PRESSURE SENSITIVE TAPES AND OUR CULTURAL HERITAGE

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Introduction

Historical evidence tells us that the first pressure sensitive tapes found their way into museums and onto valuable artifacts soon after they became available in the late 1920’s. Tape quickly became a ready tool used by those charged with the care and study of cultural treasures worldwide. Curators, librarians, archivists, archaeologists, collectors and art dealers applied tape to books, paintings, sculpture, ceramics, metal objects, archaeological finds, paper artifacts, textiles, glass and even unlikely materials such as mineral specimens and birds eggs. Tapes were used for repair, identification, and protection on an astounding array of museum collections. A conservative estimate of museum objects affected by tape must certainly number in the hundreds of thousands. One aspect of the situation is very clear—many individuals who cared for such valuable objects placed an enormous amount of faith in tape as the solution to a multitude of problems.

The Role of Conservation

Responsibility for the longevity of the objects that are part of our cultural heritage lies primarily in the hands of the conservation profession. Conservators are multidisciplinary professionals who have studied art history, chemistry, materials science, and the history of materials. The profession also requires proven ability in the studio arts. During their training conservators choose a specialization such as paintings, paper, wooden artifacts, metals, or textiles, and some subspecialize in areas such as stained glass, ivory, or outdoor sculpture. A convenient way to think of conservation is to compare it to the medical profession. Conservators care for the long-term health of culturally significant objects. One important distinction is to be made however. Where the physician takes the “cradle to the grave” approach, the conservator strives to maintain an object in perpetuity. The modern conservator is bound by a code of ethics, codified in the United States by the American Institute for Conservation of Historic and Artistic Works, headquartered in Washington, D.C.

Before the rise of the modern conservation profession, repair of artworks was often done by professional restorers. These individuals used proprietary and sometimes destructive methods to “restore” objects to a good visual state with little regard for the long-term stability of the object. Some carefully guarded their methods and took their trade secrets the grave. By contrast, conservators work in a disciplined holistic manner that includes knowledge of all aspects of the object, and make informed decisions in the selection of the materials and techniques used to conserve it. Exchange of information is of the utmost importance to the practicing conservator. Although our group is small in number (a few thousand conservators scattered worldwide), we are closely aligned in our ethical stance as well as in our research efforts. The United States has the lion’s share of conservation professionals and laboratory facilities, many of which are supported by federal and state grants.

The Conservation Point of View

When conservators apply their knowledge, training, and ethics to the evaluation of pressure sensitive tapes, they see many things that they do not like. Most conservators associate tapes with damage to
artifacts. The degree of damage that tape can cause to a museum object varies widely. It follows the principles of deterioration based in materials science and therefore should not be a surprise to those with technical knowledge. Objects made up of organic materials are the most susceptible to damage by the physical and chemical changes that occur when tape ages. Metals, ceramics, and glass objects suffer less, although remarkable damage to these objects is well documented. Most conservators have seen glazes pulled away from ancient ceramics where the bond between the tape and the glaze is stronger than between the glaze and the clay body. Metals can corrode by proximity to tapes due to acidic outgassing trapped in closed environments such as exhibit cases. The surface of plastic objects can be softened by contact with plasticizers in tape adhesives. Adhesives prone to cold flow can imbibe small particles such as pastel and graphite. Media such as ball point pen and typewriter inks can become solvated by the tackifier and plasticizer components in tape, and pH dependent dyes can shift in color from the alkaline fillers.

By and large it is the book and paper materials (including photographs) in museums, libraries, and archives which have sustained the greatest amount of damage from pressure sensitive tapes. The task of ameliorating damage from well intended but uninformed attempts to mend, reinforce, label, or protect paper objects with tapes falls to the paper conservator. The removal of degraded tape from paper is certainly one of the most demanding processes performed in conservation work.

Paper conservators evaluate tapes in ways that differ significantly from industry practices. First and most importantly, the paper conservator studies tape as a prelude to its removal from a paper object. Second, pressure sensitive tapes are tested for potential use by the conservator in preservation work. In the first instance, many of the tapes that the conservator sees prior to removal have interesting features in common. For example, most have long outlived their intended lifespan. Tapes from the early days of the industry are seen, datable because they are attached to archival documents. Who would have anticipated that 1930 vintage tape would still be functioning in the new millenium? Also, the tapes have aged naturally under unknown and quite variable conditions. It is only within the last 30 years that climate control in museums has become the norm. Prior to this practice, many collections were housed in poor environments, which, unfortunately, were conducive to the deterioration of most materials (including tape). Another commonality is the widely varying kinds of paper that tapes have been placed on. This range extends from the fine quality early hand made papers to the notoriously unstable groundwood papers of modern times. Papers have sizings, coatings, fillers, dyes, and colorants, all of which add complexity to the interaction with tape. All manner of paper based media can interact with tape. The presence of writing and printing inks, watercolor, electrostatic media, and felt tip marker can complicate or even preclude the removal process.

The obvious lack of long term stability of pressure sensitive tapes contributes greatly to conservation’s negative view of the product. The industry knows that every tape has a performance life and a shelf life, and that users should not expect performance to be guaranteed beyond the specified period. Industry test methods such as artificial aging provide comparative data for tape longevity expressed in months or years, but do not commonly provide data for long term tape performance. The poor aging characteristics of pressure sensitive tapes are well illustrated by comparing average performance expectations with the anticipated lifespan of a museum object. When viewed within the ethical precepts of conservation, all pressure sensitive tapes are not only short-lived, but also potentially very damaging. Tapes are ephemeral by nature. Simply because they happen to be placed on a valuable object does not mean that they were ever designed to function far past their chemical and physical capabilities.
The preservation community views the use of tapes on valuable artifacts as a damaging practice. The use of tape on permanently valuable objects is prohibited in the written collections care policies of many major institutions including the U.S. National Archives and the Library of Congress. Related products such as self-stick notes are also banned under these policies.

Conservation Treatment Methodology

The assessment of the condition of a paper artifact is done in a systematic way. The conservator considers the observations made during visual examination, and the results of physical and chemical testing. Visual examination is done with conventional lighting as well as with specific wavelength sources in the infrared and ultraviolet. Mechanical testing is done when it does not endanger the paper; for example the machine direction of a paper can be determined by comparing relative stiffness when the paper is gently flexed in opposing directions. Microchemical testing is done on very small samples removed from the object. This testing can provide information such as the type of sizing, the nature of colorants, or the fiber source. In some cases instrumental analysis is used to gain additional information, although this is far from common practice. If a pressure sensitive tape is present on the object, the conservator uses the same examination protocol to assess its impact on the paper and any media which may be present.

A good example to illustrate examination and treatment methods is an artwork on paper onto which a rubber based cellophane tape has been applied. A classification system is used to determine the degree of degradation of the tape, a factor that is critical to planning the removal strategy. In stage one, called the induction stage, the tape seems healthy. The adhesive is functioning well, the carrier is stable, and no discoloration is apparent. In stage two, called the oxidative stage, the carrier is still present, but the adhesive is stringy and overly sticky. During this stage volatiles such as plasticizers are lost, and the rubber elastomer is actively oxidizing. The tape may be discolored from the cumulative effect of a number of chemical changes. In stage three, called the crosslinked stage, the adhesive has failed, and the carrier is gone or will come off easily. The adhesive is brittle, highly discolored, and the paper to which it is affixed is translucent from penetration of the adhesive. After the stage of deterioration is determined, other observations are made, such as whether there is plasticizer migration or dimensional change in the carrier. Microscopic examination can show if underlying media have been affected, and crossed polar viewing can help determine the carrier material.

Adjunct to the physical examination, the conservator consults the historical record of the object and can sometimes learn when the tape was applied. With a date established, the next step is to consult industry literature to discover what components might be present in the tape. Unfortunately, there is no comprehensive history of tape production, and most companies do not maintain an archive or have an historian on staff. Often the historical technical information that the conservator needs is simply unavailable. The evaluation of the tape in context of conservation treatment is, therefore, a deductive task where the conservator attempts to assemble a comprehensive picture of the problem from many sources.

The next step after examination is development of a treatment strategy. A crucial series of tests to determine the solubility of the tape adhesive is performed at this point. Bear in mind that the ideal solvent for the adhesive might solvate a dye or optical brightener in the paper or any media present.
The testing can be a tedious and frustrating chore, but identification of the stage of deterioration can narrow the choice of the most effective solvents. For this reason, paper conservators are very interested in the shifts in solubility properties of a rubber based adhesive as it ages.

Over the past 40 years, paper conservators have developed a variety of tape removal methods. These include the use of heat, the use of solvents in liquid, vapor, and gel forms, the use of porous membranes such as Goretex®, poultice methods, and techniques that employ purpose-built suction devices. Returning to our example, the following steps describe a typical approach to removal.

The carrier is removed (or may already be gone). The brittle adhesive mass is reduced by gentle abrasion with a small brass brush. This work is done with the aid of a binocular microscope so that no paper fibers are disturbed. Solvent treatment can now begin. The decision to use solvents presupposes that the adhesive, media, and paper have all been thoroughly tested for the suitability of the solvent, and that its use and method of application will not result in damage. In all instances the conservator observes appropriate health and safety precautions in solvent handling and use. Care in the selection of the solvent application method is critical; the conservator must be able to control the movement of the solvent at all times. One option for solvent application is immersion of the object in a solvent bath, however most objects require local application methods (such as when the solvent work needs to be done in close proximity to a soluble ink). The safest method for local application is with the use of a suction disk or platen. These devices are manufactured for the conservation field and consist of a suction pump attached to a flat surface through which the solvent can pass, such as fritted glass or stainless steel mesh. The waste solvent is collected for disposal and the suction device is vented to a laboratory fume hood. The suction device is covered with filter paper, and the object is placed on top. Polyethylene sheeting is used to mask off a small area of adhesive, and the solvent is applied with a small brush or micropipette. The solvent flushes the adhesive through the back of the paper and into the filter paper. Very small areas can be treated in this manner and lateral movement of the solvent is eliminated.

Local solvent application can also be done with poultices of Fuller’s earth or diatomaceous earth. The solvent is mixed with the poultice material and placed onto the tape stain. The charged poultice is then covered by more of the dry poultice and the pile is compressed. The resulting drying action based on capillarity can be extremely effective in drawing solvated adhesive into the poultice. Both suction work and poultice treatment are very time consuming. One square centimeter of paper can take upwards of an hour to treat. Immersion treatments may proceed faster, but costs associated with waste solvent disposal still make this method expensive.

A word on solvent selection is warranted here. Paper conservators tend to use very high purity solvents such as lot analyzed or HPLC grades. This choice eliminates variables in solvent behavior which can result with less pure solvents. Many technical grade solvents also have metallic impurities, such as iron, from storage drums. Not all organic solvents which work well on tape adhesives can safely be used on paper. Generally speaking, the chlorinated solvents are avoided due to their strength and the possibility of leaving chlorides in the paper. Tetrahydrofuran, an excellent solvent for rubber, is known to have negative effects on paper. If not flushed sufficiently with water, residual THF has been shown to form peroxides in paper. Most paper conservators use the Teas method for calculation of solubility parameters. This method permits calculation of the parameters of solvent mixtures, which can be of particular use in avoiding dangerous or problematic solvents. For example, a mixture of 50:50 acetone/ethyl acetate is close to methyl ethyl ketone in the Teas parameter system.
After a third stage crosslinked adhesive mass has been removed by solvent application, there are often brownish stains left in the paper. These stains are associated with damage to the cellulose caused by the inherent acidity of the adhesive. Hydrolysis of the cellulose, carbonyl formation, and the resultant chromophores account for the color change. In many instances these stains can be reduced by washing the area (also done on the suction device or by immersion) with deionized or re-calcified water. Occasionally a weak solution of sodium borohydride or ammonium hydroxide solution can be effective. Although stronger bleaching methods are available they are rarely used by conservators due to their questionable long-term effects on cellulose, especially in paper already degraded by tape damage.

The ultimate outcome of any tape removal treatment is difficult to predict. Success requires experience and training and the ability to correctly identify and diagnose the situation on a case by case basis. It is important to note that some pressure sensitive tapes cannot be removed without unacceptable loss or damage to the object. This reality is one that the conservator accepts and documents as part of the history of the object.

Uses For Tape in Preservation

Conservators use pressure sensitive tapes in many ways, some of which might surprise you. In photographic conservation, tapes have been used to seal the glass and metal encasements of Daguerreotypes. Recently, the objects conservators at the Walters Art Museum have been experimenting with tape to selectively remove layers of corrosion on silver objects. Primarily tape is used in the construction of custom housings for museum objects. Corrugated cardboard and paperboard which meet permanent paper standards are available, and boxes made of these materials are often assembled with non-supported acrylic based pressure sensitive adhesive. Before a product is used for such critical housings, its physical and chemical properties are evaluated. One example of this testing was done by the Research and Testing Laboratory of the U. S. National Archives. The adhesion of a non-supported acrylic adhesive to alkaline filled corrugated board was tested by modifying ASTM D 2860 M-63 Procedure B, Standard Test Method for Adhesion of Pressure-Sensitive Tape to Fiberboard at 90° Angle and Constant Stress.

Other tests are commonly used by conservators. A test developed at the British Museum, called the “Oddy” test, is performed to evaluate the potential for a material to cause corrosion on metal coupons. The material to be tested is placed in a glass container with a small amount of moisture and a polished coupon of lead, copper, or silver. The container is sealed and placed in an aging oven at 100°F for two to four weeks. After this period, the containers are opened and the coupons are examined for evidence of corrosion. Most acrylic tapes fail this test due to the corrosion of the lead coupon; lead acetate is often found in these cases. The Oddy test is very useful because it can simulate the long-term effect of proximity to a material on an object kept in a closed environment (such as an exhibit case). Acidic outgassing of tapes is determined non-quantitatively by using a piece of filter paper onto which an indicator such as bromcresol green has been applied. The tape to be tested is placed in a closed container with a piece of the filter paper (the two are not in direct contact as this is a test for outgassing). After 24 hours the filter paper is checked for color shift. Bromcresol green changes from bright blue at pH 5.4 to yellow green at pH 3.8. The ambient moisture in the container is enough to complete the reaction and cause color change. A tape fails the test if the color change is significant in the first 24 hours. Many times it is the carrier which is responsible for the outgassing. Polyvinyl chloride and cellulose acetate
carriers can be prodigious sources of acidic vapors. Outgassing tests are of particular importance. The main strategy for long term preservation of museum objects is to store and display collections in a stable non-damaging environment. Any material which contributes negatively to the environment is to be excluded, therefore removing the sources of acidic gasses and other volatiles such as formaldehyde is critical.

Opportunities for Collaboration

The conservation field and the tape manufacturing industry have much information to share. Cooperation can only benefit the respective efforts of both groups. For example, there have been instances of pro bono work done by manufacturers in support of conservation projects. Analysis of tape from two sketchbooks by Paul Cézanne at the Philadelphia Museum of Art was done with industry assistance. Input by paper conservators into the development of new products has also occurred. Hopefully such cooperation will increase as more manufacturers become aware of the high level of conservation interest in pressure sensitive products. It is possible that cooperative technical seminars could be developed which would bring conservators and tape chemists together for mutual benefit.

By far the most important cooperative effort could be that of that of public education. Interestingly, the recent market for scrapbook and family history projects has raised public awareness of quality issues in materials. The number of manufacturers producing “archival” tapes has risen, which indicates that the sales potential for such specialized products is high. However, with increased sales comes increased product liability. It is the feeling of most conservators that tape manufacturers have a responsibility to the public to clearly state the recommended use for their products, and that most fail to do so. Although the conservation community recommends against the use of pressure sensitive tape on any permanently valuable object, we understand that the public likes the convenience and economy of tape. However, without proper education and product labeling the likelihood that tape will end up on valued family materials is high. Collaboration in the development of product use information would certainly benefit everyone concerned. A sobering fact is the potential for litigation that manufacturers risk by failing to adequately alert the consumer to the potential for damage caused by tape. At least one manufacturer has already come to settlement in a case of irreversible damage to artworks caused by their tape product. The conservation field has had good success in public outreach programs that promote preventative preservation methods to the public. Perhaps a collaborative effort could help avoid similar negative outcomes.

Conclusion

The combination of pressure sensitive tapes and valued objects of our material culture is a fascinating area of study. It is a modern phenomenon, large in scope, and studied by a relatively small number of professionals. The challenges we face in our respective professions are complex and will require cooperation to be effectively addressed. The costs involved in treating culturally significant objects with tape damage are extremely high, not only in terms of actual conservation treatment, but in the establishment and upkeep of conservation laboratories. The training of future generations of conservators and of the cost of ongoing research programs will continue to be great. Conservation is a relatively young field; in order to thrive it needs interaction with well established industries that have sound knowledge and technical bases. The pressure sensitive tape industry is a remarkable example of such a resource. The solution to problems created in the past lies in the future creativity and innovation surely destined for both fields.
Appendix: Further Reading


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