Canadian Conservation Institute
Institut canadien de conservation

CCI Notes 5/1

Care of Ceramics and Glass

Introduction

Many of the problems encountered with ceramics and glass can be avoided through proper handling and storage. This Note provides guidelines on the care of ceramic and glass objects in museum collections.

Ceramics

Ceramic objects are as varied as the cultures that produced them, in terms of their construction, composition, style, and use. Generally, however, they have a clay body, often with a glaze applied to the surface. The body (also known as the fabric) consists of clay minerals, temper, and impurities. Temper can be any particulate material used as a filler that helps reduce shrinkage and allows gases to escape when the object is fired. Tempers include sand, shell, chalk, mica, and ground-up fired ceramics. Organic material, which sometimes burns away during firing, can also be used as a temper.

Pure clays are white; it is the impurities associated with clay minerals that cause their particular colour. Iron, the most common colouring compound found in clays, imparts red, grey, and buff tones to the ceramic. The colour of the ceramic fabric is the result of the impurities present in the clay and the conditions under which the object was fired.

Glazes are sometimes applied to decorate or waterproof an object. A glaze is a layer of glass fused to the clay fabric. To prevent the glaze from cracking when the ceramic is fired, the thermal expansion and contraction properties of the glaze should match those of the clay fabric.

Glazes are composed of silica and fluxes such as sodium, potassium, calcium, and lead. Colorants, mostly metal oxides, can also be added. Fluxes lower the melting point of silica and can change the physical properties of glazes, such as the degree of hardness and resistance to chemicals. Silica is either derived from the body of the ceramic or added separately. For example, in forming a “salt” glaze, salt (sodium chloride) is added to the kiln as the ceramic is fired. The salt vaporizes at a high temperature and the sodium combines with the silica in the ceramic body, forming a characteristic thin, orange-peel textured glaze. The chloride goes off as a gas into the atmosphere.

Ash, which contains the fluxes sodium and potassium, can be applied directly to a ceramic fabric to create a glaze. Oriental stoneware vessels were often decorated with ash glazes. Like a salt glaze, ash glazes form at a very high temperature.

Lead glazes can be created in three ways: by applying lead oxide directly to the surface of the ceramic, by mixing it with silicates in a slurry, or as a frit. “Frits” are glazes that are made by melting silica with fluxes to form glass, which is then ground to a fine powder and applied to the ceramic. Lead glazes have a lower melting temperature than ash or salt glazes, and are the most common glaze on pre-19th-century European ceramics. If the lead was applied in a frit that was not properly made, chances are high that the glaze will have been damaged if the vessel was used to hold acidic liquids, such as orange juice, vinegar, or wine.

A variation of the pure lead glaze is the opaque white glaze, known as majolica, delft, or faience, which is produced by adding tin oxide to a lead glaze. This addition lowers the melting point of the glaze even more.

Decoration such as paint or precious metals can be applied over a glaze. Objects with overglaze decoration are particularly susceptible to physical and chemical damage during handling or cleaning.

Ceramics that have been fired at high temperatures generally have a hard, glassy fabric and a securely attached glaze. Ceramics with soft, porous fabric or poorly attached, flaking glaze have usually been fired at lower temperatures, unevenly fired, or, in some cases, may not have been fired at all. These characteristics affect the stability of a ceramic and its ability to tolerate adverse environmental conditions.

Pottery that has not been fired in a kiln, such as some prehistoric North American pottery, can be very soft and crumbly. These objects can be extremely fragile when they are recovered from an archaeological site after spending several hundred years buried in the ground.

Glass

Like glazes, glass is composed of silica, fluxes, and colorants. It is an amorphous material, i.e. it lacks the orderly three-dimensional network that characterizes a crystalline solid. Although glass is rigid and hard on cooling, the atoms of glass are randomly arranged like the atoms of a liquid.

The physical and chemical structure of glass helps explain its transparency, brittleness, and characteristic deterioration. The arrangement of the atoms allows light to pass through without interference, and gives glass the transparent quality of a liquid. Brittleness results from a combination of factors: the rigid nature of glass, the internal stresses that are set up in glass as it cools, and surface flaws that concentrate applied stresses. Because glass is a homogeneous mixture with no internal boundaries or discontinuities, cracks in glass tend to spread.

Commonly used raw ingredients for glass include quartz (silica), mixed with sodium ("soda"), potassium ("potash"), or lead as fluxes, and calcium ("lime"), which acts to stabilize the glass. Small amounts of colorants are often used, including iron, copper, cobalt, and manganese. Lead increases the density and improves the optical qualities of glass.

The composition of glass, particularly the proportion of silica to fluxes and stabilizers, determines its stability. Glass should ideally be a homogeneous mixture; inhomogeneity can make the glass more susceptible to deterioration. If the proportions of the ingredients are wrong, the fluxes will react with water and leave a depleted and fragile surface (see "Weeping and crizzling" below).

The surface of deteriorated glass is sometimes iridescent. In extreme cases, thin layers of degraded glass resembling onion skin may form on the surface. Glass in this condition is very fragile, and the surface layers can disintegrate easily.

Like ceramics, glass can also have surface decoration that could be damaged during handling or treatment.

Problems with Ceramics and Glass

Weeping and crizzling

Weeping and crizzling are two forms of glass deterioration caused by incorrect formulation.

Weeping is characterized by the formation of liquid droplets on the surface of glass, creating a cloudy and disintegrating surface layer. It occurs when water vapour from the atmosphere leaches some of the components from the glass. Fluctuating relative humidity (RH) can make the problem worse. The liquid droplets may be very alkaline and can damage material with which they come in contact (for example, a textile with glass beads sewn onto it; see CCI Notes 6/4 *Care of Objects Decorated with Glass Beads*).

Crizzled glass has a network of very fine fissures on the surface. In the early stages of crizzling, cracks may be visible only under a microscope. If the condition is more severe, the glass can appear cracked and cloudy, with fragments of glass spalling from the surface.

To prevent or reduce these conditions, the RH and temperature of the environment must be controlled (see "Relative Humidity, Temperature, and Light" below).

Soluble salts

If a ceramic object has been buried in salty or alkaline soil, submersed in seawater, or used to hold salty material (e.g. chamber pots), its porous body may have soaked up soluble salts. These salts can react to RH changes: dissolving in high humidity and recrystallizing in low humidity. Dissolution and recrystallization can cause a loose glaze to flake off, or the surface on unglazed areas to spall. Keeping the RH constant helps to prevent this type of damage.

Handling

The general, common-sense rules for handling museum objects also apply to ceramic and glass artifacts. Unlike other materials, however, ceramics and glass are hard, brittle, and can easily crack or break on impact. Storage and display areas must be designed to prevent unnecessary handling.

Before picking up an object, study it carefully — particularly noting its condition and the extent of any restoration (see "Recognizing old repairs" below). Old repairs may be hidden and may have weakened over the years: a repaired object is always weaker than one that has not been broken. Do not pick up ceramic or glass objects by their handles or spouts because these can easily break off. Remove loose lids if necessary. Avoid touching applied labels or decoration. Use two hands to pick up objects. Make sure your hands are clean, dry, and free of bulky jewellery. DO NOT WEAR GLOVES. When handling ceramics and glass, wearing gloves is unnecessary and inadvisable. Your skin can grip the object properly. You need your sense of touch to hold a slippery object.

Relative Humidity, Temperature, and Light

Ceramics and glass are generally less sensitive to extremes or fluctuations in humidity, temperature, and light than other materials (e.g. wood, ivory). However, this applies only to objects in good condition, and not to those with any of the problems discussed above. Identifying the early stages of deterioration can be difficult, so treat all pieces as if they are potential problem cases. Protect these objects from extremes or rapid fluctuations of temperature or RH.

Objects in good condition can be safely stored or displayed with mixed collections.

Glass that shows signs of active weeping or crizzling should be kept in closed containers where the humidity can be kept as constant as possible. Sudden drops in RH to below 40% or rises to above 60% can damage deteriorated glass.

Avoid temperature extremes, particularly rapid temperature changes. This causes expansion and contraction, which may result in breaking or cracking. Never heat glass, or put it in a sunny place or under spotlights where it might become very warm.

Some types of glass are adversely affected by ultraviolet radiation. For example, colourless glass sometimes includes a small amount of a decolourizing agent, such as manganese dioxide. When exposed to ultraviolet radiation, this type of glass will turn purple in a process called solarization. Glass should not be stored or displayed in direct sunlight unless ultraviolet filters are used.

Storage

Ceramic and glass objects are easily broken when dropped or jarred. Store these objects so they are protected from physical damage. Also, protect them from dust and grime to reduce the need for cleaning.

Store objects on shelves or in cupboards that will not be subject to vibration or jarring. Keep them easily accessible and visible so that handling is minimized. Line shelves with soft, non-fibrous padding such as polyethylene foam sheeting. A fibrous padding, such as polyester batting, may snag on fragile or flaking surfaces. Objects that cannot stand safely on their own should be supported so that they cannot move. For example, a top-heavy object can be placed on its rim rather than its base; or a padded, concave support can be made for a round-bottomed vessel.

Cleaning and Repair

Ceramic and glass objects in good condition can be safely cleaned to remove surface dirt. Remove loose dirt with a soft bristle brush; a cloth may snag on fragile surfaces. Washing with tap water is acceptable, but distilled or deionized water is preferable. Water temperature should be lukewarm or cooler. Do not use detergents. Glass and ceramics should be air-dried very slowly. Never use heat to reduce drying time.

Washing glazed pottery is usually a straightforward procedure. Before washing a piece, however, make sure that the glaze is not flaking off and that any painted, gilded, or printed designs are not coming off and are not soluble in water. Unglazed, or soft, crumbly, unevenly fired ceramics can be destroyed by washing. Low-fired ceramics should not be washed because the soft clay will turn to mud when exposed to water.

Undecorated glass, if not deteriorated (i.e. not weeping, crizzled, or flaking), can also be washed with clean, lukewarm water. A small amount of ethanol (about 5% by volume) can be added to act as a wetting agent. It will not damage glass or ceramics in good condition.

If an object is badly stained or has concretions on it that cannot be removed by washing, do not try to clean it with the bleach or acid formulations often recommended in many "how-to" manuals. If cleaning an object is important, consult a conservator. A stain on a piece of pottery may be disfiguring, but not harmful. Trying to dissolve the stain may dissolve parts of the artifact. Professional ceramics conservators will not try to remove stains at the risk of damaging the pottery, and can give advice on whether a piece should be cleaned for cosmetic reasons.

Repairing ceramics is a specialized skill, combining practical experience and knowledge of the chemistry and working properties of the adhesives and fillers that are safe to use. Amateur repairs done with unstable adhesives, such as five-minute epoxies, and the use of repair kits can irreparably damage ceramics. More pottery is damaged by careless handling and inexpert repair than by any other single cause.

Recognizing old repairs

Most old repairs on ceramics are easy to spot because they were done poorly or the adhesives and paints used have discoloured. Old adhesives often become insoluble as they age, making removal difficult. But even though an adhesive is impossible to dissolve, it may still have lost its ability to act as an adhesive. If a piece has yellow, brittle adhesive on it, assume that it is fragile and might fall apart. A common type of damage in collections of soft or crumbly pottery is caused by brittle adhesive that is shrinking away from the broken edges and pulling off the ceramic surface at the break. The result is an object that no longer has well-defined joins between the pieces. Objects damaged this way are very difficult to restore.

If an adhesive must be removed, consult a conservator. The solvents used to dissolve adhesives are both health and fire hazards.

Sometimes repairs are difficult to detect. Examining an object under ultraviolet radiation will reveal adhesives, paints, or fills that are not part of the original ceramic. This should be done by a conservator familiar with the procedure. Some old repairs are interesting historically. Metal rivets were commonly used to hold pieces together, especially on objects that were used even though broken (e.g. large platters, decorative plaques). If the rivets are iron or copper, the pottery may be stained by metal corrosion. Do not remove the rivets unless they have come apart and are not holding the pieces firmly together, or are seriously disfiguring the object. Rivets or wires may be difficult to remove. Consult a conservator for advice.

Conclusion

Ceramic and glass objects require the same type of clean, environmentally controlled conditions as other objects in a museum collection. However, because ceramics and glass can be more easily broken than other materials, storage and display areas must be organized to minimize handling. Museum personnel should be discouraged from mending pottery unless they are fully aware of the nature of the ceramic and the materials used for repair, and have the skill to do the job.

Chemical cleaning, repair, and restoration should be left to a conservator.

Suppliers

Polyethylene foam sheeting:
packaging firms

Ethanol:
drugstores, liquor stores

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