CURRENT TRENDS IN TEXTILES CONSERVATION AND PRESERVATION

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Abstract. A review, for collectors, curators and others entrusted with the care of textile art and artifacts who are not trained in conservation or conservation science, of the factors affecting the degradation of textiles and the means used to stabilize and preserve these objects.

Introduction.

Conservators are often considered to be analogous to physicians: experts, trained in arts and sciences unfamiliar to the laymen, who act in an advisory capacity with the intent of protecting the well being of their clients. As physicians are best able to serve patients who have some awareness of the principles of health and hygiene, so conservators are best able to serve those clients who have some knowledge of why it is that materials decay and how the processes may be retarded. In this paper the factors affecting degradation, the principles of preventive storage and maintenance, and current textile conservation practices are reviewed with the purpose of improving the interactions between conservators and their clients.

The make-up of fibers.

Almost all textile materials are composed of fibers. Fibers, with few exceptions, are made up of very large molecules known as polymers or macromolecules. Macromolecules may be modeled as long, thin, flexible chains which can fold, curl and wind within themselves or amongst other like molecules. Among the more useful properties of polymers are their ability to form extended networks with high strength and flexibility. Thus, it is their internal polymeric structure that, to a great extent, gives fibers their useful characteristics. When polymers are reduced in size by splitting of the chemical bonds which maintain the links of the chain, they are less able to flex and also lose their ability to form extended networks. This reduction in molecular size leads to concomitant losses in fiber properties, so that the fibers become weak and brittle.

Factors affecting degradation.

The major environmental factors which lead to the destruction of polymers are: Light, heat, humidity, oxygen, air pollution and biological agents. Each of these is discussed below.

Light.

The portion of the electromagnetic spectrum of interest extends from about 180 nanometers (billionths of a meter - nm) to about 1000nm, and encompasses its ultraviolet (UV), visible and infrared (IR) portions. Atoms can become excited by absorbing light energy. Ultraviolet light is energetic enough to cause the breaking of chemical bonds and the splitting of molecules. Visible light does not have the energy required to break molecular bonds, but can provide enough energy to initiate or accelerate chemical reactions. Infrared radiation generally acts to increase the temperature of the material that absorbs it.

Textile materials exposed to UV light for extended periods exhibit decreases in molecular weight which lead to discoloration, loss of strength and embrittlement. The effect is cumulative. Fabrics exposed to light, returned to dark storage and reexposed do not heal themselves. In addition to sunlight, fluorescent lamps are also UV sources, so that they should be covered with UV-absorbing filters or replaced with incandescent lamps. In general, textiles on exhibit should be protected by UV-absorbing filters. Even though window glass is a good absorber of UV light, transmitting less than one percent of incident UV radiation from sunlight, filters on windows provide a much higher level of protection, which is particularly important for objects on long-term display.

Visible light, whether from sunlight or lamps, contributes to the destruction of textiles by two processes: (1) by directly exciting macromolecules enough to cause them to react with other chemical species or (2) indirectly by raising the temperature of materials and, thus, accelerating the rates of chemical reactions. The effect of visible light, like that of UV light, is cumulative, and a light level of less than five foot-candles (50 lux) is usually recommended for fabrics on exhibit. Infrared radiation raises the temperature of fabrics and affects fibers indirectly.

It should be noted that colored textiles may be more likely to be harmed by light than plain materials. Both UV and visible light can cause dyestuffs to be chemically changed, leaving a faded or discolored fabric. In addition, some dyes, in the presence of light, can induce chemical attack of the fiber, particularly in humid atmospheres.

Heat.

A rise in temperature increases the rate of chemical reactions. A rule of thumb estimate of this effect is that a rise of 5 degrees, from about 25 to 35°C, approximately doubles the reaction rate. In addition, an increase in temperature can permit new reactions to occur. Textiles are best preserved when kept at low temperatures. It should be noted, however, that at temperatures below freezing, absorbed moisture can form ice crystals within fibers, and that these crystals can disrupt the structure of the fiber and even destroy it. In addition, fabrics kept in cold storage should be allowed to reach room temperature in a dry atmosphere to prevent moisture from condensing on the cloth. They should also be dried prior to returning them to cold storage.

Humidity.

Changes in humidity induce both mechanical and chemical changes in textiles. Increased atmospheric humidity leads to a rise in absorbed moisture and usually enhances those chemical reactions which lead to chain scission and destruction of fibers. The increase in rate of degradation may come about because the swelling induced by moisture absorption permits other chemical species to invade and react with the fiber, or because an increase in polymer mobility permitted by the infusion of water retards those processes which limit the extent of chemical reaction. The swelling caused by the absorption of moisture enough to cause cracking of the fiber. Repeated shrinking and swelling brought about by changes in atmospheric relative humidity can lead to the destruction of fibers.

Shifts in relative humidity take place on a long-term, seasonal basis, and also, on a short-term basis. Rapid, short-term variations are usually more destructive to fibers than are the slower, long-term shifts, even though the magnitude of the change may be less. This is because fibers can accomodate a slow dimensional change by rearranging their molecules. Rapid change, even though of lesser magnitude, does not permit molecular rearrangement to take place, so that high stress levels are induced in the fiber. Stress buildup over long periods can lead to sudden disruption of the fiber.

It should be noted that liquid water can cause very rapid swelling and induce very high stress levels in fibers. Old, fragile textiles should not be subjected to conditions where liquid water may condense on them, nor should they be subject to laundering without careful consideration.

Oxygen.

Atmospheric oxygen will react with almost all textile fibers. Oxidation usually occurs in a random, nonspecific attack along the polymer chains, and leads to a number of chemical species. Some of these can induce chain scission, while others make the fiber more susceptible to destruction by other chemical entities, such as acids and alkalies. The effect of extensive oxidation is extreme embrittlement and weakening of the fabric, usually accompanied by fading of colorants and discoloration of natural fibers.

Pollutants.

Atmospheric pollutants such as sulfur dioxide, oxides of nitrogen and soot can cause rapid and extensive damage to textiles. Sulfur dioxide (SO_2) is generated from the burning of coal, oil and other fuels containing sulfur. It can combine with moisture to form sulfuric acid (H_2SO_4) on fiber surfaces. The acid thus formed is highly concentrated, active and difficult to remove. Nitric acid (HNO_3) may be formed from a variety of nitrogen oxides, the major source of which is automobile exhausts, and although less active than sulfuric acid, can still damage fabrics. Soot arises from the incomplete combustion of fuels, and consists of tiny particles of carbonaceous material covered with a thin film of oil. The oil helps the soot particles stick to materials and also oxidizes to form organic acids. Thus, soot not only soils cloth, but also can help destroy it. Destruction of textiles by atmospheric pollutants can be reduced through the use of appropriate filters.

Biological attack.

All natural fibers, and some man-made materials, are food for other organisms. This is Nature's way of recycling resources. Mildew is a mold that will readily grow on cellulosic fibers. Mildew attack is easily detected by the musty odor given off by the mold. If allowed to reproduce, mildew breaks down cellulosic fibers to the starch upon which it feeds. As the organism grows, it inserts tendrils between and within fibers, leaving a black residue that is very difficult to remove.

Mildew usually develops on fabrics in storage rather than those on exhibition. It may be combatted by keeping the storage area dry, and maintaining good air circulation. In its early stages, mildew may be destroyed by exposing the fabric to outdoor sunlight and clean air. Advanced mold growth may require more drastic treatment, such as chlorine bleach. Note that the treatment can also damage the fabric, and should not be undertaken without careful consideration of the consequences.

Protein fibers are more resistent to molds, but are a food source for a variety of insect larvae. Insect infestation is more difficult to combat than mold growth, but dry well-aired storage facilities are a good barrier. Moth balls and other moth repellents are not always effective. In addition, insecticides may damage fabrics and decorative objects on costumes. Should infestation occur, a licensed exterminator should be consulted.

Summary.

Keep objects away from light. Ultraviolet and visible light enhance the destruction of fibers. Incandescent lamps are preferable to fluorescent lamps and natural sunlight. Ultraviolet filters should be used wherever possible. Lamps should be kept away from objects in order to keep the fabric from being heated. Light levels of 5 foot-candles (50 lux) or less should be maintained.

Keep objects cool. Increasing temperature increases the rate of degradation. Do not expose cold objects to moist atmospheres. Do not store fabrics at temperatures below freezing.

Keep objects dry. In storage very low relative humidities may be used. However, dry fibers are more brittle than moist ones, and will break more easily. Maintaining the relative humidity between 40 and 55 percent seems to be a good compromise.

Protect against soot and other air pollutants with filters and dust covers. Acid-free tissue paper makes a good filter, while washed muslin is both a good filter and a good cover. Plastic bags will permit moisture to condense on fabrics and also contain volatile plasticizers which may harm fabrics.

Preventive storage.

Under ideal conditions, storage facilities would be climate controlled with a temperature of about 68–72°F and relative humidity of 45–55 percent. An air lock would be used to prevent the intrusion of dust, and the entire facility would be sealed to keep out insects. Filters in the air circulation system would trap dust, molds and air pollutants and would be changed on a regular basis. Each object would have its own closed storage unit, and a central filing system would provide a record of where each object was along with its description. The whole facility would be protected from fire and other disasters by an internal fire/flood control system and a security force would prevent theft and vandalism.

However, since most collections must be maintained on a limited budget, storage facilities are usually less than ideal. It is possible to properly care for textile objects, even within the confines of a small budget if the following points are noted: (1) objects should be subject to as little stress as possible, (2) they should be kept from contact with foreign materials (including your hands), and (3) they should be inspected on a regular basis, usually about twice yearly.

As they age, textiles are less able to withstand the stresses of being pulled, crushed and flexed. Thus, handling should be kept to a minimum, and objects should be stored in a manner that will minimize stress. Most flat textiles can be stored flat on shelves. Even materials that must be folded to fit can be stored this way. Acid-free tissue paper, bunched to provide a cushion at the folds, should be placed between fabric layers. It is important that flat fabrics not be stacked too high to prevent crushing the bottom layers. The strongest materials, of course, go on the bottom. Shelves, may be of any material, but wood and metals ought to be varnished or painted to protect the cloth.

When possible, large flat fabrics should be losely rolled around acid-free cardboard tubes with Mylar film and acid-free paper. The tubes can then be hung horizontally under dust covers. Costumes are often best hung in cabinets, taking care to provide padded hangers, support straps and dust covers. Do not overfill the closet to avoid crushing costumes against each other.

The storage area, even if it is not air-conditioned, should be kept dry. This can be accomplished by the use of dehumidifiers in the warm months and heaters in the winter. It may be necessary to add moisture during the winter to keep materials from becoming too dry. Note that changes in moisture content are more stressful than changes in temperature.

Conservation practices.

The most important rule in conservation is, "IF IT AIN'T BROKE DON'T FIX IT". Objects which have managed to survive for hundreds, or thousands, of years will not suddenly fall apart if they are not given immediate treatment. It should be kept in mind that contemporary conservation practice is based on the philosophy of preserving objects rather than restoring them to their "original" condition. This philosophy has as its practical consequence the desire to avoid intrusive procedures whenever possible.

Typically, conservators prepare a condition report listing all of the problems present in an object. This report is followed by a proposed treatment plan listing all of the procedures to be applied, often with appropriate justification. Photodocumentation of the object before treatment is provided.

Cleaning procedures include vacuuming through screening to remove surface soil, washing, drycleaning and spot removal. Bleaching may be justified in some cases, but the majority opinion is that bleaching for esthetic purposes does more harm than good. It should be noted that all cleaning procedures are potentially harmful and should not be undertaken without careful consideration of the consequences.

Reinforcement of worn or torn areas may be accomplished by stitching or gluing a support fabric to the object. Common household glues are NOT appropriate, and their use is harmful. Sewing techniques, although based on classical tailoring and sewing, often employ threads and stitchery in uncommon ways so as to minimize stress on the object. In addition, unlike usual sewing techniques, mending is always done so as to be obvious to future researchers.

Support systems for textile objects may be as simple as stitching a silk backing to the fabric, or may require a variety of plastics, fabrics, films and metals to build a support structure. In all cases, the support structure should be designed with the mechanics of the object in mind.

When in doubt consult your conservator.

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