercial electroplating was developed in the 1840s, it is likely that a lot of the materials in the collections of local museums in Australia will be made of silver plate.

For more information

For more information on electroplating, please see More About Metals later in this chapter.

Signs of corrosion on silver

Silver artefacts tarnish if they are not kept polished. The silver surface changes through a

faint purplish hue to a deep black. The tarnish is a layer of silver sulphide.

Artifacts excavated from underground or from the sea may be coated with grey silver chloride and copper corrosion products. If these materials have been exposed to sunlight, the surface will have a purplish tinge.

Cleaning silver

Clean silver only when absolutely necessary, and not as a routine treatment. This is because any cleaning removes minute amounts of silver.

Take great care to differentiate between tarnish and decorative treatments which are an inherent part of the object and which would be destroyed by cleaning. For example, a decorative treatment which should not be removed is niello, a black silver sulphide/silver copper sulphide that is used deliberately to highlight engraved sections of silver jewellery.

Avoid abrasive cleaners. They can cause fine scratching of the surface and remove small amounts of silver.

There are a number of proprietary brands of silver dip solutions available, which readily remove tarnish. These are usually made up of thiourea and acid mixtures. Silver dips should be used only when the object is badly tarnished.

If you decide to use a silver dip, apply the solution, or dip the object, only for as long as it takes to remove the tarnish.



Silver tray after treatment.

Photograph courtesy of the Western Australian Museum

Then rinse the object in hot water to remove residues, and dry it with a lint-free cloth. After drying, a final polish with a silver cloth will put a thin layer of corrosion inhibitors on the surface of the silver.

If Sheffield plate is in reasonable condition, it needs no further treatment other than being wiped with a silver cloth and displayed or stored under conditions of low relative humidity and away from wool.

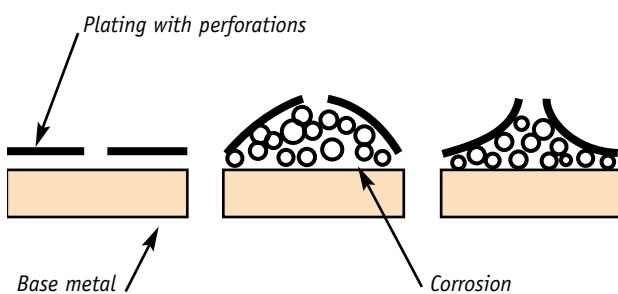
Although there are commercially available solutions which gradually redeposit small amounts of silver on worn areas, these should be used only after considering the history and function of the object.

On no account should the object be replated. This completely devalues the object by removing the technological evidence of its manufacture.

Electroplated or silver plated objects which are in good condition, but on which the silver has been worn away to reveal underlying metal, can be restored by using a solution such as the one described above. This is a better way to rejuvenate the surface than the standard electroplating, which is a lot more costly and not always successful.

If the piece is in good condition, then it is better to maintain it in that condition, rather than continually cleaning it and wearing down the silver coating. Wiping with a silver cloth, followed by storage and display under conditions of low relative humidity and low pollution levels is the simplest method of protection.

Despite the best storage, display and care methods, all electroplated silver will eventually show pin-pricks of corrosion as the plating wears thin. Once the plating has been perforated, the underlying metal is prone to pitting corrosion; and the surface will gradually become covered with blotchy, black and green-blue areas of corrosion.



Simple care techniques don't have much effect on this type of problem. It needs more complex treatment.

- Immerse the object in a solution of 10g of thiourea and 50g of citric acid in 1 litre of water. This treatment will clean the object and remove the silver corrosion products.
- After cleaning, the object must be placed in a diluted bath of sodium carbonate, 1% by weight in water, and left to soak for an hour or so to remove any citric acid from beneath the electroplate—to make sure that no further corrosion occurs. Follow this with a final wash in fresh, deionised or distilled water.
- If the corrosion damage is not too severe, then the underlying metal can be re-touched using one of the silver solutions which redeposit small amounts of silver on worn areas. Finally, polish the object with a silver cloth.

CAUTION:

Check your chemical safety data sheets, and take the appropriate precautions.

Coating silver

There are lacquers available for coating silver objects, and these can significantly slow down tarnishing processes.

CAUTION:

These lacquers can be difficult to remove if they break down. And unless an even coating is applied, a patchy and blotchy tarnish may develop on the surface. Consult a conservator before coating your silver objects.

Storing and displaying silver

The general handling, storage and display guidelines apply to silver objects.

If you must place a silver object in a display case which has previously been shown to be corrosive towards silver, add zinc oxide or an acid-free zinc carbonate blotter to the base of the case to absorb the damaging substances. This will help to keep tarnishing to a minimum.

Alternatively, you could use the commercially available sintered zinc oxide pellets, or sachets of multi-metal vapour phase corrosion inhibitors.

For more information

For more information on making a zinc carbonate blotter, please see
More About Metals later in this chapter.

Nickel silver

Most 19th and 20th century nickel silver objects will be found either as the unchanged copper-nickel-zinc alloy, or with a thin film of electro-deposited silver on the surface.

An easy way to identify nickel—as nickel plating or its presence in an alloy—is to look for the bright, lemon-green corrosion products which characterise nickel (II) compounds.

Australian coins minted before the introduction of decimal currency in 1966 contain significant amounts of silver. To remove tarnish from the imperial pre-1966 coins, follow the procedures for silver outlined above.

The corrosion products on Australian coins after the introduction of decimal currency are better treated according to the methods outlined below for copper as well as its alloys in the form of brass and bronze.

The treatment of electroplated nickel silver should follow the guidelines for silver objects.

Copper and copper alloys

Copper, a lustrous red-brown metal, is thought to be the first metal commonly used by humans. When alloyed with other elements, it provides a range of useful materials of widely different mechanical and corrosion-resistant properties.

The two main categories of alloys are:

- those created when copper combines with zinc, to form brasses; and
- those created when copper combines with tin, which are known as bronzes.

CAUTION:

Spelter bronzes which were popular from the 1850s to the early 1900s are not bronze at all, but a white, zinc-based metal to which various coatings have been applied, to give the effect of patinated bronze. Any attempt to chemically clean these objects renders them worthless.

Corrosion of copper

The types of corrosion products formed on copper and its alloys depend on the environment and the metal's composition.

The most common corrosion products are copper oxides, basic copper sulphates and basic copper carbonates. These are generally stable, and protect the underlying metal from further corrosion.

The corrosion products are sometimes produced artificially—to give the attractive green-brown patina seen on outdoor bronze statues.

The passivating layers of copper corrosion products tend to break down in the presence of chlorides. Whether the chlorides are derived from the sea or from ground water, the overall impact—accelerated corrosion—is the same.

In a humid environment, the presence of chlorides in copper alloys can cause the development of the cyclic corrosion phenomenon known as bronze disease. This type of corrosion is characterised by the presence of a light blue-green, crumbly outgrowth on the surface. If this is brushed away, a pit will be evident on the surface. To determine whether an object is affected by bronze disease, consult a conservator.

It is important to note the difference between bronze disease and a natural patina. Many bronzes are formulated specifically to obtain a certain coloured patina. If you are not sure, consult a conservator before attempting any treatment. This is particularly important for Japanese and Chinese bronzes, and for bronzes from the Renaissance period onwards, as the patinas of these objects are intrinsic to the objects and should not be removed.

For more information

For more information on the treatment of bronze disease, please see More About Metals later in this chapter.

What causes the corrosion of copper?

Constant high humidity, pollutants such as sulphide gases, acids and careless handling causing physical damage can all cause deterioration of copper-based objects. In addition, heating and acidic cleaning solutions can etch the zinc out of brasses—leaving a copper-red discolouration on the surface.

Copper and copper alloys which have been buried or recovered from a wet site can suffer from the effects of chloride salts, resulting in the development of bronze disease.

Objects may also have special surface coatings, such as lacquers, which can be damaged easily by scratching or improper cleaning.

Cleaning copper and copper alloys

Items which are in good condition need only be wiped with a dry cloth.

Alcohol, preferably ethanol, may be used to remove greasy stains, but only after spot-testing to ensure there are no surface coatings that will be affected by this solvent.

If a badly tarnished copper alloy must be cleaned, immerse it in a solution of 10g of thiourea and 50g of citric acid in 1 litre of distilled water. This treatment will clean the object and remove the corrosion products.

The thiourea is an inhibitor which prevents any chemical attack on the metal itself. If thiourea is not used in the treatment solution, dissolved copper will be redeposited on the surface of the object, leaving a salmon-pink blush on the surface. This then has to be removed by polishing.

Leave the object in the solution until it is clean. This can take from several minutes to several hours, depending on the condition of the object.

You can speed up the treatment by brushing the surface, under running water, with a soft bristle brush, for example, toothbrush or soft Nylon, bristle brush. If necessary, a fine pumice powder can be used as a mild abrasive.

If this solution is not effective in removing tarnish, then the amounts of citric acid and thiourea used in solution can be increased to up to twice the strength.

The object must then be thoroughly washed to remove all traces of acid. This can be done under running water, or by immersion in baths of clean water.

If the object has been soaking for a considerable time or is porous, immerse it in a weak sodium carbonate bath—5g in 1 litre of water—in order to neutralise any remaining acid.

To ensure that washing has been effective, the pH of the surface of the metal object and that of the



Bronze coins before treatment.

Photograph courtesy of the Western Australian Museum



Bronze coins after citric acid/thiourea treatment.

Photograph courtesy of the Western Australian Museum

wash-water should be checked. The pH should be very close to 7, that is, close to neutral.

After washing, and before applying any protective coating, it is essential to make sure that the surface is free from grease and water. Any such contamination will show up later as corrosion areas.

Wear rubber gloves when cleaning and coating the artefacts.

If oven-drying at 100°C is not appropriate, the object can be dried by painting it liberally with acetone. The acetone drives out water in crevices and cracks, ensuring that the metal is fully dry.

The metal is considered dry when there is no longer any smell of acetone.

It is not appropriate to use acetone on composite materials or painted surfaces. To dry composite objects and painted objects, use a hair drier on a cold setting.

Note that this cleaning procedure will not produce a bright, shiny surface finish to the metal. If this is required, a proprietary metal polish can be used. Repeated polishing should be avoided, however, because it wears the metal surface.

CAUTION:

Check your chemical safety data sheets and take the appropriate precautions.

Coating copper and copper alloys

A protective coating can be applied, to maintain a clean, shiny surface on copper-based objects.

Lacquers and waxes are commonly used for this purpose. The patinas—excluding bronze disease—that form on bronze and copper objects are attractive and stable, and do not need a protective coating unless they are in a harsh environment.

Do not get dirt or fingerprints on the object between the cleaning and coating stages—any such contamination shows up later in the form of corrosion areas.

For coating, apply a microcrystalline-polyethylene wax preparation. An alternative coating is an acrylic lacquer containing a corrosion inhibitor. This is most satisfactory in preventing retarnishing

of bronze and copper. Incralac is a commercially available lacquer which is available in a spray can or as a brush-on paint. This product can be removed with acetone.

For more information

For a recipe and for information on the application of microcrystalline-polyethylene wax, please see More About Metals, later in this chapter.

Iron and its alloys

Iron is the most useful and abundant of metals and it is probably the most common metal found in the collections of local museums and historical societies. It has been known from prehistoric times and in its various forms—such as cast iron, wrought iron and various steels—it is the element upon which our present industrialised civilisation has been built.

Deterioration of iron and steel

Iron and steel, with the exception of stainless steel and other similar alloys, are readily attacked by oxygen when in the presence of moisture, forming rust.

Rust is a term used to describe non-specific corrosion products which form on the surface of degraded iron.

Unlike copper, the surface layers of iron corrosion products are not protective. They tend to accelerate corrosion of the metal by forming localised corrosion cells.

When an iron object is acquired, it should first be examined to determine the extent of deterioration and whether the corrosion is still active. If the surface is covered with yellow to brown droplets of moisture, it is a sign of severe corrosion activity, and indicates the presence of chloride salts. This necessitates a specialised conservation treatment to remove chloride ions. Please consult a conservator for more information about this treatment.

Many objects are covered with thick scales of rust—but there is often sound metal underneath.

Treatment of iron objects

Its future role, as either an object on display or in storage, will have a major impact on the treatment method.

To display an object in its working order, it may be that nothing needs to be done other than keeping it in a dry environment or coating it with an appropriate protective layer.

As with every metal type, there is a range of treatment options available; and the final decision will depend on the balance between aesthetics, economics and the function of the artefact.

Cleaning iron objects

Dirt, grease and loose or flaking rust must be removed before protective coatings can be applied to iron objects. Such deposits can be removed by chemical or mechanical techniques.

Chemical cleaning techniques include:

- using soapy solutions to dissolve grease and remove surface dirt; and
- immersing the object in an aqueous alkaline solution—caustic soda—to remove grease and paint. Concentrations in the range of 20–40g of sodium hydroxide per litre of water are normally used.
- stripping corrosion products by immersing the objects in a solution of 50g of citric acid in water. While citric acid is relatively safe on most objects, care should be taken to ensure that cast iron, cast steel or spring steel, or combinations of these, are not left unattended for long periods, because these metals will actively corrode. Prolonged gas evolution—which you will see as bubbling—indicates that the iron surface is corroding. With harder alloys, this can also cause hydrogen embrittlement in which the hydrogen is generated within the metal and the stress of the gas pressure cracks the metal. Gas evolution can also result in pitted, weakened or destroyed objects.

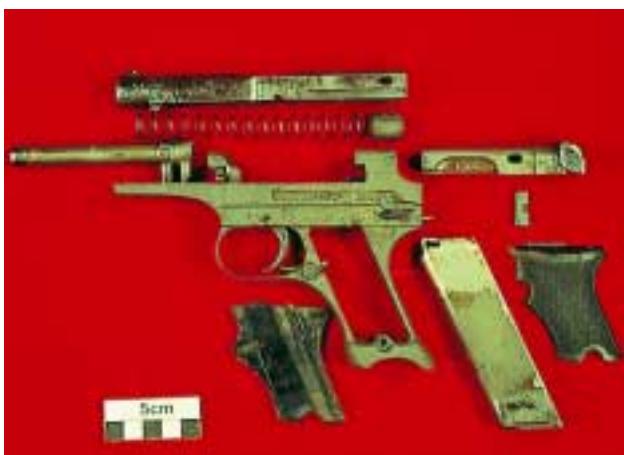
CAUTION:

Do not use hydrochloric acid and phosphoric acid, because they will attack the underlying metal.



Japanese .32 calibre pistol before treatment.

Photograph courtesy of the Western Australian Museum



Pistol after treatment with citric acid/heat, fish oil/white spirit solution.

Photograph courtesy of the Western Australian Museum

Because some mechanical cleaning techniques can be quite severe, they should be used very carefully—especially with small or fragile objects.

Techniques which can be used with care include:

- simple wire brushing. This is often very effective in removing loose or flaking rust. Wire brushes are available in a range of bristle materials, for example, steel and brass, and grades, for example, coarse to fine, so take care to select one appropriate for your object;

CAUTION:

Never use a brass brush on an iron object.

- sandblasting. This technique uses a high-speed jet of sand, and is usually applied to large iron or steel objects, such as agricultural implements. It is quick and provides an excellent surface for long-life

coatings. You need approval from local authorities to sandblast because of the associated dust problem. An alternative form of sandblasting, wet sandblasting, uses a suspension of sand in water combined with a corrosion inhibitor. This method causes less pollution, and is more acceptable to local authorities. Sandblasting should be carried out by commercial operators, with conservators close at hand to provide any necessary advice; and

- flame cleaning. A blow torch or an oxyacetylene flame is used to quickly and effectively remove paint and rust.

CAUTION:

This technique must be very carefully applied because thin, section metal is likely to distort rapidly, and spring steel will lose its 'temper' and thus its 'spring', if overheated. There is also a risk of injury, because rust particles fly off rapidly with this method. Some form of eye protection must be worn.

This work should be done only by people experienced in the use of oxyacetylene equipment.

The techniques described above can be combined. For example, flame cleaning and wire brushing could be used to remove large areas of rust and paint. This could then be followed by immersion in citric acid for the removal of residual rust, and neutralisation of the citric acid by immersion in a caustic bath.

If in doubt regarding the type of iron or the duration of acid treatment, more time should be spent removing corrosion products by mechanical means. Once the worst deposits are removed, a short treatment in citric acid should clean the object, with reduced risk of damage. Some forms of corrosion leave spots on the object, which cannot be removed by citric acid. These can usually be picked off mechanically.

It is important to note that an object which has very little metal remaining should not be cleaned, but should be stored in a plastic bag containing self-indicating silica gel to keep it dry. Prior to storage, it is desirable to totally dry out the object in an oven at 110°C, to remove moisture from fissures deep within the metal. This improves the effectiveness of the silica gel.

For more information

For more information about silica gel, please see the chapter on Humidity and Temperature in *Damage and Decay*.

Large steel objects

When treating large objects, it can be difficult to find containers or tubs large enough to immerse the objects for caustic or citric treatments. If sandblasting is inappropriate, the acid or alkaline stripping solution can be applied to the surface by using a bentonite paste.

For more information

For more information about the preparation and use of bentonite paste, please see More About Metals later in this chapter.

A note of caution about treating composite materials

As many objects are made up of a combination of different metals and/or wood, different treatments must be applied. For example:

- if an object is made up of iron and aluminium, cleaning in caustic should not be carried out, because the caustic will react adversely with the aluminium; and
- similarly, a composite of iron and brass in a citric solution will result in the copper from the brass corrosion products plating out on the iron, causing the iron to corrode more quickly.

Finishing techniques for iron objects

There are many varied methods available to give the object the right colour and protective coating. The type of finish chosen depends on the intended role of the finished object, with the final decision being a balance between ethical, aesthetic, practical and personal considerations. The most commonly used techniques are described below.

Tannic acid

Rust converters are commercial products which can be applied to an object which has been cleaned chemically or mechanically, or to one which still has light rusting present on its surface. A rust converter will form a thin, black layer on the surface.

Subsequent applications further darken the object.

This coating system results in the formation by chemical reaction of stable iron tannates, which passivate the metal and protect it from further corrosion.

Fish oil/white spirit mixture

A mixture of 80 parts white spirit to 20 parts fish oil can be applied very effectively to freshly cleaned iron objects. Thinning the mixture with white spirit allows it to soak into the steel. It usually dries within minutes. Several coats can be applied and, when dry, it can be painted if required. This mixture does not change the metal colour, and gives good protection. It does not involve chemical reaction with the metal.

Oil quenching

Oil quenching is an old blacksmiths' method which gives good protection from rust. The end result is a deep blue-black object. This method works best on low carbon steel, because flaking occurs in small patches on high carbon or alloy steels. The method involves heating the metal, by either an oxyacetylene torch or forge, to a dull red colour, then plunging the object into old, dirty oil—the dirtier the oil, the blacker the final colour. The object is agitated for 30–60 seconds, depending on its size, removed from the oil and then wiped with a rag. Repeated applications of this method will further darken the object. Protective clothing and eye protection must be worn.

Blueing

Blueing is a method applied to many types of firearms, especially to their barrels, to produce a lustrous, dark blue finish. Although this is usually done by commercial gunsmiths, a blueing paste is available commercially, and can be applied easily.

After treatment, take care when you're handling the treated object, because acids from hands readily etch these surfaces.

Paint

There are numerous enamel and water-based paints, which protect and beautify metal surfaces. A range of primers, undercoats and topcoats are available. If these are applied correctly to properly prepared and cleaned surfaces, adequate protection should be maintained for many years.

Inorganic zinc primer

For iron objects that are displayed outdoors—particularly in an aggressive, marine environment—an inorganic zinc primer, a high-build epoxy top coat and a final clear polyurethane coating—with a UV absorbing reagent provide good protection.

Lacquer

Clear lacquers are available in spray cans, or can be applied by brush. The desired surface finish and colour must be obtained on the iron before you apply the lacquer. Follow the manufacturer's instructions on the product. This finish gives a lasting protection against oxide build-up, provided the entire object is coated. If air or moisture penetrates this layer, it will lift and the corrosion will begin again.

Microcrystalline wax

Microcrystalline wax provides both good protection and finish to an object. The object is immersed in a hot liquid-wax solution for up to several hours, depending on the size of the object. It is then withdrawn and allowed to cool. Excess wax can be scraped or wiped off. The wax can also be mixed with white spirit and applied with a brush or rag. This latter method is not as effective as immersion in the molten wax.

For more information

For a recipe for microcrystalline-polyethylene wax please see the section More About Metals later in this chapter.

Flame colouring

The colour of iron and steel can be altered by the application of direct heat from a forge or an oxyacetylene flame. After cleaning and removing rust, a gentle flame is applied to the object. The colour changes from light straw through to deep blue. When the object has attained the desired colour, it should be plunged into water.

CAUTION:

This method can change the molecular structure of the steel, depending on the grade and its carbon content. This method must not be used on spring steel.

Natural patina

If an iron object is in a stable condition, with only a lightly rusted surface, it may be that this is the type of finish you require to demonstrate the history and past use of the object. Such finishes can be maintained if the storage and/or display conditions are controlled to prevent further deterioration.

Storing and displaying iron and iron alloys

Although the general handling, storage and display guidelines apply to iron and its alloys, a few additional points need to be made.

Once an object has been treated and coated, correct storage or display conditions and careful monitoring should ensure its stability.

Large objects such as machinery and horse-drawn and motor vehicles should be housed, if not in controlled environments, at least with some protection from the elements. This protection can be in the form of a shed, a verandah or even a lean-to. Unless some protection is provided, moisture and dust accumulation will soon restart deterioration processes.

If an object is displayed in the open, it should be:

- raised and supported above ground level;
- monitored regularly for signs of deterioration; and
- treated as necessary.

Metal components of firearms should be cleaned and re-oiled frequently, and if possible kept in a protective environment.

As iron is one of the most reactive of the commonly used metals, good environmental control is essential to ensure continued stability of these materials. The preferred relative humidity is less than 45%.

Highly polished metal surfaces which are not protected by a clear lacquer can be coated with a light machine oil, a periodic spray of CRC or similar water-dispersant chemicals. As long as they are stored in a dust-free environment, this is a simple and effective means of preventing deterioration.

Plated iron

Iron may be plated with zinc, as in galvanised iron or tin, copper, chromium or nickel. These coatings protect the base iron sheet from corroding, and also provide a bright surface finish.

Corrosion of plated iron

Corrosion usually occurs after the breakdown of the surface plate. This exposes the iron, which then starts to rust.

Treatment of plated iron

To remove the rust, a citric acid solution containing an inhibitor can be used. The inhibitor is included to prevent any attack on the plating metal.

The solution is 10g of thiourea and 50g of citric acid in 1 litre of water. Thiourea is the inhibitor.

Test the solution on an inconspicuous area of the object, or on a scrap piece of the same material, before proceeding with the treatment.

Following removal of the rust, dry the object by dipping it in three successive acetone baths. At this stage, or earlier if there are no rust problems, the plate can be cleaned with industrial methylated spirits. Corroded areas can be removed with a mild abrasive such as pumice powder in methylated spirits.

CAUTION:

Check your chemical safety data sheets, and take the appropriate precautions.

Coating plated iron

If a bright surface finish is required after cleaning, a proprietary metal cleaner can be used as a once-only polish. The artefact can then be coated with a clear, acrylic lacquer.

Lead and pewter

Lead is a soft, grey metal, used mainly in combination with tin to form pewter. Because of toxicity problems associated with the use of pewter food vessels, the lead in pewter was

replaced in the 19th century with antimony and some copper. Modern leadless pewters are usually alloyed tin and Britannia metal.

Corrosion of lead and pewter

The main corrosion product on lead and pewter is white-grey basic lead carbonate. This provides a deep, protective patina to the metal surface, which should not be removed.

If the pewter and lead have been in a low-oxygen environment and exposed to sulphide compounds, a rich, lustrous, grey-black patina of metal sulphides remains on the surface. These minerals are stable and should also not be removed.

Lead and pewter are particularly susceptible to attack by acids given out by wood. Acetic acid combines with lead and pewter to form lead acetates.

Both tin and lead are very soft and are susceptible to denting and scratching.

Cleaning lead and pewter

The stable patinas which form on lead and its alloys, the white-grey lead carbonate and the dark lead sulphide, should not be removed because they form protective layers which prevent further corrosion. Other corrosion products may require treatment.

Because it is difficult to obtain very mild abrasives, it is generally recommended that abrasives not be used to clean these soft metals. If, however, the white bloom on the surface of these metals is thin, the deposit can be removed from the surface using a one-micron-grade alumina powder mixed into a slurry polish.

If the white, bloom—an acetate layer—is pustular or thick, it is best removed by chemical or electrochemical reduction. These techniques are best left to conservators.

Thin layers of corrosion products can be removed by soaking the objects in a solution of 50g of disodium ethylenediamine tetraacetic acid in 1 litre of water. Avoid prolonged soaking because the dissolved oxygen can cause increased corrosion.

General cleaning can be carried out with warm water and a pure soap. Then rinse the object with

fresh water, wipe it with methylated spirits, and polish it with a soft cloth.

A protective surface coating of microcrystalline wax may be applied after cleaning.

For more information

For a recipe and for information on the application of microcrystalline-polyethylene wax, please see More About Metals, later in this chapter.

CAUTION:

Check your chemical safety data sheets, and take the appropriate precautions.

Storing and displaying lead and pewter

Lead and pewter are prone to attack from acetic acid and other organic acid vapours, which are found in poor-quality papers and some fabrics, and given off by various woods.

Storing lead-based objects in cupboards containing these materials contributes significantly to the deterioration. This type of degradation usually shows up when white, powdery crystals form on these materials.

Because lead and pewter objects are particularly susceptible to attack by acids emanating from certain woods, it is very important to store and display them in enamelled metal cupboards.

The general handling, storage and display guidelines previously described earlier in this chapter should be followed.

Tin and its alloys

Tin is a soft, white metal which is found in essentially pure form in some objects such as plates; but it is more commonly seen alloyed with lead in the form of pewter.

In the 19th and 20th centuries, tin was combined with a number of other elements to produce a range of alloys which were used principally for utensils and ornamental ware.

Typical examples are:

- Britannia metal which is 93% tin, 5% antimony, 2% copper. It was developed in England during the mid-1700s in response to the threat to the pewter utensil industry from cheap porcelain. Old pewter was dull and, because of its lead content, was undesirable as a food container. Although the new alloy was brighter and stronger, it eventually lost favour as a metal for the production of household utensils; and
- leadless pewter which is alloyed tin.

Corrosion of tin

Although it is normally quite stable, tin reacts slowly with the atmosphere to form grey, stannous oxide and finally stable, white to grey-black stannic oxide.

Many museum objects made of tin or its alloys are covered with a dull, grey coating of corrosion products. These form a protective patina. Unless very pronounced or unsightly, this patina should be retained.

Cleaning tin

Although tin objects are quite strong, careless handling will still damage their surfaces.

If an object must be cleaned, a pure soap in warm water can be used to remove dirt and grime. This should be followed by rinsing it with fresh water, wiping it with methylated spirits and then polishing it with a soft cloth.

Ask the advice of a conservator before treating badly deteriorated objects.

Aluminium

Most aluminium objects found in museum collections are alloys containing copper as a minor component. The addition of only 3% by weight of copper trebles the mechanical strength of the parent metal.

As aluminium corrodes, an oxide layer forms on the surface and protects it against further corrosion. Therefore, under normal environmental conditions the metal does not corrode to any great extent.

Deterioration of aluminium



Aluminium cylinders showing the effects of attack by chloride ions.

Photograph courtesy of the Western Australian Museum

If in contact with metals such as copper and iron, or in the presence of chloride ions from sea water, aluminium and its alloys will corrode appreciably.

Aluminium must never come into contact with mercury. Since mercury prevents the formation of the protective oxide patina, subsequent corrosion of aluminium is rapid.

For more information

For more information on the effects of chloride ions on aluminium and its alloys, please see [More About Metals](#), later in this chapter.

Cleaning aluminium

Aluminium should be cleaned only with industrial methylated spirits, to remove dirt. Heavy deposits of oil, grease and petroleum products, commonly encountered on vintage car parts, can be removed by using kerosene or similar products.

If the metal is heavily stained or corroded, a 1% solution of phosphoric acid can be used. This will produce a mild, uniform etch on the metal surface which, after thorough washing and drying, should be left for a day to enable the protective corrosion film to reform through contact with the air. Consult a conservator for more information about this treatment.

Aluminium that has been contaminated with chloride ions can be treated by washing the corroded metal with a solution that contains

ammonia and ammonium sulphate. This is a long term treatment which is best left to conservators. A corroded sea plane float, for instance, was only stabilised after soaking for a period of 12 months.



Sea plane float after treatment.

Photograph courtesy of the Western Australian Museum

CAUTION:

Never use caustic soda to remove grease or paint from aluminium products, because it reacts vigorously with them. Don't use abrasives on aluminium, because these can remove the protective oxide layer.

Coating aluminium

After cleaning, the aluminium surface may be coated with a protective, clear, acrylic lacquer. This protection is generally not needed unless the aluminium is likely to be affected by salt—for example, because of a sea-side location.

Gold

Gold has been used from the earliest times. It is yellow and lustrous, and the most malleable and ductile of all metals. As it is a rare metal, it has been used for jewellery and coinage.

Gold is often applied as a decorative surface coating—in the form of gold leaf for manuscript illumination and for gilt frames or tempera/fresco paintings, and as gold amalgam for gilding copper and silver. It is also alloyed with copper and silver to improve its mechanical properties.

Treatment of gold

Because gold is very resistant to corrosion, it usually requires only polishing with a soft cloth. No coating is required on pure gold; but if it is alloyed with copper or silver, a clear acrylic or nitrocellulose lacquer gives protection against retarnishing.



Gold/silver watch from the wreck of the Pandora, before treatment.

Photograph courtesy of the Western Australian Museum



Watch after treatment

Photograph courtesy of the Western Australian Museum

MORE ABOUT METALS

Alloys

All metals have physical properties—malleability, conductivity, strength, impact resistance and chemical reactivity. Their usefulness is determined by how these properties can be altered through

alloying with other metals to produce a wide range of materials with tailor-made properties.

Alloying changes the corrosion resistance of the parent metal. Properties such as mechanical hardness and melting point also alter dramatically with alloying. The microstructure of alloys and metals is dependent on the rate at which they are cooled. This subsequently affects the rate of corrosion.

Mechanical working—such as hammering, drawing and rolling—also changes the microstructure of metals. If the stresses imparted to the metal are not relieved after fabrication, then stress corrosion can significantly diminish the service life of the materials.

An awareness of this behaviour in metals helps the conservator to respond in the most appropriate fashion to the various degradation problems that they find in collections.

Corrosion of metals

The overall driving forces of nature work to return metals to their stable oxidised states, that is, combined with oxygen, sulphates, carbonates, sulphides and chlorides. Unoxidised or native metallic element is produced when metals are unbound from their compounds with oxygen, sulphate, carbonate, sulphide and chloride. For this to happen there must be a sufficient driving force available through a high energy intervention. This intervention can be a carbon reduction or smelting. When metal ores are processed to produce metals, they start to corrode.

The primary property of electrical conductivity of metals is due to the dispersed nature of the electrons in the structure of the metals. When an external voltage is applied to a metal, the electrons flow. This very same useful property is the underlying cause for the corrosion of metals, because the voltage applied to the metal by the presence of oxygen in a moist environment will cause the electrons to flow irreversibly from the metal into the oxygen—to form an oxide coating.

A simple overview of corrosion

The corrosion of metals consists of two separate reactions:

- an oxidation reaction; and
- a reduction reaction.

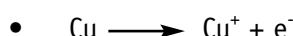
To explain these reactions, it is necessary to give a simple overview of the structure of atoms. Atoms are made up of a nucleus which contains neutral particles called neutrons and positively charged particles called protons. Electrons, which are negatively charged particles, orbit around the nucleus of the atom. The number and activity of the electrons will determine how readily the atoms will react with other atoms. Many metals, because of the way their molecules are structured, can readily lose electrons. When they do this, they are no longer atoms. They are positively charged and are called ions. Because of the charge, ions are not stable and combine readily to achieve a stable, electrically neutral state.

An oxidation reaction is one in which an atom loses electrons. This can be represented very simply by the equation:



where 'n' represents the number of electrons lost

For example, copper—Cu—can be put into this equation. In an oxidation reaction:



It can be oxidised further:



Copper is described as polyvalent, that is, it has different combining powers: a Cu^+ ion needs one negative ion to achieve a stable state, while a Cu^{2+} ion needs two negative ions to form neutral compounds. Once these ions combine with other substances, they produce cuprous and cupric compounds respectively. For example, Cu_2O is cuprous oxide or copper (I) oxide and CuO is cupric oxide or copper (II) oxide.

Iron and zinc are other examples of polyvalent metals.

In reduction reactions, atoms gain electrons. A simple representation of this would be:



where 'n' represents the number of electrons needed

These electrolytic reactions are used to produce solid metals from their ionic solutions. The negative ions can be supplied by a range of materials. For example, if the metal object is in a seaside location, chloride ions— Cl^- —will combine readily with the metal ions.

They will also combine with:

- sulphides— SO_3^- —sulphates— SO_4^{2-} —nitrates— NO_3^{2-} —from atmospheric pollutants; and
- oxygen.

If the metal combines with oxygen, it forms a metal oxide on the surface of the metal. If this metal oxide is continuous, then the overall corrosion rate of the underlying metal will slow down and it will become passivated or protected.

Corrosion cells

Corrosion cells are small areas on metal objects where electrical differences are set up. Electrons flow between the charged areas, just as an electrical current flows between the positively and negatively charged electrodes of a battery.

A corrosion cell is an electrochemical cell which acts very much like a battery. The corrosion of metals consists of two separate reactions:

- oxidation. The oxidation reactions are called anodic reactions; and
- reduction. The reduction reactions are called cathodic reactions.

In an electrochemical cell the anodic, oxidation, half of the cell produces electrons as the metal is oxidised, while at the cathodic half of the cell, reduction occurs. The electrons are taken and held by the oxidising agent, which in aerated environments is oxygen.

In a corrosion cell, these reactions can continue in a cycle. The localised corrosion activity causes pitting in the metal.

The rate at which the electrons move out of the metal and across into the oxygen molecules is the principal factor controlling the overall corrosion rate.

Fats, oils and sweat

Organic acids—formed by the oxidation of oils and fats—are capable of attacking metals which rely on a protective oxide coating to produce a good corrosion resistance. To prevent this type of damage, avoid direct contact between the object and the source of the organic material. Some examples of this type of damage are leather objects with copper fittings. The gradual deterioration of old candle wax in leather-lubricating oils leads to organic acids penetrating the protective copper oxide film, and reacting with the underlying metal—to form outgrowths of bright green organic copper compounds.

Human sweat on metal objects causes corrosion. Bacterial reactions with sweat can produce sulphides as metabolic by-products, and convert inherently inert sulphate ions into reactive sulphide ions.

Uneven coatings of oil—from sweaty hands for instance—can alter the ease of access of oxygen to metal surfaces. This has two major effects. It hinders the formation of passivating layers of corrosion. It also alters the relative reactivities of areas of the metals; and so it causes one part of the metal to corrode at the expense of another.

Acids

Inorganic acids such as hydrochloric acid—derived from the decay of plastics like polyvinyl chloride—and nitric and sulphuric acids—derived from air pollution—will attack metals which are either in the same storage environment as the plastic or in the open air.

Anything that prevents direct contact between the metal surface and acidic solutions helps to prolong the life of the object. Therefore, vapour phase inhibitors, lacquers, waxes and other coatings minimise the damage from air pollution. The filtering of external air also greatly helps to minimise corrosion damage.

Sulphide pollutants

Normally unreactive metals such as copper and silver can suffer significant corrosion in the presence of sulphide ions. Common sources of sulphide ions are:

- hydrogen sulphide— H_2S —from the anaerobic decay of plant material; and
- carbonyl sulphide— COS —from the degradation of sulphur-containing proteins, such as those found in wool.

Base metals such as zinc and tin are also significantly affected by sulphide pollution and/or contamination. Small concentrations of sulphur compounds in damp, oxygenated conditions cause corrosion. The resulting metal sulphides can often form a protective patina, as in the case of tin sulphides which protect pewter objects.

Adsorption of the sulphur-containing species is an essential step in the overall corrosion process and any factor which inhibits adsorption helps minimise attack on the metal. Therefore, adsorption of organic materials, such as vapour phase corrosion inhibitors, greatly decreases the corrosion rate.

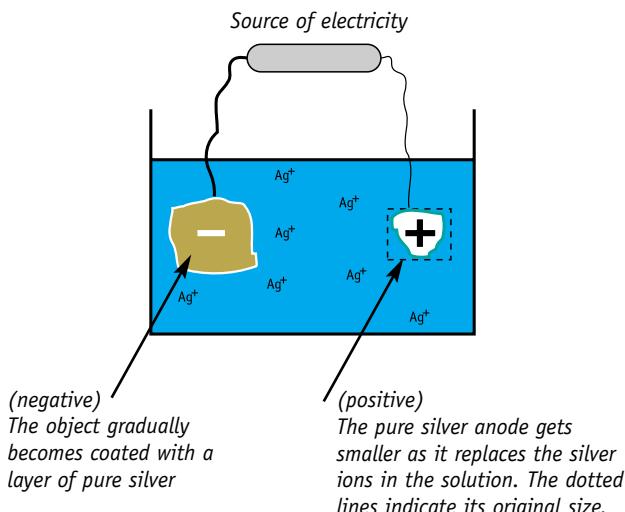
Electroplate

The principal function of electroplating is to make a cheaper metal look like silver. The physical properties of the materials are dominated by the underlying parent metal or alloy.

When an object is being electroplated, it becomes part of an electrolytic cell, as if it were part of a battery. The object is the negative electrode—that is—the cathode. The anode—or positive electrode—is usually made of pure silver. During the electroplating process, the object is placed in a solution containing silver salts—for example silver cyanide—and a direct, electrical current is passed through the object. As this happens, the object becomes coated with a layer of pure silver. At the anode, the silver is oxidised to produce silver ions, which replace the silver in the solution.

If an inert anode such as stainless steel or platinum is used, the bath would need regular replenishment of the silver salts, to keep the same operating conditions in the plating bath.

Brasses



If a silver/copper alloy layer is required, then the appropriate combination of silver and copper salts is dissolved, and the corresponding alloy is used as the anode.

Zinc carbonate blotter

If woven charcoal cloth or sintered zinc oxide pellets are not available or easy to obtain, then zinc carbonate can be used as a simple and very effective treatment against the adverse effects of sulphur pollution.

Sheets of acid-free blotting paper are immersed in a bath of a soluble zinc salt such as 10g of zinc sulphate in 1 litre of water.

Once the blotter is wet, a solution of 20g of sodium carbonate in 1 litre of water is poured into the bath, producing a white, cloudy solution of zinc carbonate.

The blotter is removed from the bath, and dried under pressure—to prevent cockling.

When dry, it can be placed underneath textile coverings in the base of a display case, or rolled up and placed in a support beneath a raised display platform within the display case.

This simple treatment has prevented the tarnishing of silver objects for a period of six years in a display case which has not been opened to release pollutant build-ups.

The addition of varying amounts of zinc—Zn—to copper—Cu—produces a wide range of industrial brasses of differing physical and mechanical properties. These include:

- gilding metal. The addition of only 5% zinc produces this alloy, which is commonly used as an artificial gold in decorative uses;
- red brass: 85% copper/15% zinc. In this alloy, the underlying red colour of copper is still present;
- yellow brass: 65% copper/35% zinc. The addition of more zinc hardens the alloy and changes the colour. This alloy is used for a wide range of industrial purposes, such as hinges, taps and valves; and
- muntz metal: 60% copper/40% zinc. This alloy has a variety of uses, including sheathing for wooden sailing vessels.

In order to improve the ease of machining, varying amounts of lead are added to the hard brass alloys. Brasses containing more than 5% lead are self-lubricating, a very important factor for bearings and other similar objects.

Bronzes

When copper is alloyed with tin as the major additional component, different types of bronzes are formed. Bronzes can have significant differences in reactivity towards oxygen. The mechanical strength of the bronze normally increases with the addition of more tin, but the alloys become increasingly more brittle. Some of these alloys include:

- bell metal. With 20–25% tin, this is very strong, but very susceptible to cracking if struck with hard and sharp instruments;
- leaded bronzes: 80% copper/10% tin/10% lead. These are very robust and can be extensively cold-worked;
- statuary bronzes: 65–85% copper/10–30% zinc/2.5–5% tin. These are commonly used for casting; and
- china silver is an alloy of copper, tin, nickel and silver with 65% copper/20% tin/13% nickel/2% silver.

Bronze disease

Bronze disease is the name given to the type of corrosion of copper and its alloys in which light blue/green, pustular outgrowths form on the surface. It is due to the breakdown—by chloride ions—of the passivating layers of corrosion products which normally protect the surface of these metals.

The surface deposits tend to crumble and fall away when touched. As this loose debris is removed from the surface, a pitted surface is exposed directly under the corrosion mound.

Increased temperatures enhance this form of corrosion. A detailed description of the fundamental processes involved in the bronze disease cycle is given in an article by MacLeod, 1981.

This type of corrosion problem is most commonly found with bronzes—hence the name—less frequently in brasses, and occurs least frequently with copper itself.

Because of the relatively high background levels of chloride ions in much of the soil in arid Australia, the problems of bronze disease are encountered in objects that have been recovered from land sites, as well as those from a marine environment or coastal areas.

The corrosion problems are much worse when the materials are stored in high humidities. Under these conditions, a series of little dots and pustules will break out over the surface of an object. If the humidity is not lowered, or if some other form of treatment is not given to the object, then extensive corrosion and gross disfigurement of the object is inevitable.

One of the problems associated with bronze disease is that after the surface has been pitted, it is difficult to disguise that area, unless it is infilled with coloured wax or some other suitable resinous material.

Treatment of bronze disease

The main aim of treating bronze disease is to remove all of the chlorides from the object.

This is done simply and effectively by immersing the object completely in a solution of 10g of

sodium carbonate and 10g of sodium bicarbonate in 1 litre of distilled or deionised water.

A first wash of two to four months, followed by a second wash of four to six months in the solution is normally sufficient.

If the object originally had a bright metal surface, this treatment will produce a green-brown patina which is attractive and stable.

If a clean, metal surface is desired, the patina can be removed after treatment—using the citric acid stripping process or by polishing.

This method is effective for all cases of bronze disease, but the time required varies greatly from object to object.

Remove any protective coating on the object before treatment.

This treatment should be carried out by a conservator, or in close consultation with a conservator.

After removing the chlorides, apply a finishing treatment. Wax impregnation, a coating with benzotriazole or a coating with Incralac are commonly used.

Benzotriazole is one of a number of corrosion inhibitors for copper and its alloys. The reaction mechanisms are complex, but the primary protection is due to the formation of a very stable complex with copper, which protects the metal from further corrosion. Benzotriazole displaces chloride ions from cuprous chloride—this overcomes one of the fundamental causes of accelerated corrosion.

Microcrystalline/polyethylene wax

This is a good recipe:

- 100g of microcrystalline wax
- 25g of polyethylene wax
- 230g of white spirits

Melt the waxes together and stir well to make sure they are mixed thoroughly. Quickly pour the molten mixture into the white spirits and stir it constantly while it cools. This makes a smooth, white paste. The sheen of the resultant wax film

can be altered by varying either the grades or the proportions of the waxes used. When it is dry, the wax can be polished, for a shiny finish, or left untouched for a matt finish. If subsequent treatment is necessary, this wax can be removed with white spirit.

Iron and steel

The most important alloying element for iron is carbon—because it combines to form a diverse range of alloys, including wrought iron through to steels and cast iron.

In cast iron, carbon can exist as discrete phases or minute areas of graphite, in a variety of physical forms. Because of the differences in the hardness and chemical reactivity of the various phases, steels and cast iron are subject to localised corrosion—one phase is selectively corroded while another is protected. This is a form of internal galvanic corrosion.

The addition of other metals such as nickel and chromium result in the wide range of stainless steels, which are hard and chemically durable alloys. These alloys corrode to form protective coatings of chromium oxide/nickel oxide, and transform iron into a much less reactive metal with a much wider range of uses.

Adding elements such as molybdenum further improves the corrosion-resistance properties of the stainless steel alloys in chloride solutions.

Bentonite paste

Bentonite paste is made by sprinkling bentonite powder into a prepared solution of the alkali or acid, and mixing it into a paste. The concentrations of acid and alkali in the paste are usually higher than if a corresponding solution was being used.

For example, an 8% solution—that is, 80g per litre—of alkali and a 10% solution—that is, 100g per litre—of citric acid are recommended. The paste can be applied directly to the area to be treated.

If the surface is not smooth, residues of the paste can become clogged, making it awkward to remove. To make removal easier, first place a piece

of water-dampened tissue paper over the treatment area, and apply the paste on top. It is preferable to cover the poultice of paste with cling wrap, to prevent it drying out.

Repeated applications of the paste may be required. The paste can be removed by hosing the surface with water and scrubbing it with a bristle brush. Then dry the object fully.

Bentonite paste treatment is also recommended if solder joints or related fastenings are present, because these are also readily attacked by citric acid.

Chloride ions and aluminium and its alloys

The presence of chlorides in aluminium alloys containing copper is a problem because chloride ions:

- penetrate the protective oxide coating;
- cause aluminium pitting corrosion; and
- promote localised copper corrosion from within the alloy.

As the copper corrosion products move to the surface, they interact with the aluminium corrosion products and form a blue-green, copper-stained aluminium hydroxide corrosion matrix.

The real problem occurs when—as a result of electrochemical reduction by the parent metal—copper is redeposited in metallic form on the surface of the alloy. The redeposited copper acts as a cathode in a pitting corrosion cell.

The conservation problem is to remove a relatively unreactive metal deposit from the surface of a very reactive metal, while at the same time trying to remove the chloride ions.

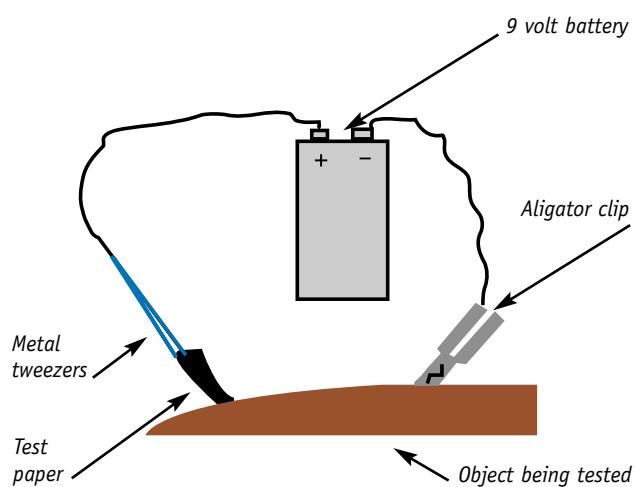
One simple solution to the problem is to use a solution of ammonia and ammonium sulphate to wash away the chlorides and the metallic copper from the surface. This produces complex reactions, but is effective.

When a corroded sea plane float was treated this way, it took 12 months of steady soaking, scrubbing and cleaning to stabilise the corroded metal.

Spot-tests

Spot-tests are used to distinguish different metals which make up an alloy. Simple instructions and a list of the tests are provided, to help you identify metal objects in your collections. It is important to note that these tests are only qualitative in nature—they will not tell you the relative amounts of the different metals in an alloy.

General instructions



Do the tests in unobtrusive spots, because marks may be left.

Remove protective coatings such as lacquers and waxes, otherwise there will be no reaction and no identification can be made.

The test papers to be used with the electrolysis are best cut into triangles. They are easier to handle this way and, if cut reasonably small, will leave less of a mark on the metal object being tested.

When wet—but not soaking—with distilled water or salt solution, the papers should be shiny.

The alligator clip needs to be attached firmly to an area of reasonably solid metal.

The test paper in the tweezers should be put on the surface of the object, about 1cm away from the clip.

Don't let the metal tweezers contact the surface of the metal. The electrical contact must be made through the wet test paper.

Rinse wet spots of electrolyte, for example, NaCl—sodium chloride—or other reagents with distilled water, and dry them.

The battery should be stored disconnected from the tweezers and clip—to avoid accidental discharging if the two should touch.

Tests for identifying metals in an alloy

Antimony—Sb

Procedure: dip a small piece of antimony test paper in diluted HCl—hydrochloric acid—and apply it to the object.

Results: the presence of Sb is indicated by an orange colour. The reaction is complete in five seconds on pure Sb using 2% HCl. Surfaces containing trace Sb will be much slower. Gold—Au—and silver—Ag—surfaces remain unaffected by the test. Lead—Pb—is slightly darkened, copper—Cu—and iron—Fe—corrosion products change colour slightly.

Copper—Cu

Procedure: wet a small piece of commercial test paper—Cuprotesmo—with distilled water and place it on the surface of the metal.

Results: the copper metal or Cu⁺ and Cu²⁺ ions cause the pale yellow paper to turn pink/purple. This test works particularly well on corroded or patinated areas, and leaves no trace of the test. On highly polished or new surfaces, the reaction is much slower.

Gold—Au

Procedure: dip a small triangle of plain, filter paper in a saturated solution of sodium chloride in water. Electrolyse for less than 15 seconds. Some darkening will probably be evident if copper is present. Leave the paper on the spot until it is slightly dried, to ensure that gold is on the surface of the paper. Then dip it into a mixture of 20% tin chloride—SnCl₂—in 15%HCl.

Results: the paper turns black if gold is present.

Iron—Fe

Procedure: for corroded objects, dip a small square of dipyridyl test paper in distilled water and place it on the surface of the object. This leaves no

visible effect on the object. For uncorroded objects, dip a long piece of dipyridyl test paper in NaCl saturated solution so that the paper is wet but not saturated—electrolyse. The paper should be long, to prevent confusion with any colour reaction which occurs with the steel of the tweezers.

Results: if iron is present, the white test paper turns red after several seconds—for corroded and uncorroded objects.

Nickel—Ni

Procedure: dip a small piece of nickel test paper into a saturated solution of NaCl. Electrolyse for about five seconds.

Results: on drying, the following colours may be observed: pink-red for nickel, brown for iron, green for copper and yellow for gold.

Silver—Ag

Procedure: wet a filter paper with 10% potassium chromate K_2CrO_4 . Electrolyse for one second or less.

Results: if silver is present, a red silver chromate Ag_4CrO_4 forms in the spot of the metal. This mark, if small, can be polished off very easily.

Tin—Sn

Procedure: dip a small piece of filter paper in a saturated cacotheline solution—0.6% aqueous. When the cacotheline dries slightly, dip the filter paper in NaCl saturated solution. Electrolyse.

Results: if tin is present, the paper turns purple. Shiny surfaces become matte and dark after two second of electrolysis.

Zinc—Zn

Procedure: dip a small piece of filter paper in sodium hydroxide NaOH—5–10% solution—and apply the paper to the surface of the object for five to ten seconds. Electrolysis is recommended. When the sample has been absorbed in the filter paper, place this paper in the centre of a larger filter paper, making a wet spot. Wash this spot with successive drops of dithizone/carbon tetrachloride, CCl_4 .

Results: if zinc is present, the edges around the spot turn pink—not orange. Wipe off immediately any NaOH remaining on the metal of the object. This can be done with the same filter paper being used for the dithizone reaction. Shiny zinc surfaces may be slightly darkened or dulled after electrolysis. There is a small effect on some copper corrosion products, and the NaOH droplet causes a shiny spot to develop on lead.

If you have a problem relating to the care of metals, contact a conservator. Conservators can offer advice and practical solutions.

For further reading

Brown, B.F., Burnett, H.C., Thomas Chase, W., Goodway, M., Kruger, J., Pourbaix M., eds. 1977, *Corrosion and Metal Artefacts—A Dialogue between Conservators and Archaeologists and Corrosion Scientists*, NBS Special Publication 479, U.S. Department of Commerce/National Bureau of Standards, Washington, D.C.

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Scott, David A., 1991, *Metallography and Microstructure of Ancient and Historic Metals*, The Getty Conservation Institute, The J. Paul Getty Museum in association with Archetype Books, Marina del Rey, California.

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Self-evaluation quiz

Question 1.

Select the incorrect statement from the following:

- a) damaged Sheffield plate may be repaired by electroplating;
- b) moisture and oxygen enhance corrosion;
- c) a protective oxide layer forms on the surface of copper objects;
- d) microcrystalline wax gives good corrosion protection for iron objects.

Question 2.

Gloves should be worn when handling metal objects so that:

- a) oils, fats and sweat are not transferred to the object;
- b) the object is less likely to slip from your grip;
- c) protective lacquers are not damaged by nails;
- d) your hands are not affected by toxic corrosion inhibitors.

Question 3.

Silver cleaning should be carried out only when absolutely necessary because:

- a) silver dip solutions are very expensive;
- b) any cleaning solutions remove small amounts of silver;
- c) cleaning solutions tend to accumulate in indentations and surface cracks;
- d) evidence of historic usage may be lost.

Question 4.

Select the correct statement from the following:

- a) copper is more susceptible to bronze disease than is brass;
- b) bronze disease only occurs in objects

recovered from the sea;

- c) bronze disease can be treated with a citric acid/thiourea solution;
- d) the presence of high concentrations of chloride ions leads to bronze disease.

Question 5.

The presence of brown droplets of moisture on an iron object indicates:

- a) there are low levels of chloride ions in the metal;
- b) the metal is being attacked by sulphide pollutants;
- c) the metal has been buried in a low-oxygen environment;
- d) corrosion reactions are still active.

Question 6.

Select the correct statement from the following:

- a) wooden cabinets are preferred to painted metal ones for storing metal objects;
- b) metal objects should be wrapped in unbuffered, acid-free tissue paper;
- c) storage in plastic bags is acceptable as long as they are not made of PVC;
- d) relative humidities greater than 45% are essential to help in the release of chlorides from metals.

Question 7.

Which of the following statements are correct?

- a) The main corrosion products that form on lead are stable and protective.
- b) Abrasives are recommended for the removal of most corrosion products from lead.
- c) Use of ethylenediamine tetraacetic acid is effective in removing thin layers of corrosion products.
- d) Microcrystalline wax may be applied to lead as a surface finish.

- e) Storage of lead in chipboard cupboards is recommended because the resultant lead acetate patina is protective.

Question 8.

Which of the following statements is incorrect?

- a) Aluminium may be cleaned with methylated spirits.
- b) Caustic soda should be used to remove grease from aluminium.
- c) Abrasives should be avoided for cleaning aluminium because they can damage the protective layer.
- d) Chloride ions are potentially damaging to aluminium objects.

Question 9.

Citric acid may be used to treat:

- a) cast iron, cast steel, spring steel and plated iron;
- b) brass and bronze, but only if thiourea is added;
- c) silver plate;
- d) lead and pewter.

Answers to self-evaluation quiz

Question 1.

Answer: a).

Question 2.

Answer: a).

Question 3.

Answer: b).

Question 4.

Answer: d).

Question 5.

Answer: d).

Question 6.

Answer: b).

Question 7.

Answer: c).

Question 8.

Answer: b).

Question 9.

Answer: b).



OUTDOOR COLLECTIONS

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Objectives

At the end of this chapter you should:

- be aware of the need to care for outdoor cultural material;
- have a basic understanding of the main causes of damage to objects in an outdoor environment; and
- know the basics of caring for and maintaining outdoor cultural materials.

Introduction

Sculpture, monuments, war memorials and even stone horse-troughs are all familiar features of our landscape. There is no doubt that we notice them and appreciate them. They are decorative, they have meaning for us and they contribute to the visual texture of our surroundings.

Despite the fact that we value these items, it is not often that we examine these objects closely and observe their detail, or note any damage unless it is very obvious—a graffiti attack, for example.

Because these objects are designed to be outside and are made from durable materials, we think that they can withstand all sorts of conditions. They are durable but, like all materials, deteriorate. The process is constant.

Damage and deterioration can occur rapidly and be obvious. However, many items deteriorate slowly over long periods of time—and the damage is not seen clearly until it is advanced. It is important to be aware that this will happen inevitably and that there are steps you can take to minimise the risks to your valued outdoor cultural material.

What is outdoor cultural material?

Outdoor cultural material includes such items as:

- sculpture—art work in three dimensions;
- fountains—figures, animals and other decorative items combined with hydraulics to

form jets, sprays and waterfalls;

- monuments—dedicated to the memory of people or events;
- murals—paintings or decorative items on walls;
- war memorials—dedicated to the memory of those who died during a specific war. Often with larger memorials, additional plaques have been added as other wars have occurred; and
- artefacts—objects which have some link to an historic event, often with a plaque or other memorial features. Such items include cannons, war relics, anchors and items saved from larger pieces which have since been destroyed.



A stone sculpture in the grounds of Carrick Hill, South Australia.

Photograph courtesy of Artlab Australia, reproduced with permission of Carrick Hill

What is outdoor cultural material made of?

Outdoor cultural material includes a vast array of items made from varying materials.

Sculpture gives an indication of the range of materials. Traditional sculptures tend to be made from:

- metals such as bronze and, less frequently, cast iron;
- stones such as marble, sandstone, granite, limestone and bluestone; and
- wood—this is used less frequently, probably because it is generally considered to be less durable.



Close-up of one component of a timber sculpture.

Photograph courtesy of Artlab Australia, reproduced with permission of Carrick Hill

In recent years, a greater range of materials have been used. They are used in combination with each other, and with the more traditional materials. There is now sculpture which uses materials as varied as:

- concrete;
- glass;
- terracotta;
- fibreglass;
- corrugated iron;
- terrazzo; and
- painted metal.

What are the most common types and causes of damage?

Objects in an outdoor setting are fully exposed to almost all of the factors that cause damage and deterioration.

Being outside, sculptures, memorials and other objects are very vulnerable to physical damage such as:

- scratching and abrasion, for example, through children climbing on objects;
- graffiti;
- deliberate breakages and other forms of vandalism;

- accidental damage such as vehicles crashing into—or trees falling on—objects;
- splitting and cracking through plants growing in small fissures in the objects; and
- splitting, cracking, distortion, and loss of coatings and paint layers as objects adjust to extremes and fluctuations in their environment. This type of damage rarely happens quickly. It usually happens over a long period and is often considered to be natural weathering.



This imitation stone work has split, leaving it vulnerable to further damage.

Photograph courtesy of Artlab Australia, reproduced with permission of Carrick Hill

Environmental factors which can contribute to physical damage include:

- extremes and fluctuations in temperature and relative humidity;
- dust storms and dirt picked up by cars on dirt roads—high velocity dust particles act like a sand-blaster. Stone surfaces—especially the softer stones such as limestone and sandstone—are particularly vulnerable to this type of damage especially on areas with fine-detailed carving;
- chipping and flaking of the surface of objects caused by mowing or whipper snippering too close to them; and
- damage from insect and mould attack.

For more information

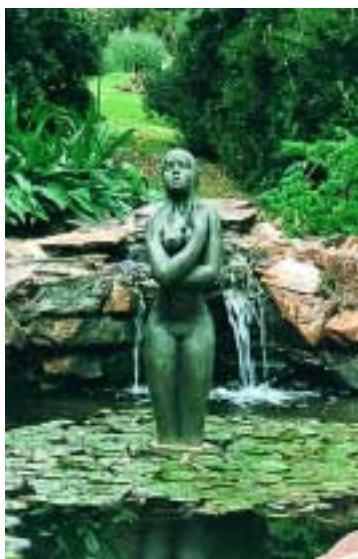
For more information about adverse environmental effects, please see *Damage and Decay*.

Chemical deterioration also happens. Light, UV radiation, high humidity and high temperatures all contribute to chemical changes, which can include:

- corrosion;
- fading;
- discolouration; and
- materials drying out and becoming brittle.

Airborne pollutants, which produce acid rain, are one of the major causes of damage to outdoor objects. The unsightly black and brownish-yellow streaks seen on many bronze sculptures are a direct result of pollution. This is not just a problem in the city or in industrial areas. Acid rain can travel vast distances before actually falling. Pollution from fertilisers and crop sprays can also have a detrimental affect on objects in outdoor settings.

Salts cause damage to metals, as well as to concrete and stone.



This bronze sculpture is vulnerable to plant growth below the water level and to accelerated corrosion at the water surface. If the water contained chlorine, extensive damage would occur.

Photograph courtesy of Artlab Australia, reproduced with permission of Carrick Hill

As bird droppings age, they can become quite acidic and can etch into the surface of outdoor objects.

Mould growth also involves chemical action on the object, as moulds digest the items they are feeding on. Moulds can also stain the surfaces on which they are growing.

Plants growing on objects can cause chemical damage, especially if they are feeding off the object.

Resins and other substances which fall on objects from trees can be very difficult to remove from porous materials, and can stain and disfigure the objects.

For more information

For more information on the adverse effects salts have on metals, please see the chapter on Metals in this volume.



This piece is made from wood and iron. It is vulnerable to corrosion of the iron and to deterioration of the wood. It also collects large amounts of pine needles from surrounding trees, because of its shape.

Photograph courtesy of Artlab Australia, reproduced with permission of Carrick Hill.

Care of outdoor objects

National inventory

The Australian Institute for the Conservation of Cultural Materials—Sculptures, Monuments and Outdoor Cultural Material specialty group—AICCM-SMOCM—is preparing a national inventory of sculptures, monuments and outdoor cultural material.

SMOCM's leaflet *Saving the Past for the Future—We Need Your Help!* states that the program will:

'...culminate in the creation of a National Inventory of Sculpture, Monuments and Outdoor Cultural Material. The results of the primary research, on-site documentation and condition assessments will be used by custodians to develop management plans for local collections.'

It further states:

'AICCM wants to work with local councils and private owners of significant objects to assist in establishing conservation parameters for these diverse heritage collections—from documentation to graffiti removal to preventive conservation.'

'Our aim is to ensure that collections are appropriately documented and conserved for greater understanding and enjoyment now and into the future'

At the end of the project there will be a central, computerised database, which will be available through public screens at the Art Gallery of NSW and on the Internet. This database will be available as a community tool for local councils and custodians. The NSW inventory was completed in December 1997.

To collect the information for the national inventory, SMOCM is carrying out a survey. The survey form and the instructions for completing the form follow.

This survey form is a good starting point for local groups to gather information about the sculptures, monuments and outdoor cultural material in their area. With this information, you can take stock of what you have; and determine what items need attention and the priorities for treatment.

Australian survey of sculpture, monuments and outdoor cultural material—SCOCM—survey form

Guidelines for on-site reporting

- Read the entire form carefully before beginning the report.
- When filling out this form, type or print using a ballpoint pen or pencil. Legibility is critical.
- Do not guess at the information; an answer of 'unknown' is more helpful.
- Research at your local library or Council will be required to complete questions in Parts 4 and 5.
- For sculptures with several separate sculptural components, complete one Survey Form for the entire work. If necessary, complete relevant sections of the Survey Form for each component and staple them together. Attach photographs, photocopies, slides or other reproductions of the work to the back of the Survey Form.

Send completed forms to Inventory of SMOCM, AICCM (NSW), GPO Box 3762, Sydney 2001. Keep a copy for your records.

If you have any questions, please contact Julie Potts, Project Coordinator (02) 9225 1782.

SURVEY COMPLETED BY: _____

ADDRESS: _____

TELEPHONE: Work _____ Home _____

DATE: _____

SUPERVISOR'S NAME: _____

ADDRESS: _____

TELEPHONE: Work _____ Home _____

The printing of this Survey Form has been kindly funded by the Art Gallery of New South Wales.

1: BASIC DESCRIPTIVE INFORMATION—See Guidelines**1.1 Category—see Guidelines** Sculpture (S) Fountain (F) Monument (Mon)
(include war memorials) Mural (Mur) Mosaics/terrazzo
floors (Mos) Artefact (A) cannon,
anchor, horse trough or other**1.2 Title of Work—if unsure, indicate ‘unknown’; if artist named the work ‘Untitled’, note accordingly.**

1.3 Alternate Title(s)—other titles of work known by

1.4 Overall Description—see Guidelines

1.5 Overall Condition—see Guidelines

1.6 Primary Artist(s)—see Guidelines

1.7 Other Collaborators—check as many as apply and see Guidelines

Architect _____

Carver _____

Designer _____

Other (Designate role, eg. landscape architect, engineer) _____

1.8 Foundry/Fabricator _____

1.9 Execution Date—often found by sculptor's name _____

1.10 Media—if known, name specific medium, and see Guidelines

MEDIA						
	Metal	Stone	Wood	Ceramic	Plastic	Other
Sculpture						
Fountain						
Monument						
Mural						
Mosaic						
Artefact						
Base						

Was information obtained by direct observation? YES NO

If no, indicate source of information.

1.11 Approximate Dimensions—indicate unit of measure, millimetres preferred

	Height	Width	Depth
Sculpture			
Fountain			
Mural			
Mos/Ter			
Artefact			
Base			

1.12 Markings/Inscriptions—check as many as apply

Is the artist's signature visible on the piece?

Yes, examined and found signature.

No, examined sculpture/base but did not see any signature.

Unable to determine, could not get close enough to check.

If signature is visible, record here—indicate location _____

Does the work have foundry/fabricator marks?

- Yes, examined and found foundry marks.
- No, examined sculpture/base but did not see foundry mark.
- Unable to determine, could not get close enough to check.

If foundry mark/marks are visible, record here. _____

Record the text of any associated nearby identification or commemorative plaques.

Are there any inscriptions badly worn or unreadable?

- Yes
- No

If 'yes' provide details.

PART 2: LOCATION/JURISDICTION INFORMATION

2.1 The sculpture is currently located at:

Street address or site location _____

Suburb _____ City _____ State _____

2.2 Setting of Work—see Guidelines

Is the work a focus of space? For example, at the end of a road, in the centre of a prominent intersection, or in a park with views along paths leading to the work.

If yes, describe the setting

2.3 Immediate Locale—check as many as apply

- Industrial
- Street/Roadside—within 6 metres
- Tree-covered—overhanging branches or trees nearby
- Residential
- Commercial
- Institution
- Park
- Other—specify _____

2.4 Is the sculpture in a protected setting?—check if applicable

- Protected from the elements—for example niche, canopy
- Protected from the public—for example fenced
- Security—for example guards
- Lighting

Any other significant environmental factor—such as near airport, subway, sprinklers, cars or birds

PART 3: CONDITION INFORMATION

3.1 Surface Coating—see Guidelines

	OBJECT	BASE
Does there appear to be an applied surface coating?	<input type="checkbox"/>	<input type="checkbox"/>
Yes	<input type="checkbox"/>	<input type="checkbox"/>
Unable to determine	<input type="checkbox"/>	<input type="checkbox"/>

If known, identify type of coating—see Guidelines

3.2 Surface Appearance—see Guidelines

Complete for all materials—check as many as apply

	OBJECT	BASE
1. Guano	r	r
2. Dirty surface	r	r
3. Graffiti applied to surface	r	r
4. Graffiti scratched into the surface	r	r
5. Abraded or gouged surface	r	r
6. Cracked surface	r	r
7. Discoloured surface	r	r
8. Dented	r	r

Other Comments: _____

Complete for metal objects

	OBJECT	BASE
9. Corrosion	r	r
Other Comments: _____		

Complete for stone objects

	OBJECT	BASE
10. Organic growth	r	r
11. White crusts	r	r
12. Chalky or powdery surface	r	r
13. Spalling	r	r
Other Comments: _____		

3.3 Structural Condition—check as many as apply

	OBJECT	BASE
Is the support deteriorating?	r	r
Are there any cracked joints?	r	r
Is mortar or caulking missing?	r	r
Are there any broken or missing parts?	r	r
Any cracks, splits or holes?	r	r
Look for straight or branching fractures	r	r
Dented	r	r

Does water collect in recessed areas?

r

r

Other Comments: _____

PART 4: OWNER/ADMINISTRATOR

State Government

Local Council

Other

Please give the name and address of the agency, institution or individual who currently owns or administers the work and is responsible for its long-term care.

Name _____

Department/Division _____

Street Address _____

Suburb _____ State _____ Post Code _____

Contact Name _____ Telephone _____

If sculpture has been moved, please list former location(s) and owner(s)

PART 5: HISTORY AND IMPORTANCE—OR SIGNIFICANCE—OF THE WORK

**5.1 Attach dated photographs, slides, and a photocopy of an illustration or drawing of the work.
Please provide details of the source material.**

5.2 Artist Intentions for Future Use/Weathering/Maintenance—if known

When did the artist make this statement? _____

Was this a verbal or written communication? _____

What was the date of communication? _____

Who did the artist address? _____

5.3 What is the history of the work?—see Guidelines

5.4 What is the importance—or heritage significance—of the work?—see Guidelines

Is the work already recognised, that is listed by any of the following?

- The National Trust.
- The State or Local Government Heritage Authorities.
- The Australian Heritage Commission—The Register of the National Estate.
- Other.

Supply any references.

What value does the work have for the local community?—see Guidelines

Guidelines for Use with Survey Form

PART 1: BASIC DESCRIPTIVE INFORMATION

This survey will include any three-dimensional artwork or artefact which is cast, carved, modelled, fabricated, fired or assembled in materials such as stone, wood, metal, ceramic or plastic, located in an outdoor setting, is free standing and accessible to the public.

1.1 Category

'Sculpture' is any work of art carried out in three dimensions.

'Fountain' is an important category of sculpture linking art and hydraulics. Figures, animals and other objects are combined to deliver jets, sprays and waterfalls. This includes drinking fountains for humans and animals.

'Monument' is usually in dedication to the memory of a person(s), founder(s), institution or government, which will usually be stipulated upon an accompanying plaque.

'War Memorial' is dedicated to involvement in any war, usually stipulated on a plaque as part of the memorial.

'Mural' is a decorative item. However, our interest lies with works executed by artists, rather than minor decorative embellishments. What one needs to look for is a signature or plaque commemorating the work of the artist(s).

'Mosaic' is a design made by cementing small pieces of hard, coloured materials (eg. marble, glass, ceramic or semi-precious stones) to a base.

'Terrazzo floor' is a mixture of marble chips and cement used for flooring. It is laid in situ, ground smooth and then polished.

'Artefact' is an item which is related to historical events, and may include items such as a cannon, anchor or horse trough.

The following items will not be included in the AICCM's current project: plaque, gate, fence, step, an architectural feature—part of a building, rock art, outdoor site, engineering structure, mining equipment, agricultural machinery, garden, 'big' thing—advertising material, street furniture, playground equipment and cemeteries. These items are not priorities for this survey. However, you may decide to use this form for your own record-keeping about these items.

1.4 Overall Description Briefly describe the work including its subject/theme. For figurative works, use the abbreviations PR—proper right—and PL—proper left—to indicate the right or left side of the statue from the perspective of the statue, that is your right or left side if you were positioned on the base facing in the same direction as the statue. For abstract works, describe the predominant forms, colours, shapes and textures. For descriptions of either abstract or figurative pieces, avoid judgemental language.

1.5 Overall Condition What is the overall general appearance or condition of the work? Please indicate any broken or missing parts and describe evidence of cracks. Are there obvious signs of deterioration which require urgent treatment, or is it well maintained?

1.6 Primary Artist(s) Is(are) the person(s) responsible for the overall conception and creation of the work. Frequently the artist's name will appear toward the back, lower edge or another inconspicuous place on the sculpture, followed by the abbreviations 'Sc', 'Sculp' for sculptor/sculpted.

1.7 Foundry/Fabricator If the piece was cast, the foundry name or monogram symbol, as well as cast date, may appear on the base of the sculpture or another inconspicuous place.

'Base' is the support on which the object is placed. Some works will include a plinth as well as a base; however, for the purpose of this survey they should be described jointly.

1.10 Media

Metal	Stone	Wood
1. Bronze	9. Sandstone	17. Blackbutt
2. Copper Alloy	10. Limestone	18. Teak
3. Lead Alloy	11. Granite	
4. Aluminium Alloy	12. Marble	
5. Gold Alloy	13. Reconstituted Stone (Terrazzo)	19. Marine Grade
6. Iron Alloy	14. Trachyte (NSW)	Plywood
7. Unknown metal	15. Bluestone (Vic)	20. Other
8. Other metal	16. Other	
Ceramic	Plastic	Other
21. Terracotta	24. Polyester	30. Brick
22. Glazed earthenware	25. Epoxy	31. Concrete
23. Porcelain	26. Spun Glass reinforced resin	32. Glass
	27. Cast Resin	33. Plaster
	28. Other Resin ie. expanded foam	34. Bone
	29. Methods of construction eg. cast or laminated	35. Fabric
		36. Leather
		37. Rubber
		38. Other

1.11 APPROXIMATE DIMENSIONS Always measure the tallest and widest points. Do not climb on objects or lean ladders against them while measuring. A simple diagram or drawing of the object identifying where measurements were taken from would be of assistance. Please include this on the back page of the Survey Form. Taking a photo of someone of known height next to a sculpture can help to estimate height—measure against them with a ruler on the photo.

PART 2: LOCATION/JURISDICTION INFORMATION

2.3 Environmental Setting of work The general vicinity and immediate locale surrounding an object play a major role in its overall condition. The size of the work can be an important factor here. The Archibald Fountain in Hyde Park, Sydney is very much a focus of space, whereas a small bust on a low pedestal between shrubs in a garden is unlikely to be a focus. But size alone is not the determining factor. For example, the Richard Johnson Obelisk in Bligh/Hunter Streets, Sydney, though smallish, is a focus of the space it occupies—the little square at the street intersection.

PART 3: CONDITION INFORMATION

3.1 Surface Coating

1. Applied patina—chemicals applied to the surface of metal to create a desired colour.
2. Electroplated—the process of depositing metal from a solution of its salts onto a surface, using an electrical current.
3. Gilded—thin layer of gold laid on as gold leaf.
4. Glazed—smooth lustrous coating usually applied to ceramics.
5. Painted—usually applied by brush or spray.
6. Polished—smooth and glossy surface produced by friction.
7. Textured—rough surface, applied as part of the original design.
8. Waxed or lacquered—clear, protective coating, often appears shiny.
9. Other—please specify.

3.2 Surface Appearance

1. Guano—bird droppings, insect or animal remains.
2. Dirty—accumulation of dust and dirt.
3. Graffiti—applied over the surface with paint, felt pen or a similar material.
4. Graffiti—scratched into the surface, damaging original object and exposing fresh material below the surface.
5. Abraded or gouged surface.
6. Cracked surface.
7. Discoloured—a faded or darkened surface.
8. Dented.
9. Corrosion—iron is indicated by rust red but can be orange/brown; copper is indicated by green or black; aluminium is indicated by a dull silver colour.
10. Organic growth—this can be moss, algae, lichen, vines or any other plant matter.
11. White crusts—caused by crystallised salts on the surface.
12. Chalky or powdery surface—loose material is easily transferred to your hand when touched.
13. Spalling—small pieces breaking away from a surface.

PART 4: OWNER/ADMINISTRATOR

4.1 It is very important to establish who owns the work, because that agency or body are responsible for its long-term care and maintenance. The researcher will need to check local Council records and, if the owner cannot be clearly identified from these records, it may be necessary to carry out a Land Titles search. It is usually the case that whoever owns the land is responsible for the maintenance of any structure on that land.

PART 5: HISTORY AND IMPORTANCE — OR SIGNIFICANCE—OF THE WORK

This section is to be completed at your local library, historical society or Council.

5.3 What is the history of the work?

- (a) Why was it made?
- (b) Are there any original drawings or records of the work? Who owns these materials?
- (c) Are there any historical photographs of the work? For example, of the opening ceremony; and any others which may illustrate changes to the work or its surrounds.
- (d) Are there any books or other references to the work?
- (e) Has the work been altered in any way—other than through decay? For example, have parts been added—plaques perhaps—or have the surrounds been changed—was there once a fence?

5.4 What is the importance—or heritage significance—of the work?

Is the work:

- (a) associated with events, or developments in history?
- (b) associated with important people?
- (c) rare?
- (d) of high aesthetic quality?
- (e) a creative or technical achievement?

What value does the work have for the local community?

- (a) Observe how people react to the work.
- (b) Listen to people's comments about the work.
- (c) Ask them whether the work is of special value to them.
- (d) How does the community use the work? Is it the focus of events?

What you can do— general do's and don'ts

Maintenance

Regular maintenance is important if an item and its surroundings are kept clean and tidy and appear cared for, the item is less likely to be vandalised.

This also helps to raise public interest in the piece, which means that any vandalism that does take place is more likely to be reported and can be dealt with swiftly.

If maintenance is done regularly, you are more likely to notice problems as they occur, and can deal with damage earlier.

Maintenance includes:

- washing surfaces regularly with water and sponges. This prevents a build-up of dirt on the surface, which not only looks unattractive but can lead to staining, particularly in the case of porous stone items. Make sure that water is not left pooling on the object; dry it with rags if necessary;
- removal of bird droppings—the sooner the better. Bird droppings become acidic over time and can etch into surfaces. The longer they are left, the more damage they can cause. Bird droppings can remove patinas on metal objects; and
- clearing drainage outlets and weep holes. Many sculptures are designed with water outlets, to prevent water building up in unwanted areas. These holes are generally quite small, and easily clog up with leaves and debris. Clearing them regularly helps to ensure the longevity of the object.

Ground barrier

Display items with wheels—like carts—in such a way that the wheels are lifted up off the ground. This alleviates stress on the small areas of the wheels which are touching the ground, and prevents contact between the wheel and the ground.

This is important, because every time it rains the ground becomes wet and acts like a sponge around the wheel, creating conditions that will contribute to corrosion if the wheel is metal, and to rot and insect attack if the wheel is made of wood.

There should always be a barrier between a sculpture and the ground, unless the artist specifically wants the work directly in contact with the ground.

Grass and plants

If contact between an outdoor object and the ground is considered necessary, it is important to keep grass trimmed around the piece, because long grass will also hold moisture close to the surface of the object.

When you are mowing around outdoor heritage items, take care that small stones and sticks are not thrown up, because they can damage the item's surface. This is especially important with painted metal items, where a break in the paint layer can cause corrosion problems.

It is best not to whipper snipper close to outdoor heritage items because the whipper snipper action can cause damage.

Consider the positioning of plants around outdoor objects. Remember that overgrown bushes make it difficult to see the objects clearly. Plants can also cause damage, for example, by scratching the surface; by branches dropping onto the object; a faster build-up of leaves in drainage holes; damage to foundations from root growth; and by attracting insects which will attack the object.

Naturally, it is important to consider the heritage value of the planting as well. It is also important to note that well positioned planting can act as a windbreak on sites where dust and pollutants are problems for the objects.

Water

Look for areas where rain can become trapped and held against a surface. Where possible, alter the display technique to prevent this happening. If you are unable to make any alterations, it is important to set up a program of regular monitoring, so that you can identify damage early on and act to treat it.

Avoid watering the object when you are watering surrounding gardens. The garden may need water to survive, but outdoor objects do better without additional water.

Sprinklers often spread water horizontally, so that the water can enter areas of the sculpture protected from normal rainfall.

Coatings

Microcrystalline wax is often applied to bronze sculptures to protect them from damage—from both the environment and graffiti. Like all coating systems, it offers protection only if it is complete.

A coating system which has broken down can be more damaging to a sculpture than no coating system at all. So it is important to monitor the condition of the coating and renew it annually.

For more information

For more information on the care of bronze items and the application of coatings to bronze items, please see the chapter on Metals in this volume.

Graffiti

Graffiti can be a major problem. If the object has an anti-graffiti coating, then it is this coating which is damaged, not the object. If an appropriate system is used, it is far easier to remove a coating system than graffiti.

CAUTION:

Beware of coating systems which seal off stone surfaces, this can lead to spalling of the stone, as moisture trapped under the coating cannot escape and may build up pressure. If a graffiti coating is to be applied to the surface of a heritage item, it is recommended that a conservator is consulted for advice.

If graffiti needs to be removed from the surface of a heritage item, it is best to contact a conservator for advice before taking any action. The successful removal of graffiti is very much dependent upon the media used to apply the graffiti and the nature of the object which has been graffitied.

When consulting a conservator about graffiti removal, try to be specific about the amount of graffiti and what it looks like. Systems used to remove graffiti can be quite specific and the conservator needs specific information; this is particularly important if a range of graffiti media has been used, for example, spray can, pen or crayon.

It is best to remove graffiti as soon as possible. Graffiti invites more graffiti, and it is far easier to remove when it is fresh than when it has had several months to set.

If you are using solvents to remove graffiti from stone, you run the risk of driving the stain further into the object rather than drawing it out, as stone is extremely porous. It is best to use a poultice system such as Safest Stripper by 3M or Quick Strip when removing graffiti from stone.

CAUTION:

If you are using Quick Strip remember that even if the system used removes the graffiti, it may alter the colour of the underlying stone so that the ghost of the graffiti is still present. Do not paint over graffiti on a cultural heritage item.

Consult a conservator if you are considering using an air-abrasive cleaning system, such as sand-blasting to remove graffiti. Abrasive cleaning removes graffiti, but often removes a layer from the surface of the object as well.

If damage has occurred, what should and shouldn't be done?

There has been a lot of discussion recently about the appearance of outdoor cultural material. This discussion has focused particularly on bronze sculpture, but is equally valid for all outdoor artefacts.

It is only natural that outdoor materials will deteriorate, simply because they are located in a harsh environment; and in many ways this deterioration is a significant part of their history. If treatment gives them an as new appearance,

this visual history will be lost. In some cases this may be valid, for example, if the deterioration is threatening the existence of the object. However, in most cases it will be a matter of:

- consulting with the relevant people, that is, conservators, custodians, historians and the artist;
- weighing up a number of factors, such as the artist's intention, the relationship between the item and its site, and the historic or cultural significance of the piece; and
- taking into account the ethics of the conservation treatment.

These general guidelines are provided to help you if you have a damaged piece of outdoor cultural material.

If part of an item has broken off, collect all the pieces, wrap each piece separately and place the pieces in a clearly labelled box. Contact a conservator as soon as possible. Because the other half of the break is in an outdoor setting, it is best that the repair is done as soon as possible before the edges are worn by weathering, or before more damage occurs.

Do not repair stone with concrete. These repairs are usually unattractive; but they can also be damaging because the concrete can be harder than the stone. If this is the case, future cracks form in the stone, not in the concrete.

Heritage items should not be repainted. The original paintwork is an integral part of these items and can be damaged and destroyed by repainting. Consult a conservator if you feel that repainting is important for the future survival of any painted items.

Beware of replacing components of a heritage item to 'pretty it up'. It is often tempting to replace worn or damaged components, especially where the skills and technology are readily available; but you must be aware that it may interfere with the historic value of the item. Remember, an historic artefact is only as historic as the sum of its components. Consult a conservator if you are unsure about whether to replace components.

Avoid using sand-blasting and steam-cleaning to treat historic artefacts. While there are occasions when an air-abrasive technique will be necessary

to treat an item, sand-blasting is generally considered to be too abrasive. It causes loss of surface detail and pitting of the surface, which in metal objects can lead to accelerated corrosion. Steam-cleaning is often used on stone and it is also too harsh. It can cause loss of detail on delicate, stone surfaces.

If you need to use metal fixtures with metal outdoor objects, wherever possible use fixtures of the same metal as the structure to be secured. In this way you can avoid the problems of galvanic corrosion. If you cannot use the same metal, place an inert barrier layer between the two different metals.

Some outdoor sculpture is intended to deteriorate. Unless there is a public safety issue involved, these objects should be left alone to deteriorate slowly. Any work that must be done on the piece should always be carried out in consultation with the artist, if the artist is alive and accessible.

Outdoor cultural material in Australia's climatic zones

The climatic zones outlined below are broad categories; and conditions may vary within these categories, depending on the state of repair of your building and whether the building is air conditioned or not.

Arid

This climate is generally very dry, however, in arid areas, it is often very hot during the day and very cold at night. This wide fluctuation in temperature is matched by wide fluctuations in relative humidity, for example, from 75%–20% in a day.

When caring for outdoor materials in arid areas it is important to note that:

- insects can still survive;
- wood moved from more humid climates may be prone to cracking and splitting; and
- condensation may form on metal objects which become very cold overnight.

Dust storms effectively sandblast outdoor objects. It is worth considering strategic placement of windbreaks to prevent damage. If the objects are small enough you may want to have covers made. The covers can be put in place during periods of high wind.

Remember also that outdoor objects can be adversely affected by the dust raised when vehicles travel over dirt roads. Similar steps as those taken for preventing damage from dust storms should be considered.

If the area is very dusty, you may need to inspect items for dust and dirt build-ups, especially in periods of low rainfall.

Note: If your collection of outdoor cultural materials have been displayed in an arid environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

Temperate

A temperate climate is considered a moderate climate, however, temperate climates tend to have a greater range of temperatures than tropical climates and may include extreme climatic variations.

When caring for outdoor cultural material in temperate climates it is important to note that:

- freezing conditions will occur in some regions. Where water has entered cracks in stone and wood, freezing conditions can lead to splitting. Ice takes up more space than water and thus as the water freezes it opens up cracks in the material;
- seasonal fluctuations can lead to the splitting of wood; and
- extended rainy periods can accelerate corrosion in metals and can promote the growth of lichens, mosses etc.

Note: If your collections of outdoor cultural material have been displayed in a temperate environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

Tropical

These climates are characterised by heavy rainfall, high humidity and high temperatures.

When caring for outdoor cultural materials in high humidity conditions, it is important to note that:

- insects, lichens, moulds and plants thrive and reproduce rapidly;
- metal corrosion will be accelerated;
- wooden components of objects will take up water and hold it. If the wood is in contact with metal components, metal corrosion will proceed faster in these areas; and
- deterioration, particularly of plastic components, due to light and UV radiation will be accelerated.

Because the rate of deterioration is likely to be quite rapid, it is important to check items for damage and carry out maintenance more regularly than in other climatic zones.

Carry out the maintenance of coatings on metal components during the dry season, when there is less moisture present. In this way you are less likely to trap moisture between the coating and the metal.

Note: If your collections of outdoor cultural material have been displayed in a tropical environment for a considerable period and they are stable—**do not** try to alter the environment to meet the recommended ideal conditions. This could do more harm than good. The emphasis should be on long term stability.

Coastal Regions

Coastal regions generally have more moderate climates than inland areas but they also have high levels of wind-borne salt. Consideration must be given to counteracting the corrosive effects of salty air.

When caring for outdoor cultural materials in coastal regions it is important to note that the presence of moist salty air is going to lead to high levels of corrosion and damage from windborne particulates. It is, therefore, vital that metal components are treated, coated and frequently inspected in these conditions.

Take all steps possible to reduce water retention. These steps include ensuring there is good drainage and clearing weep holes.

It is better to display outdoor cultural material away from the sea front. Windbreaks would also assist in protecting items.

It is important to monitor items for the formation of salt crystals, and concrete and stone should be checked for spalling.

If you have a problem related to the care of outdoor cultural material contact a conservator. Conservators can offer advice and practical solutions.

Self-evaluation quiz

Question 1.

Which of the following statements are true?

- a) Objects in an outdoor setting have been designed to be there and should last a long time without attention.
- b) Acid rain is only a problem in the city—regional areas are not affected by pollutants.
- c) Plants and mould can severely damage items and, if allowed to continue growing, will continue to cause damage.
- d) Bird droppings don't look too good, but they don't cause any damage.

Question 2.

Regular maintenance of outdoor material and its surroundings is important because:

- a) people are more likely to care for objects that appear well cared for;
- b) vandalism is less likely to occur;
- c) you are more likely to notice problems if you are regularly examining and caring for an item;
- d) the sooner problems are dealt with, the less damage is likely to occur;
- e) all of the above

Question 3.

Which of the following should be included in a maintenance program for your outdoor objects?

- a) Regular whipper snippering close in to the base of objects to remove long grass.
- b) Regular washing with water and sponges, followed by drying with rags if necessary.

- c) Removal of bird droppings as soon as possible.
- d) Ensuring that the surrounding plants and grass do not become too overgrown.
- e) Watering the object in dry weather to ensure that it does not dry out too much.
- f) Clearing drainage outlets and weep holes so that they do not become clogged.
- g) Removing graffiti as soon as possible in consultation with a conservator.

Answers to self-evaluation quiz

Question 1.

Answer: c) is true. a), b) and d) are false. Objects in an outdoor setting are exposed to almost all factors that cause damage and deterioration and, although most are durable, they will deteriorate. Acid rain is not confined to the city: pollutants can travel over large distances, and fertilisers and crop sprays become pollutants when they are in the atmosphere rather than on the crops. Bird droppings become quite acidic as they age and can etch into the surface of outdoor objects.

Question 2.

Answer: e).

Question 3.

Answer: b), c), d), f), and g) are all valuable parts of a regular maintenance program. a) and e) should be avoided.

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