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Special Bulletin #3: Conservation Practices for Slide and Photograph Collections

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Author Bio & Acknowledgements
Christine L. Sundt - University of Oregon

Cover design and title page layout: Terry Arzola - University of Texas at Austin

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Conservation Practices for Slide and Photograph Collections

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Conservation Practices for Slide and Photograph Collections

By
Christine L. Sundt
Slide & Photograph Curator
University of Oregon Library
Architecture and Allied Arts Library
Slide & Photograph Collection

1989 VRA Publications Advisory Committee: Nancy Schuller, Chairman, University of Texas at Austin; Elizabeth O'Donnell, Dartmouth College; Anne-Marie Logan, Yale University; Mary Lampe, Amon Carter Museum.

Cover design and title page layout by Terry Arzola, University of Texas at Austin

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for Richard

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Foreword

In 1980 when I first became interested in the conservation and preservation of color film mounted between glass, it was mostly out of frustration, because I found so little published on the subject. At that time I had no idea that my reading and research would still be ongoing nearly a decade later. With both the film industry and product manufacturers engaged in a seemingly endless quest for the perfect product, I should not have been surprised to realize that keeping informed on conservation and preservation issues would be just as endless a quest. Stimulated by my own need to know and encouraged by Nancy DeLaurier, then Editor of the Mid-America College Art Association Slides and Photograph Newsletter (which later became the International Bulletin for Photographic Documentation of the Visual Arts), I recorded my discoveries and conclusions in a series of articles in a column dedicated to conservation issues. The range of topics covered over the years has been as broad as our readers' interests -- from slides to photographs, but with a definite predilection for the former, and from techniques to products. Motivated by how often I have referred others to these publications, I have assembled the articles which seemed to me worthwhile as a reference tool on conservation matters. In preparing this collection, I have sought out errors (mine as well as the typesetters') in the original publications, revising or expanding where needed. I hope that you, the reader, will find this compilation informative and maybe even useful.

To thank all the people who helped me over the years would probably require several pages. However, I would be remiss not to acknowledge Nancy Schuller and Foster Foreman of the University of Texas at Austin and Christina Pierce of the University of Oregon for editorial assistance in the preparation of this manuscript.

C.L.S.

University of Oregon, Eugene, Oregon
July 1989

SLIDES

I. WHEN TO CONSERVE:
A GUIDE TO SLIDES DESERVING SPECIAL CARE

(Vol.12, No.3) Autumn 1985

Few would argue that **every** slide in a teaching resource collection is worth protecting and conserving according to guidelines for long-term safekeeping. With the exception of unique and irreplaceable images, many others probably do not warrant full-scale conservation practices which can be both costly to implement and somewhat difficult to maintain.

A typical slide collection serving teaching needs is likely to be heavily stocked with slides made from secondary images (books, postcards, reproductions, and the like) along with slides purchased from commercial sources, usually copies of stock originals, better known as duplicates. Most often the smallest part of the collection is represented by those precious one-of-a-kind slides commissioned or received as gifts from traveling scholars, curators, faculty members, or photographers -- professional or otherwise -- skilled in the use of a 35mm camera. In the commercial marketplace, originals may be purchased from the handful of vendors who specialize in original transparencies (Saskia Cultural Documentation and Hartill Art Associates are two examples).

An original slide is valuable to a collection when it faithfully reproduces the original work or site without undue distortion caused by shadows, contrast, lighting, angle, depth-of-field, distance from the object, and it is free from distracting elements in the surrounding areas. A good original is difficult to produce because of what can go wrong at any time: before the film enters the camera, at the time the image is recorded, or during processing and, finally, because there is often so little recourse after the fact to make adjustments. In terms of clarity and faithfulness to the image represented, an original transparency is usually far superior to an ordinary slide duplicate.

The ultimate value of an original image is measured by the rarity of the representation -- a site that no longer exists or that has been permanently altered; an event that cannot be recreated; a reproduction of an art work that is otherwise

unavailable for public viewing. If an image can be readily and easily photographed without restriction, then the value of the original may be diminished.

Originals made on Kodachrome film are often considered more desirable than originals on Ektachrome or Ektachrome-type films because the former, a dye-additive process, has been known to offer better, longer lasting dye stability in storage than slide films like Ektachrome, a color subtraction process. Ektachrome and Ektachrome-type films (e.g., Agfachrome), but especially pre-E-6 emulsions, may thus require greater care and maintenance because of their characteristically more delicate or impermanent nature.[1]

Duplicate slides are reproductions from an original positive or negative image. These are derivative images which are at least twice removed from the original object or scene. Duplicates will vary in quality depending on the care given during the copying process. The original film should be perfectly free of dust or fibers since these will be reproduced in the copy. If the color of the original is slightly off due to an imbalance between illumination and the film's emulsion, then correction is necessary through the use of a different type of light or filters. In reproducing an original, care must be taken to control contrast so that details in shadows or highly saturated colors are not lost. A skilled technician can effectively reconstitute an imperfect original transparency during the duplication process or make a faithful copy of a good original that cannot be distinguished from the original.

Duplicate slides offered by commercial vendors are sold either as single transparencies or as sets. Often when sold in sets, individual replacements for lost or damaged slides cannot be obtained. One must purchase another set to recover missing images. Extra protection for slide sets may be warranted if losses will render the set less usable.

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[1]Today's Kodachromes and Ektachromes are said to be very similar with regard to long-term keeping. This, of course, depends on how they are stored and used: temperatures should be below 70 degrees F. and relative humidity 25-50 percent; projection should be limited to short exposures (seconds, not minutes!) in properly ventilated equipment using the low-lamp setting. Compared to Kodachromes, Fujichrome, an E-6 film, has exceptional durability as a projected transparency.

Slides produced from secondary sources -- book plates, reproductions, photographs -- are probably the slide-type least worthy of costly preservation practices. Typically, slides reproduced from books betray their source -- a screen print made up of thousands of dots which, when projected, can become the size of golf balls on the screen. The fact that the source is still available after the copy is made guarantees that the slide can be replaced, if necessary, quickly and at minimal cost. Furthermore, if the fair use condition of the copyright law is to be observed, any preparation or treatment that affords permanence could be inappropriate for images made from copyrighted materials.

While on the subject of copyright, a few words about making duplicates from commercially produced slides is in order. It is unethical to reproduce a slide purchased from a slide company unless permission has been granted by the owner or manager of the firm. If multiple copies are desired, multiple copies should be purchased. If the image is needed for reproduction in a publication, the vendor or copyright holder must be contacted for the necessary permission which may require an additional fee over and above the cost of the slide or photograph. Most of the major slide vendors are more than generous in accommodating our slide needs. It is in our best interest to respect the simple regulations they have asked us to observe.

In summary, while all slides represent an investment both in terms of materials and labor, all slides are not equal in value. Some slides, especially good quality originals that are impossible to replace, deserve greater care than poor quality slides photographed from low-contrast black-and-white postage-stamp-size reproductions in books. Deciding which slides should receive special treatment may, in the end, require more time and energy than using a blanket policy for binding, storage, and maintenance that covers most basic conservation loopholes. Good environment control may be ultimately the best way to protect your rare or special collections and, at the same time, everything else (e.g., microcomputers, but also humans) in the same room.

II. MOISTURE CONTROL THROUGH SLIDE MOUNTING

(Vol.8, Nos.3 & 4) Fall & Winter 1981

Unless your slide collection is housed in a desert or a desert-like environment, you probably have had to deal with the problem of moisture within glass slide mounts at one time or another. In areas where high relative humidity (RH) is prevalent for long periods of time and where environmental controls are lacking or inadequate, the problem of excessive moisture can be devastating to the health and survival of your color film materials.

It is a well-known fact that color deterioration is brought about by adverse environmental conditions, specifically temperature above 70 degrees F. and RH higher than 50 percent. Deterioration under these conditions occurs even though the color material is kept out of light. This phenomenon is known as "dark-storage fading." To counteract this tendency in film which, incidentally, varies among film brands and types, film manufacturers recommend that color materials be kept in storage where the temperature is below freezing and the RH at about 15 percent. These recommendation, which could very well extend the life of your film indefinitely, are fine if yours is an archival collection, but what if your collection is meant to be used -- handled, projected, and unintentionally abused? These circumstances necessitate a different approach.

Fading is by no means the only problem induced by moisture. Moisture is also linked to fungus propagation on film and adjacent surfaces as well as to the film's ability to hold up even under normal projection. When a conventionally mounted slide is subjected to a humid environment, the dampness in the air rapidly collects on the film, on both the base and emulsion sides. In the so-called "breathable" mounts (such as the Gepe, Perrot-Color, Quickpoint, and Wess brands to name but a few), widely used for ease of assembly and relative durability, moisture can enter the mount and be absorbed by the film in just a matter of minutes. However, if a barrier is created, such as sustained pressure between the film and the glass, a tight closure between mount halves, or some means of sealing off the open portions of the mount, the moisture invasion can be slowed down, although it may not be stopped entirely in all cases. With excess moisture present within the mount, the safety of the film is threatened. During projection, a moist slide can become permanently warped when subjected to the intense

heat or, worse, portions of its softened emulsion can be seared by the hot glass of the mount at the points of contact. This latter effect, called "ferrotyping," causes irreversible damage to the film.

Less serious though often equally alarming is the occurrence of precipitation within the mount, usually opposite the base side of the film. Sometimes the precipitate also contains an oily substance which could be a plasticizer from the plastic of the mount or from film itself, a residue from a cleaner/lubricant, or it could be something that was already on the glass before the film was introduced. Usually the film shows no signs of permanent physical damage when a precipitate is observed although slight warpage and buckling have been known to accompany this effect in cases where a plasticizer precipitate from the film was identified.

In order for the film to be safe from the damaging effects of the environment and from projection, moisture control must be in effect at all times -- while the slide is in storage and when it is being used. This can be accomplished most effectively with an "airtight" mounting system.

While it is difficult at best to modify either the Perrot-Color or Gepe mounts into "airtight" film containers,[2] the easiest and most economical way to achieve this goal is with standard slide binding equipment and supplies: 2-inch by 2-inch glass plates (available from Eastman Kodak, Erie Scientific, and Wess

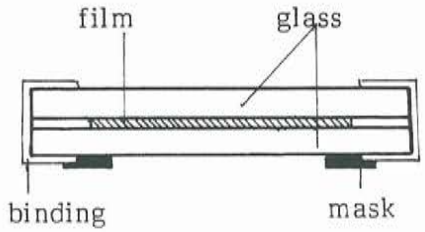

Figure 1. Diagram of "glass-film sandwich."

[2]I have described and illustrated this technique in "Mounting Slide Film Between Glass -- For Preservation or Destruction?" in Visual Resources: An International Journal of Documentation, Vol. II, No. 1/2/3 (Fall/Winter 1981/Spring 1982), pp. 37-62, especially Plates 2 and 3. Since this article was written, a new "archival" slide mount has been introduced by Wess Plastics, Inc. The new mount resembles the Perrot-Color mount (no longer manufactured) except that the outer frames are made of Noryl (a plastic made for use in microwave bakeware which is extremely resistant to melting), hinged together, with a built-in snap closure (no additional locking tools are needed). The mount is packaged with separate anti-Newton glass plates which can be assembled with or without tape. Wess Plastics has also designed a binding machine that facilitates using an 1/8-inch metallic mylar tape to created an "airtight" assembly of the glass-film sandwich.

Plastics, for example), 1/2-inch polyester metallic binding tape (made by 3M and Horizon Tape Products Company), and a binding rig or clamp. Assembly of this "glass-film sandwich" (Fig. 1) is as follows: the film is positioned between two pieces of glass and bound tightly around the edges, without intervening masks or tapes between the plates; masking is done on the outside, directly on the glass, after the plates are sealed. In using this method, the air space between the glass and the film is near-zero, thus eliminating the possibility of steam formation, the release of precipitates, and the occurrence of film warp in the recesses between the film and the cover glass when an intervening mask is employed. However, such close contact between film and glass may result in Newton's rings which will be especially noticeable in light portions of the image.[3] Using anti-Newton (or No-Ring) glass against the base or shiny slide of the film helps to alleviate most but, unfortunately, not all of the colorful Newton's rings.

MOISTURE CONTROL SLIDE BINDING TECHNIQUES: Step-by-Step Instructions

It is important to remember when binding slides for moisture control that both the slide film and the environment in which the binding is being accomplished should be dry. If a damp slide is bound up, it is likely that a moisture spot (looks like a puddle) will show up opposite the base side of the film when it comes in contact with the glass. If this should happen, remove the film and allow it to dry out. Use an airtight chamber containing silica gel, if necessary.

Technique No. 1: "Airtight" Glass-Film Sandwich

1. **Remove film chip from its cardboard or plastic mount.** When separating the film from its mount, be careful not to touch the film with your fingers. Wear cotton gloves or use tweezers to hold the film while removing any stray dust particles or fibers before proceeding to the next step.

[3]Newton's rings, by the way, are formed when two shiny surfaces come in contact. The normal level of moisture present within a piece of slide film is enough to generate the rainbow effect, commonly known as "Newton's rings." The occurrence of Newton's rings, however, does not necessarily indicate an excessive moisture level within the mount.

2. Position the film between two pieces of pre-cleaned glass. (Fig. 2) Use the Film Positioning Guide (see instructions below) if necessary to align the film.

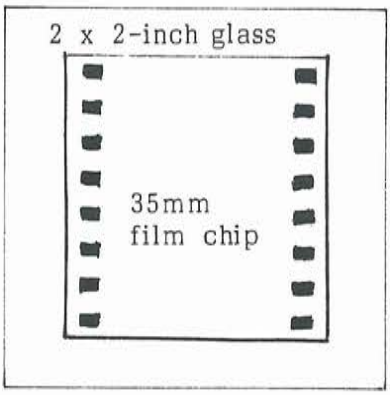

Figure 2. Film chip between pre-cleaned glass plates.

Figure 3. Compco Slide Binder.

3. Clamp the glass-film sandwich in a vise or binding machine. (Figs. 3 and 4) In years past, "binding machines" were manufactured by companies such as Burke & James, Compco, and Mansfield. Vises and hand clamps are usually available at hobby shops and hardware stores.

4. Wrap 1/2-inch silver or polyester metallic tape (Fig. 5) around the periphery of the glass-film sandwich, allowing 1/4-inch for overlap at the end.

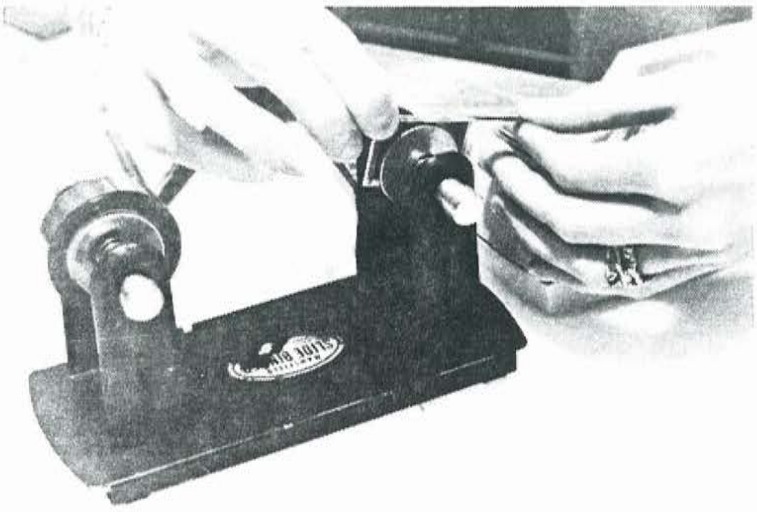

Figure 4. Mansfield Ind. Slide Binder.

One-half-inch silver or metallic tape is available from 3M (Product No. 850-Silver) and from the Horizon Tape Products Company (Product No. 425). It is important to use a continuous length of tape (about 8 1/2-inches long) so that the corners will be fully sealed.

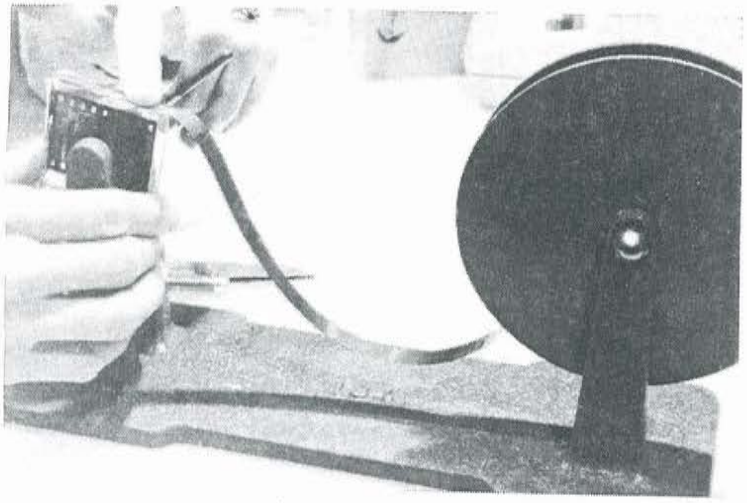

Figure 5. Silver tape being wrapped around glass-film sandwich in a Burke & James Slide Vise.

5. Firmly turn down the tape on both sides of the glass-film sandwich, forming in the process an overlapped miter at each corner (Fig. 6).

The tape should be applied to create a tight closure between the glass plates and the film. The pressure exerted by the vise or clamp should be sufficient to achieve this seal. The sealing tape should be applied smoothly and evenly.

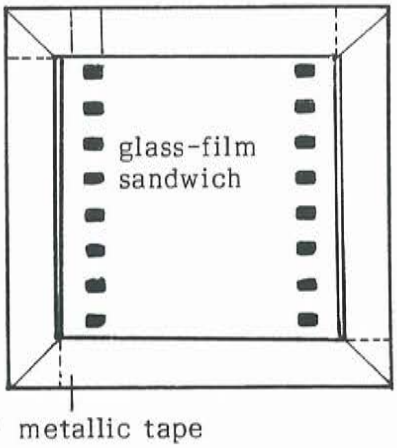

Figure 6. Mitered corner formed on glass-film sandwich.

6. Mask extraneous or open areas between the image and the edge of the binding tape using an opaque metallic tape on the glass.

Begin masking on the long sides of the film chip and finish on the short sides, except if the image occupies the full area of the film frame. (Fig. 7) In this case, mask only the short sides; Step 7 will take care of the remaining unmasked spaces on the long sides.

I have found that the 1/4-inch Horizon No. 425 tape is the most efficient tape for this job because it is completely opaque, unlike the 3M No. 850-silver tape which requires a double layer because of irregularities in the silver coating. The Horizon tape is also

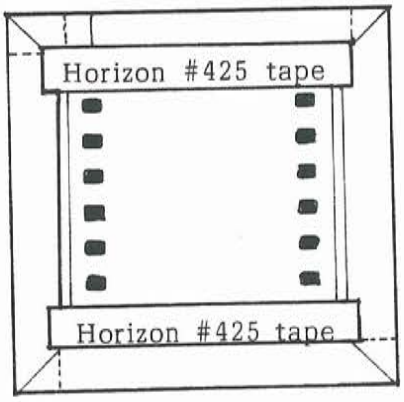

Figure 7. Masking tape on outside of glass-film sandwich.

economical: as little as $3.00 per roll of 100 feet, on a one-inch core when purchased in quantity.

7. Measure out two 4 1/2-inch pieces of 1/2-inch polyester metallic tape.

Position the tape along the long edges of the film's image, carry it around to the opposite side, and overlap the excess. Repeat for the remaining long side (Fig. 8). The tape should cover the previously bound, mitered corners, the ends of the mask-out tape, and meet the film's image, thus completing the mask. Besides working as a mask for the remaining open spaces, this application effectively seals and protects the "mitered" corners from any moisture seepage and subsequent damage that can occur during use.

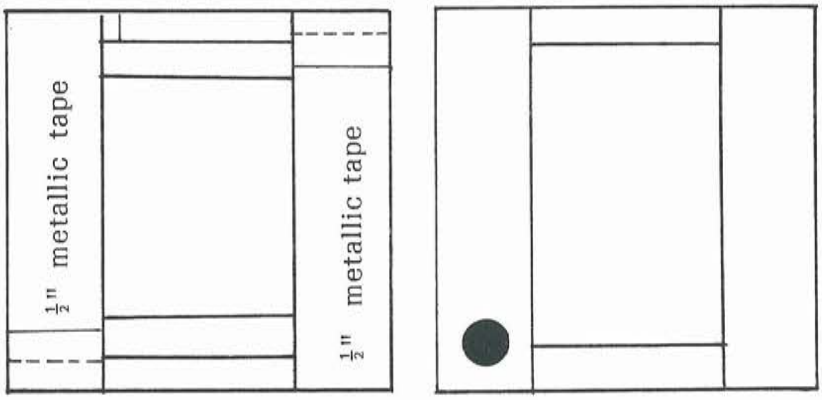

Figure 8. Left: 1/2-inch metallic mylar tape applied over 1/4-inch masking tape. Right: Completed slide, front side.

A glass-film sandwich, fully bound, masked, and labeled is only about 2 mm. thick. This will easily fit into an 80-slot universal carousel tray. Glass-mounted slides do not fit into 140-slot carousel trays.

Tests which I have carried out on the glass-film sandwich mounting method show it to be extremely effective in blocking out high moisture in the environment. A slide carefully prepared according to the instructions given above can even survive complete submersion in water for a short period of time. In my tests, moisture indicator paper was used to gauge the incidence of moisture between the glass. Even after about 30 seconds in the water, none could be detected within the mount. Try, if

you dare, this same test with the binding method you are currently using and compare the results.

This method produces a bound slide that is as close to being completely airtight as possible. Microscopic seepage seems to be insurmountable. The mounting method described above will render a near-airtight enclosure for the transparency. Ambient moisture in the environment (RH), pollution and chemical vapors should have minimal effects on the enclosed film.

Technique No. 2: Limited Moisture Control

1. **Remove film chip from cardboard or plastic mount.**

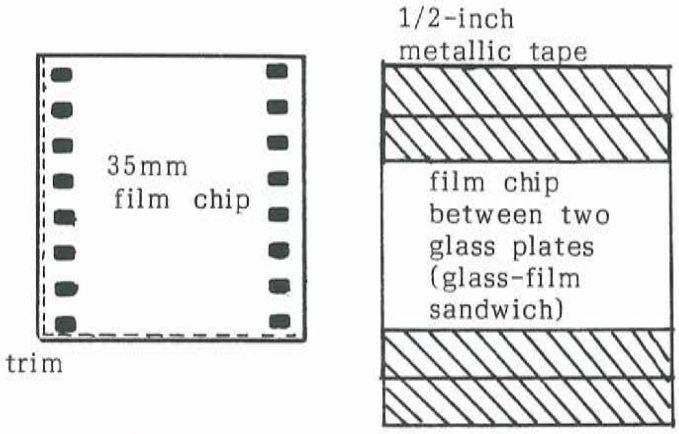

Figure 9. Left: Areas to be trimmed on film chip when using Perrot-Color mounts. Right: Tape applied to glass-film sandwich.

2. **Trim the film slightly (about 1/16-inch) on two adjacent sides (one short and one long side),** to provide sufficient space for film expansion (Fig. 9, left). (This step is not necessary with the Wess Plastics "archival" slide mount.)

3. **Position the film between two pieces of pre-cleaned glass.**

4. **Clamp the glass-film sandwich in a vise or binding machine.** (Figs. 3 and 4)

5. **Center a piece of 1/2-inch polyester metallic tape, 1 1/2-inches long, over the long side of the glass-film sandwich** (Fig. 9, Right). Firmly press down on both sides of the glass (Fig. 10). Repeat for the other long side.

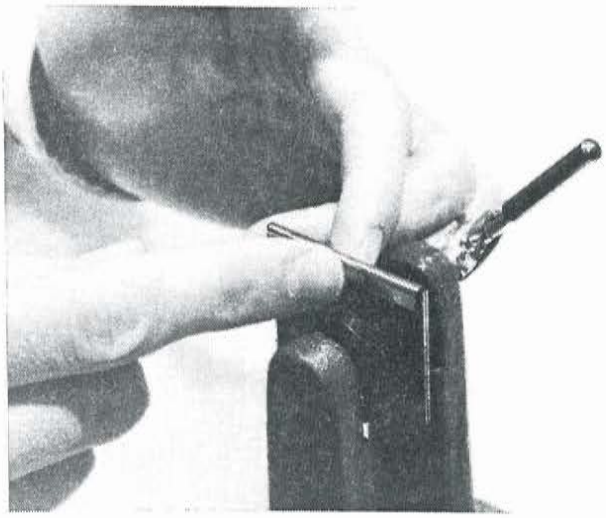

Figure 10. Tape being pressed against glass on long sides of glass-film sandwich.

6. Drop the glass-film sandwich into the interior indentation ("bed") of the mount (Fig. 11, Left). Using 1/4-inch polyester metallic tape, **cover the short (open) sides of the glass-film sandwich** (Fig. 11, Right); press the tape firmly to seal.

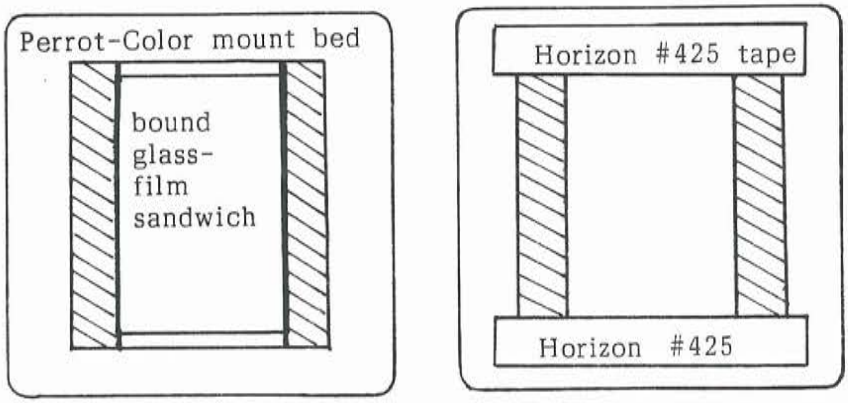

Figure 11. Left: Bound glass-film sandwich fitted into mount bed. Right: Short sides of glass-film sandwich covered with metallic tape.

7. Mask image, if necessary, using Horizon Tape No. 425. (Masking tape is applied to the glass, never to the film.)

8. Position mount cover; crimp edges using Proloc Fastener. (With the Wess mounts, snap the frames together.)

This method of modifying an existing popular commercial mount is not as "airtight" as the first technique described above. It is effective, however, in retarding moisture seepage. The Perrot-Color and Wess "archival" mounts are the easiest to alter;

less so is the Gepe mount because this requires removing the aluminum frames from both halves of the mount in order to free the glass. With the Perrot-Color and Wess "archival" mounts, since the glass is already separate, the modification is easier to facilitate. For the Limited Moisture Control technique using the Perrot-Color mount, it is necessary to trim the film slightly on two adjoining slides before inserting it between the glass plates. This ensures an allowance for expansion that occurs naturally when the film is heated during projection (Fig. 12). If the film is not trimmed, the exerted pressure from expansion may cause the glass to rupture. With the Wess "archival" mount, the glass is slightly larger than the film chip, thus already allowing space for expansion.

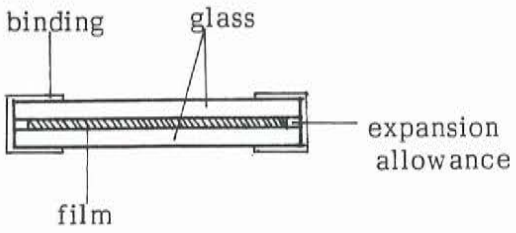

Figure 12. Diagram showing expansion allowance.

Masking, of course, is always done on the glass. The best tapes available for masking are the Horizon Tape No. 425 and the Brady splicing/sensing silver mylar tape. The Horizon No. 425 tape is preferred because it combines thinness and opacity which is not found in either the 3M No. 850-silver (which, because of the unevenness of the silver coating, allows tiny pin-holes of light to show during projection) or the Brady tape (somewhat thicker than the others and also less tacky). Thinness in tape is desirable since too much bulk may cause an imperfect seal or cause the glass to break when the base and cover are fastened together.

Providing the best environment for color slides may be highly desirable, but if budgetary constraints limit how much you can do in terms of time, staff, and supplies, you may want to consider establishing priorities for slide binding techniques. For example, you may choose to use the safest binding/protection method currently known, such as the "Airtight" Glass-Film Sandwich Technique, for original color slides, one-of-a-kind duplicates, and images on known unstable film stock that cannot be replaced (to retard further deterioration). Less valuable materials (replaceable duplicates that are initially not too expensive nor difficult to obtain) could be bound in the next best method (the Limited Moisture Control Technique). Slides made from reproductions in

books, postcards, etc., could be considered the easiest to replace and therefore these would not require any special moisture controlling safeguards. These slides should be replaced with a commercially produced original or high quality duplicate which are unquestionably superior to slides made from secondary, printed materials.

DIRECTIONS FOR MAKING A FILM POSITIONING GUIDE FOR 2-INCH BY 2-INCH GLASS PLATES

1. Center a discarded 35mm film chip (film frame) on a piece of 2-inch by 2-inch cover glass.

2. Draw an outline around the film chip and fill in the sprockets, using a black permanent marking pen with an ultra-fine point.

3. To form the "Flexible Grip," wrap a 5-inch long piece of 1/2-inch polyester metallic tape around the left edge of the glass, overlapping the excess. The tape should extend at least 1/4-inch beyond the edge of the glass plate.

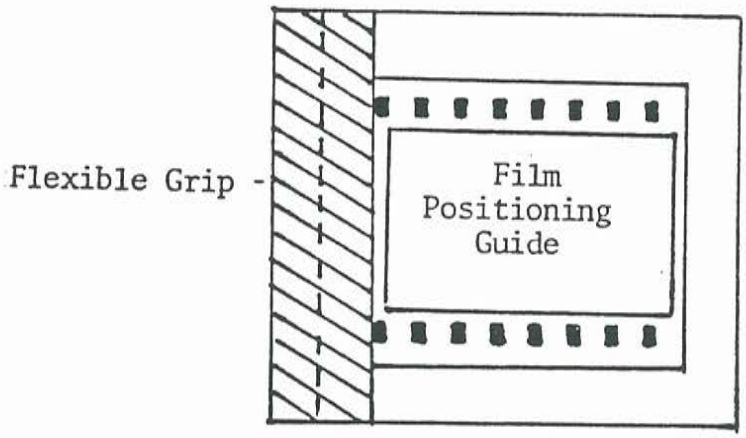

Figure 13. Film Positioning Guide.

Use:

1. While holding the Film Positioning Guide beneath the glass-film sandwich, adjust the alignment of the film by nudging it with a piece of 35mm film, one to two frames long, for which you no longer have a use. Use the sprocket marks or film outline as your placement guide.

2. When the film is satisfactorily positioned, remove the Film Positioning Guide by holding the "Flexible Grip" between the fingers of the opposite hand and slowly pull the Guide away from the glass-film sandwich in the direction of the "Grip."

3. Carefully insert the glass-film sandwich into the binding machine or between a vise. Bind the edges in the usual manner.

III. DE LAURIER BINDMASTER -- A HOMEMADE SLIDE BINDER FOR THE "SUNDT" METHOD

(Vol.10, Nos.1 and 4) Spring & Winter 1983

Nancy DeLaurier, Art/Art History Slide Curator at the University of Missouri-Kansas City, persuaded her husband, Jacques DeLaurier, to design a slide binding machine when she was unable to locate any of those illustrated in my article, "Moisture Control Through Slide Binding." After having used the binder during a workshop to teach the participants how to wrap silver tape around two pieces of glass that enclose a piece of film, carefully positioned inside, I can attest to its fine design and superb performance. For the convenience of those who may not have either of the original issues where the binding machine was presented, I submit the following diagrams with special thanks to Nancy and Jacques, once again.

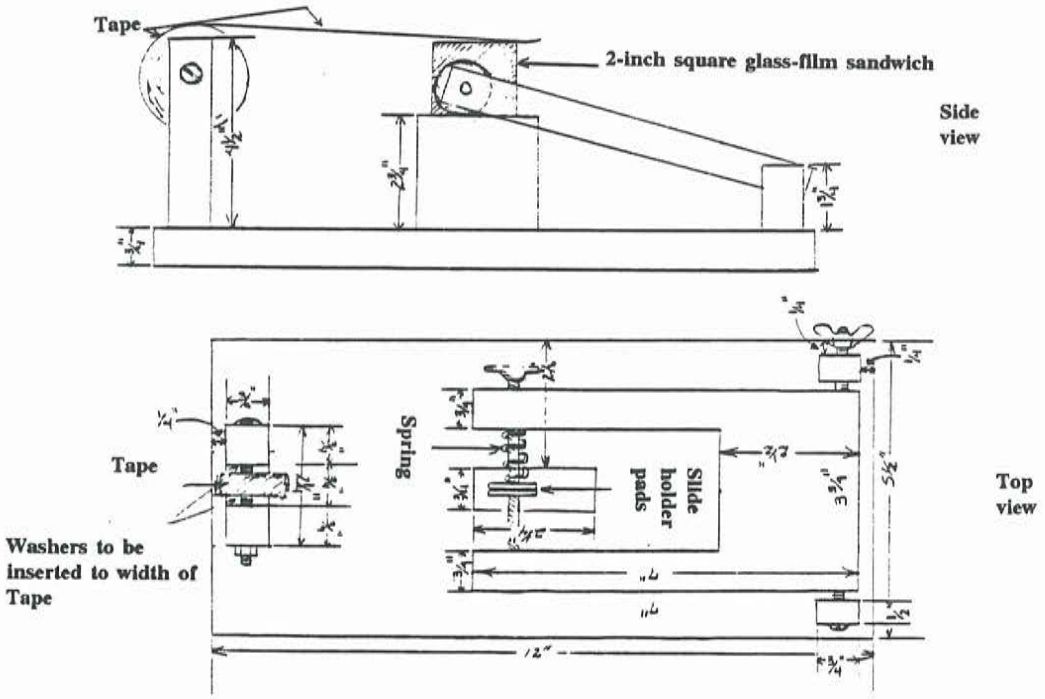

Figure 14. DeLaurier Bindmaster (design by Jacques DeLaurier; rendering by Bradford Bray, Kansas City, Missouri).

IV. FUNGUS IN GLASS-MOUNTED SLIDES: RECENT FINDINGS[4]

(Vol.9, No. 4 [Supplement]) Winter 1982

Most people believe that fungi are responsible for many forms of damage to slides. This seems to be a reasonable belief especially because of what we know about fungus growth, namely that film materials readily absorb moisture and that moisture can be easily trapped between the glass in glass-bound slides. Furthermore, fungi spores are everywhere in the environment and the gelatin of the film's emulsion layer is, quite conveniently, available right there as a nutrient source for fungi. Add to these a warm environment and you have what seems to be nearly ideal laboratory conditions for fungus growth.

Furthermore, the literature on the preservation of film materials appropriately warns us about fungus. Our awareness and fear of this menace are further enhanced by colorful descriptions, often with pictures of affected images. Fungus-consciousness is further sharpened if some form of growth activity has been found among treasured slide materials. Based on what has been presented in the descriptions and illustrations in the literature, we are led to believe that fungus is the cause of most physical problems in film where growth patterns can be observed.

While the fear of fungus, undoubtedly and yet fortunately, is the major catalyst for bringing about better and safer environmental controls into film storage areas, it is also perhaps a bit overplayed as a threat to most glass-bound slide collections. The purpose of this paper is to attempt to dispel the growing myth that fungus is the primary perpetrator of damage among glass-mounted slides by showing that what may initially seem to be a fungal growth could be a chemical reaction, usually encouraged by contaminants within the mount or on the film.

I am not here to deny or downplay the fact that fungus can and will attack film materials. Indeed, fungi and film products in damp, tropical environments are anything

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[4]I wish to acknowledge and thank Dr. Harold Burdsall, a botanist specializing in mycology, at the Center for Forest Mycology Research at the Forest Products Laboratory of the United States Department of Agriculture in Madison, Wisconsin, for helping me to identify and record the fungus I describe in this paper.

but incompatible, but, then again, little is safe from fungi in such a climate. One of the problems I found in using the information presented in the literature is that when fungus is discussed, it is usually in the context of its affect on photographic prints and plates or slide film in open-frame mounts. The glass-mounted slide seems to be somewhat of an anomaly in the commercial world of photography because in common practice most slides are left in their original paper or plastic frames. Confusion enters the picture when the descriptions of fungus on photographic emulsions and unprotected film are indiscriminately used in deciphering reactions within glass-mounted slides. Blotches, spots, and branching patterns on the glass may look like an attack of fungus, or fungus in its early stages of development, but when this substance is scientifically analyzed, the conclusion is quite different. In fact, in most cases observed, the outward signs (blotches, branching patterns, and the like) were confined to the glass alone. Once the glass was removed, there was no evidence of any residue or formation on the film proper. In the case of spots, usually yellow-orange to red in color, a contaminant was usually noted directly above or in close proximity to the spot. A contaminant can be a particle of glass, a fiber, or a dust speck to name but a few.

Because the question of fungus was my major reason for conducting the research which has brought me to these conclusions, I think it fitting to include a description of what fungus actually looks like. I will use an example which was discovered during the course of this study. In fact, this was the only fungus specimen that could be identified from among approximately 100 examples initially studied.

Fungi is a blanket term covering a wide variety of unusual and diverse organisms. Consequently, a simple definition is almost impossible. J. W. Deacon in his Introduction to Modern Mycology (which is Vol. 7 in the series Basic Microbiology), suggests that consideration of the main features of fungi may provide a better understanding of what they are.

Fungi are characteristically filamentous, or thread-like. Individual threads are known as hyphae and these threads are capable of branching and even fusing profusely with each other. A mycelium is the term for a mass of such branches. Typical of fungi is the presence of a rigid cell wall that surrounds an individual hypha. Fungi grow from the tips of their branches which in scientific terms is known as apical growth. This

growth pattern, according to Deacon, is a feature which marks fungi as distinctive from almost all other organisms. Energy is obtained by fungi from pre-formed organic compounds. Not all nutrients can be taken up intact through the cell walls -- the usual means of ingestion; in fact, most compounds must be degraded into simpler substances before they can be absorbed and used. Co-existence with other living structures that can help in breaking down these compounds is almost as vital as the nutrients themselves. Spores are the end-products of fungi reproduction.

Fungi are known to thrive in both high and low temperatures, but not all fungi will tolerate this range. Similarly, fungi will grow in wet and relatively dry conditions, but again, probably not with equal success in both.

Identifying the specific class of the fungus found on the slide studied has, so far, been impossible because all we have had to work with are fungal cells. These have been identified as such through a standard laboratory technique involving the application of a two-percent solution of potassium hydroxide. This substance is dropped onto the area suspected of containing a fungal structure. It is then covered with a glass plate and examined under a microscope. In this process, most substances with which a fungus may be confused will be converted by potassium hydroxide. If a structure remains and its features include branching and identifiable hyphae having rigid cell walls and septa, or cross-walls, then the specimen is a fungus. If the structure dissolves, leaving only a residue such as oil droplets, fibers, or other debris, the formation is not a fungus but a chemical cluster. Further identification of the specific class and species of the fungus will depend on being able to cultivate it under laboratory conditions in order to observe its full life cycle (morphology). Our specimen has yet to show any signs of growth or life in the time that has elapsed since it was prepared for cultivation. When the culture medium or augur (agar) which is comprised of gelatin and malt extract is no longer viable, re-cultivation will be attempted. It is hoped that additional bonafide specimens will be found to be included in this study. Identification of the fungus class and species is desirable in order to determine if a single type of fungus affects film materials or if the possibilities are numerous. This knowledge may help to control the growth and spread of fungus on film materials.

Because certain temperatures, a moisture quotient, and oxygen are significant

ingredients in the life cycle of fungi, controlling these organisms may be possible by mere manipulation of their requirements for survival. Most fungi have a maximum heat tolerance of no greater than 58 degrees C. (roughly 137 degrees F.). Consequently, projection of a slide just before binding in a projector where the at-gate temperature will range between 145 and 170 degrees F., may be all that is necessary to kill any organisms present on the film. This method would also simultaneously reduce the moisture to a level beneath the minimum needed for survival and growth of typical fungi (70 percent R.H. is probably the lowest limit for most). This would also ensure that the film is free of excess moisture before being bound between the glass plates. The possibility of damage during the projection due to trapped moisture would thus also be averted (unless the slide were stored in an extremely humid area and where no provisions were made in the binding technique to restrict moisture intake during storage or use).

The oxygen needed for fungi development could be restricted significantly if an air-inhibiting binding system were employed. I should mention that the fungus was found on a slide bound in a Gepe mount. While I am unaware of any product that would enable me to achieve a completely airtight enclosure, I have been able to demonstrate that a near-airtight system is possible.[5] This has been shown to be significantly safer for film materials than the popular, commercial snap-together or "breathable" glass frames even if the slides are stored in an extremely moist environment and then projected at abnormally high temperatures.

Another control measure could be sterilization. While it may not be possible to actually sterilize the slide film, sterilization of the mounting glass is conceivable.

These suggestions for controlling fungi are based on general characteristics of the organism. Specific recommendations would be possible only if the fungus or fungi affecting the film materials could be identified.

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[5]See "Moisture Control Through Slide Mounting" [reprinted here] and "Mounting Slide Film Between Glass -- For Preservation or Destruction? Visual Resources: An International Journal of Documentation, Vol. 2, No. 1/2/3, pp. 37-62.

Having explained in very general terms a fungus -- what it looks like, what it requires for nourishment, and what conditions it can or cannot tolerate -- I would now like to describe my findings with regard to fungi that were actually identified within glass mounts:

1. The growth usually started in the area where masking tape had been affixed to the film. The fungus used the tape edges as its substrate, according to Dr. Burdsall. Thus, it appears that the film emulsion was not being used as its nutrient source. Black paper tape which requires moistening for adhesion seemed to be largely responsible for providing the sustenance for the micro-organic growth.

2. Fungus occurred in mounts that did not restrict oxygen and other gases from passing through the binder. This group included samples mounted in Perrot-Color, Gepe, and glass plates bound with paper tape.

3. The fungus was found on the film rather than on the glass.

4. The environment within the mount including the glass, masking materials, and film was contaminated with foreign matter such as dust particles, fibers, and oily residues.

5. The slide had not been used for a while.

6. The contaminated slides did not seem to affect others stored in close proximity.

Chemical activity within a slide mount is another problem that must be addressed. It is not surprising that we have consistently called any suspicious foreign substance observed within a glass mount a fungus. Outwardly, a chemical reaction bears a close resemblance to the textbook illustration of fungi. It is probably not incorrect to say that most of us have seen filamentous structures within mounts, film damage in the form of emulsion displacement and dye loss, while also noting the presence of droplets that look like moisture beads between the film and the glass. Furthermore, we very likely have found

more than one example in our collections, suggesting that the problem is widespread and perhaps contagious.

What has often struck me as curious, however, is the fact that the so-called fungus growth seems to affect the collection selectively. Seldom, if ever, have all the slides in the same filing group been infected. Indeed, the problem seems to be related to origin -- either slides from the same commercial source or film produced and mounted at the same time. As I explained above, in the potassium hydroxide test for fungi, substances that are not fungus cells will be broken down and converted when this solution is applied. As a result, filamentous structures of a crystalline nature will disappear, leaving only droplets and assorted debris behind. I will try to anticipate your next question. What comprises this residue that looks so much like a fungal structure before the potassium hydroxide test? For this I do not have a firm answer at this time but with the help of a chemist specializing in physical chemistry one should be able to determine the composition of these residues. For now, all I have to offer are several suggestions based on conditions observed in the glass-mounted slide samples used in this study. For the most part I will be discussing deposits on the glass, most of these having no effect on the film next to it.

The droplets found within the mounts that are so often mistaken for moisture beads are of an oily nature and may actually be a plasticizer used in the manufacture of the slide mount or the film itself. Plasticizers are necessary for flexibility in plastics. Another possibility is that the droplets may be a residue on the glass from the cutting process not properly removed before use. Incidentally, these droplets showed up under the microscope even though a beading pattern could not be observed with the unaided eye.

The debris within the mount is just what the word implies. Dust, paper fibers, lint, hair, glass particles,[6] adhesive residue, and perhaps even crumbs left over from

[6]Glass particles have been identified as the cause of certain dye deterioration in Sandak slides. These are characterized by red-orange spots readily noticeable when the slide is projected. Although it may seem that whenever something can go wrong with a slide, it will probably happen to a Sandak slide, Ed Wiitala of Eastman Kodak informed me by letter that "current Eastman Color Print Films, Kodak Ektachrome, and Kodachrome films are believed to be much less susceptible to adverse effects of alkaline glass dust particles." Perhaps there is

lunch! The best solution to this problem is quite obvious: stricter and more sanitary binding practices. A cleaner work space may be ultimately more satisfying to the workers as well as being beneficial to the materials being handled.

Residue from products bound inside the mount such as masks, positioners, identification labels, tacky adhesives are not only common, especially in older slides,[7] but also horrifying in their effects to the film enclosed with them.

I am sure we all have samples in our collections of film masked with electrical or cloth tapes. Over the years, the adhesives have degraded into a sticky mess both inside and outside the mount. Furthermore, it is possible that in the areas covered by the tape, a color shift has occurred. Whether or not the shift has been brought about because of a chemical reaction from the covering materials or if this is simply evidence of how much fading has taken place in the areas not covered by the tape, is difficult to determine without scientific analysis. However, in most samples studied, the areas underneath the tape show a distinctive greenish cast. I am hesitant to accept this as representative of color in a protected or controlled area and hence closer to the original color balance of the image prior to light fading. In any case, the film would have undergone dark storage fading as well, perhaps contributing to this shift towards green.

If at all possible, tapes and adhesives should be kept away from the film. I advocate masking on the outside of the glass for several reasons not the least of which is that we do not know for certain that any of the tapes we are now using are safe when applied directly to the film. More research is needed on tapes and adhesives.

The papers used in the manufacture of masks, tapes, and labels may also be

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hope for everyone, Sandak included. [The red-orange spots on color slides, not to be confused with redox blemishes on microfilm, are not limited to Sandak films. They have been found on other films as well.]

[7]A red tacky adhesive is currently used in the Quickpoint slide mounts to affix the film chip to the mounting frame. Slides sold by Barry Capper (England) and Rosenthal Art Slides (Chicago, Illinois), among others, are distributed in Quickpoint mounts. The adhesive residue can only be dissolved with a solvent (film cleaner). The adhesive is also very strong, making the removal of the film chip a chore which has more than once resulted in irreparable damage to the film chip itself.

associated with chemical residues found inside glass mounts. It is not unusual to find an outline of the paper product inside the glass and in at least one example, to see that printing ink was also reactive. The high acidity of most paper products used for masking and binding should be reason enough to warrant their removal and any practice in which they are still used abandoned. Along these lines, one can also question the safety of the paper mounts commonly used to mount film following processing. One wonders if the newer, plastic mounts are safer. Most are made of plastics that are chemically inert, although with plastics one should retain a modicum of skepticism because so little is known about these materials and their actual performance over long periods of time in less than ideal conditions.

In trying to determine the source of the residue found so often inside the slide mount, one cannot discount the possibility that substances other than plasticizers may be exuded from the film itself. Chemicals left because of improper washing as well as from products applied to film after processing to control static or to remove fingerprints or water spots, may be contributing factors in the formation of internal gases and residues. Chemicals should always be used with extreme caution for lack of basic information about what their long-term effects may be on the film. One should also remember that many products in the commercial market recommended for use on slide film are probably intended for film in open-frame mounts only. Keep in mind that in the commercial circuit, glass binding is the exception, not the rule.

Finally, do not be fooled by slide glass plates that look clean in the package. Unless you have the manufacturer's assurances in writing that the product is "pre-cleaned," assume that it is not. Manufacturers today, hard pressed because of rising production and labor costs, have been forced to eliminate some of the amenities, clean glass included. What you will probably find on the glass is a fine greasy residue from the mechanical process of cutting the glass. This substance will not be removed by mere polishing; a solvent such as isopropyl, ethyl, or denatured alcohol should be used to remove it.

In conclusion, the threat of fungus may not be as imminent as we have been led to believe. In fact, if glass binding can inhibit the flow of oxygen and restrict the amount of moisture around the film, the chances are slim that a fungal spore, if present

within the mount, will germinate. Furthermore, projecting the slide, while not in aid of dye integrity, could be a useful mechanism for destroying fungal cells. Further research is necessary to determine the effectiveness of such a technique. More rigid standards with regard to binding methods could eliminate many of the problems that have been illustrated here. In my study, contaminants have been shown to be the most prevalent cause of damage to the slides, while also contributing to unsightly residues on the glass inside the mount.

V. HOW TO MASK A SLIDE WITHOUT TAPING THE FILM

(Vol.14, No.3) Fall 1987

A few years ago, I stumbled on a product called a No-Peg Holder, made by Wess Plastics that was useful when masking film in a Gepe mount.[8] By using this small plastic holder, I was able to position tape on the glass of the mount rather than on the film and still achieve accurate placement and alignment. The procedure is as follows:

1. While working on a lighted surface, fit the film chip as usual within the grooves of the Gepe grey mount half. If you are using pin-registration mounts, position the chip so that the film sprockets lock between the pegs of the mount. If you are using regular mounts, use a very small piece of tape to anchor one of the chip's corners to the aluminum frame.

2. Place the grey mount half with the secured film chip film-side down into the Wess No-Peg Holder.

3. Place the white mount half on top of the grey half with the inside (aluminum frame) facing up. The mount should now be inside out, outside faces touching, with the open white half on top.

4. Using 1/4-inch aluminum or silver foil tape, begin masking the image by positioning the tape on the inside glass of the white mount half. Keep the masking tape away from the mount's locking pins. Trim away any excess tape from the outer edges as well.

5. When masking is completed, remove both mount halves as a unit from the holder. Carefully reverse the mount halves bringing the grey half over the white half and lock the two pieces together.

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[8]As I mentioned in the previous article, above, my preference is to keep tape away from the film. However for those who use the Gepe mounts and cannot for whatever reason change to another type of mount, I offer this alternative to the practice of masking directly on the film chip.

This method of masking on the glass inside a Gepe mount is safer than applying the tape directly onto the film. The film chip is less likely to be damaged by the tape (warping, chemical deterioration due to adhesive residue, etc.), and because the tape does not restrict the expansion and contraction of the film chip, the slide is less likely to incur damage during projection. Another benefit will be that the film has less tendency to buckle during projection; you will see a sharper image on the screen.

Using a reflective silver or aluminum mylar tape rather than black plastic or paper tape also improves the safety of the slide. Black tapes absorb heat and light making the slide much hotter during projection than if a reflective tape is used. The best tape currently available for masking is probably the No. 425 Ultra-Thin Metalized Polyester Tape made by Horizon Tape Products Company, 251 West Lafayette Frontage Road, St. Paul, MN 55107 (612-224-4083). This tape is also available from two of the major archival products suppliers: Light Impressions Corporation, P.O. Box 940, Rochester, NY 14603-0940, and University Products, Inc., P.O. Box 101, South Canal Street, Holyoke, MA 01041.

The Wess No-Peg Holder, catalog no. 11-2041, may be ordered directly from Wess Plastics, 55 Schmitt Boulevard, Farmingdale, NY 11735-1484 (telephone 516-293-8994). The price is $4.25 plus shipping.

VI. FOGGY GLASS -- YOUR FAULT OR THEIRS?

(Vol.13, No.2) Summer 1986

Have you ever wondered about the foggy residue that you often find on the glass interiors and exteriors of some of the glass-mounted slides in your collection? If so, you are not alone. This is a problem that is very common and particularly annoying because of the extra work it takes to correct once you discover it.

The fog is typically an accumulation of airborne substances and/or residue from glass manufacture. So-called "pre-cleaned" glass may retain chemicals which are later exuded as a gas. Temperature changes, high humidity, and less than pristine housekeeping conditions accelerate the formation of the residue which appears milky and often splotchy and is usually quite easily rubbed off when touched. What is most annoying is that in most glass mounts, it forms on the inside as well as the outside of the mount.

To remove the residue when it is on the inside of a mount, you must open the mount, remove the film, and polish (or wash) the glass to get rid of the fog before returning the film to the mount and re-sealing it. Polishing with a clean, dry chamois is usually enough to remove the fog; washing with denatured or ethyl alcohol may be necessary if the residue is more than just a fog -- especially if it includes a chemical deposit from resident materials such as tapes, masking materials, etc.

With reusable mounts such as manufactured by Gepe, disassembly is relatively easy; the mount can be opened without damaging any of its components and then snapped together after cleaning. There is usually no need to retype or reapply any of the labels affixed to the outer surfaces. Removing the fog from the interior glass of a Perrot-Color mount is another story. It is more than likely that if one of the aluminum frames is peeled off, it cannot be reused. So much for the attached labels; a new label must be produced.

To avoid disassembling slide mounts after only a few years in storage, it is recommended that all glass parts of glass-component mounts be polished or washed before they are used. Polishing with a chamois seems to be sufficient for the Gepe

mounts, but washing the glass elements of the Perrot-Color (and Wess "archival") mounts with alcohol (isopropyl, ethyl, or denatured) is almost a requisite. By the time we open a new box of Perrot-Color mounts and unwrap the glass pieces, the foggy residue -- among other offenses -- is already there. The extra effort given to cleaning at the onset will save you time and money in the future.

Other "internal problems" are not as easily handled. Newton's rings (the rainbow effect), are diminished but usually not completely eliminated even when anti-Newton glass is used. The effect is particularly evident in the lighter areas of the image -- light backgrounds or milky-white skin. Newton's rings are seldom a sign of serious problems. The "dancing colors" exhibited during projection are the result of the phenomenon caused by two shiny surfaces in close contact. Anti-Newton glass with its pebbled surface is designed to add distance to the surfaces and thereby breakup any refraction resulting from the contact of glass and film. Sometimes this special glass works; other times the effect is still evident. After using anti-Newton glass for a while, you will also be aware of quality differences. Some glass is more heavily etched than others and the former may cause distortion in the projected image, but no damage to the film itself.

Chemical residue on glass, manifested as crystalline growths, greasy deposits, or what I call "dirty windows," require full-scale cleaning. Alcohol or distilled water will do the job. After applying the alcohol or water, the glass should be polished with a clean, lint-free, cotton cloth -- the tighter the weave the better. Cotton cloths are reusable after laundering in a mild detergent without fabric softeners. Similarly, chamois pieces may be washed in a mild detergent, thoroughly rinsed in clear water, and hung to dry. When dry, stretching the piece will renew its softness. For ease-of-use, a large chamois skin should be cut into smaller pieces -- a 4-inch square seems quite workable for most uses associated with slide collections.

These are not the only afflictions common to glass mounts. Fungus, dust and fibers, and precipitates from the film, should also be mentioned. Since I have already covered these topics in previous columns I recommend that you consult back issues of the International Bulletin, from 1983 to 1985, for more information [some reprinted here].

Good housekeeping and a stable environment are essential for a trouble-free slide (and photograph) collection. Unfortunately, neither comes naturally nor without extra effort and expense. Shortcuts and cost-saving measures such as broom-sweeping instead of vacuuming in the work area, blocking vents to control temperature, turning off air-conditioning at night or when the collection is not being used are never cost-effective in the end. If anything, problems associated with dust, pollution, or excessive humidity are exacerbated when safeguards or precautionary measures are eliminated. Keep in mind the magnitude of investment in a typical institutional slide/photograph collection and the few extra dollars it costs to keep temperature-humidity controls in effect will seem like a token amount next to the cost of replacing or repairing damaged materials. Look for other ways to save money and mollify annual budget shortfalls than sacrificing basic requirements for maintaining a slide and photograph collection. Unattended problems never go away -- they only get more expensive.

NOTABLE NEWS (Summer 1986)

New Tape for Masking

A new tape has been introduced to us by the Horizon Tape Products Company, 251 West Lafayette Frontage Road, St. Paul, Minnesota 55107 (telephone: 612-224-4083). This product, No. 425 Ultra Thin Metalized Polyester Tape, has been designed specifically for our needs as a "masking" product, and is described as "archival, opaque, virtually pin-hole free, ultra-thin, with a special cured, firm adhesive with low out-gasing properties. It is solvent and UV resistant." The tape is available in rolls of 1/4 inch x 100 feet for $3.00/roll, 48 roll minimum or 1/2 inch x 100 feet for $6.00/roll, 48 roll minimum. Requests for quotes on larger quantities or different sizes are invited. Please address these to Mr. Jeff Piper, the owner of Horizon Tape Products Company. Mr. Piper has been in contact with the Light Impressions Corporation as a possible dealer for this tape. [As of 1989, both Light Impressions Corporation and University Products carry this product.]

Image Permanance Institute established at RIT

The Rochester Institute of Technology in cooperation with the Society of Photographic Scientists and Engineers has established the Image Permanence Institute (IPI) at RIT. James Reilly of RIT and founder of its Photographic Preservation Laboratory will direct the new Institute. One of the first projects for the Institute, of which the Lab is now a part, will be to study and evaluate storage enclosure materials. The Image Permanence Institute is located at One Lomb Memorial Drive, Rochester, NY 14623 (telephone 716-475-2303).

New Publication

A new Eastman Kodak publication, Conservation of Photographs, has been announced. This is an update and expansion of Kodak's 1979 booklet, Preservation of Photographs. Conservation of Photographs, Kodak Publication No. F-40, is available from Eastman Kodak, Photographic Products Group, Rochester, NY 14650, for $29.95. This is an essential reference tool for curators of slides and photographs -- actually, anyone interested in knowing how to take care of Kodak film materials for posterity.

VII. FILM CLEANERS, GLASS POLISHERS, AND OTHER WONDER PRODUCTS

(Vol.8, No.1) Spring 1981

The market place is filled with products purported to be usable on slides and slide films. Cleaners, lubricants, preservers, scratch removers, anti-static conditioners, and the like, are offered under a variety of names and carry as many claims and promises. Shortage of supply is certainly not the problem. What is lacking, though, is information about the safety of these products when used on film mounted between glass.

Much the same is true about glass cleaners. These may be effective in cleaning the glass of the mounts, but what is the effect on the film when in contact with the glass, especially when this is coupled with projection heat? Since so little is known about the effects these products have on film when mounted between glass, it seems best to avoid them until their safety has been verified. What is desperately needed is an agency or special committee to review and evaluate such products scientifically before being used in this special way.

One film and glass cleaner which has been recommended to us by the Preservation Department of the Library of Congress is alcohol. This well-known substance is effective in removing oily deposits and residues, including fingerprints and the remnants of oil from the glass-cutting machinery.

Alcohol comes in a variety of strengths, types, and purities. Any of these may be used, although ethyl and isopropyl alcohols might be preferable to denatured alcohol because of their higher degree of purity. Anhydrous rather than dilute alcohol is also preferable, but apparently not required. Alcohol is safe to use full-strength.

Alcohol is easily applied to glass (do not use on film) with a cotton applicator (avoid synthetic fibers). We have found cotton-tip applicators to be quite inexpensive when purchased in quantity from medical supply companies. Because of the highly volatile nature of alcohol, it evaporates rapidly, but it is also highly flammable. When used to clean glass, alcohol should be applied liberally to both sides of the plate.

Rubbing the plate "dry" with a clean cotton cloth will lift and remove residues with very little effort.

VIII. HOW TO AVOID CHEMICAL STREAKING ON FILM

(Vol.9, No.1) Spring 1982

While the safety of film cleaners, lubricants, and preservatives when used on film mounted between glass is yet to be confirmed, it is clear from the responses to a questionnaire mailed last summer that these chemicals are being used regularly in slide collections everywhere. The "Survey of Current Stock (Supplies) and Post-1977 Equipment Purchases" sent to about 90 curators, reveals that the two most popular products for cleaning film are Eastman Kodak Film Cleaner No. 195 6986 and Edwal Anti-Stat Color and B&W Film Cleaner. Among the comments recorded about these products, one of the most common complaints expressed by users is that the cleaners often caused streaks on the film, usually requiring additional wiping to remove the residue.

The reason for the streaks could be simple: the use of an applicator made of synthetic fibers or a contaminated cleaner. The chemicals in the cleaner may be causing the synthetic fibers to "melt" in much the same way that these chemicals when applied to plastic cause the plastic to become tacky or gummy. To eliminate the possibility of the cleaner's incompatibility with certain synthetic substances, use a pure cotton applicator. Furthermore, in order to avoid merely spreading or reapplying the residue you are trying to eliminate, use a fresh cotton swab or wad with each application of the chemical. Wipe the cleaner across the film's surface in one direction only. Do not rub, unless you are trying to ruin the film. Remember, too, that film cleaners are designed to remove greasy substances. Water spots require treatment with water, distilled water, applied in the same manner as film cleaner. Finally, in order to ensure that you are not contaminating your cleaner, do not re-wet a used applicator. For larger projects, it is good practice to portion out only enough of the cleaner needed for the job and to dispose of any excess after the job is completed.

IX. TRANSPARENCIES IN PAPER MOUNTS: MAINTAINING A SLIDE COLLECTION WITHOUT THE BENEFITS OF GLASS

(Vol.11, No.4) Winter 1984

It has long been assumed that slides bound in glass are better off than slides left in their original mounts. This is something of a myth especially when you consider just how safe transparencies are when sandwiched between glass in most conventional mounts.[9] Glass mounts must provide an airless, dustless, chemical-free environment for slide film,[10] if adverse side-effects are to be avoided. Furthermore, glass mounts are expensive, labor intensive, and somewhat fragile, but for often-used slides, they do offer protection from at least two common adversaries: greasy fingers and abrasive surfaces. But what about collections that are not man- (or woman-) handled -- personal or archival collections, for example? Are glass mounts necessary? The answer will depend on many variables, but given the evidence, it is likely that glass mounts will add little to the stability of the film if a controlled environment is maintained and care is taken to ensure that the film is not damaged by careless or thoughtless action.

ALTERED STATES

Studies conducted by the major film manufacturers and several independent researchers have shown that the less you do to your slide, which includes removing it from its original mount, the better off it will be. This applies to all slides not just those enjoying the luxury of an undisturbed existence in a climate-controlled vault. Brushing, blowing on, stroking, touching, spraying, cleaning, with or without the addition of chemical substances (cleaners, lubricants, anti-static treatments, and the like) all

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[9]See the following by this author for additional comments on this topic: "Mounting Slide Film Between Glass -- For Preservation or Destruction?" Visual Resources: An International Journal of Documentation, Vol. 2, Nos. 1-3 (Fall 1981-Spring 1982), pp. 37-62, and "Slide Preservation," with Nancy Carlson Schrock, chapter 5 in Conservation in the Library, edited by Susan Swartzburg (Greenwood Press, 1983).

[10]A method for binding that comes close to meeting these requirements is explained in the following short pieces by this author in the International Bulletin for Photographic Documentation of the Visual Arts: "Moisture Control Through Slide Mounting," Vol. 8, No. 3, pp.8-10; Part II: "Techniques and Supplies," Vol. 8, No. 4, pp. 8-10; "Chemical Streaking on Film: How to Avoid It," Vol. 9, No. 1, p. 20; and "Film Cleaners, Glass Polishers, and Other Wonder Products," Vol. 8, No. 1, p. 12 [reprinted here].

constitute a kind of "post-processing treatment" and each treatment, in turn, alters the pristine state of the film or slide. Using a brush that has been collecting dirt and grime from the environment or from the acids and oils on your hands (stroking the bristles with your fingers is enough to do it) may be more harmful to the slide in the long run than a nasty fingerprint right in the middle of the image. Fingerprints can be seen and immediately dealt with using a prescribed and usually effective treatment (e.g., a film cleaner); the former, however, is less obvious and often will not show up until other factors, such as heat, humidity, and pollution enter into the picture. Therefore, even the simple process of removing the film from its original mount could necessitate other treatments, and in this process factors are likely to be introduced that may lead to later problems.

Retaining the original mount has other advantages. Most reputable film processing labs date and code the mount to indicate the type of processing used and the location of the lab. Unless transferred to another permanent record for the slide, this information, which may be important later in an historical or conservation context, could be lost forever.

PAPER VS. PLASTIC MOUNTS

One question often asked about film in paper mounts is "How safe is the film within a paper mount relative to what we are told about harmful substances in paper?" and "What about plastic glassless mounts; are they better?"

Aside from the fact that paper mounts are easily bent and the edges often fray causing the slide to jam in a projector, the popular opinion is that the paper used by Eastman Kodak for their paper mounts over the years will not cause any significant damage to the film. One clue that a paper product is safe or not is if it turns yellow with age. Yellowing and brittleness usually signify a high sulfur content in paper and such materials should be kept as far away from film as possible.

The plastic mount, on the other hand, is rigid, fray-proof, and generally buckle-free (unless warped by heat). It offers greater dependability in projection and, furthermore, plastic mounts do not absorb moisture as do paper mounts. But some plastics expel plasticizers and may even be linked to formaldehyde emission. Polystyrene

is one such rigid plastic currently under scrutiny.[11] This is the plastic from which many items are made including Byers, Gepe, and Quickpoint slide mounts, Kodak carousel trays, as well as the dividers/inserts used in Neumade slide storage cabinets. Until more data is available regarding plastics and their effects on the health and safety of humans as well as film products, we should be mindful that the use of plastics in archival environments is still unproven.

STORAGE

Selecting the best storage medium for glassless slides also should be considered carefully. Since slides usually are stored more than they are actually used (projected or viewed), this could be one of the most important factors determining how well your slides survive in time.

One of the most popular methods for storing slides is the plastic storage page. This provides an inexpensive and easy-to-handle means for grouping twenty 2-inch by 2-inch slides in a standard loose-leaf sheet format (sheets are also available for 2 1/4-inch slides). The slide page fits neatly into a notebook or file folder (use acid-free products to provide the best and safest storage environment for your slides). There is even an accessory available that fits over the long side of the sheet allowing it to be suspended like a hanging folder in a standard filing cabinet.

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[11]According to R. Scott Williams, Conservation Scientist, Analytical Research Services, Canadian Conservation Institute, in "Commercial Storage and Filing Enclosures for Processed Photographic Materials," a paper presented at the Second International Symposium: The Stability and Preservation of Photographic Images, August 25-28, 1985, "Polystyrene has been both recommended and proscribed in the photographic literature. The American National Standards Institute recommends it as a suitable non-corrosive material for the construction of containers for storing film that degrades to yield acidic gases. But, on the other hand, Polaroid Corporation, in its publication Storing, Handling and Preserving Polaroid Photographs: A Guide, published in 1983, in a table entitled "Avoid these materials" lists "unstable plastics (such as polyvinyl chloride and polystyrene)." In response to Williams' inquiry, Polaroid's reply was that "this precaution was based on the recommendations of our chemists, due to concern over possible long term release of low molecular weight plasticizers from such plastics. There is certainly much greater concern over highly plasticized vinyl products." Williams counters Polaroids statement by saying "To my knowledge, polystyrene is not plasticized by low molecular weight plasticizers but rather, flexibility is introduced by copolymerization or blending with other polymers. These other polymers are not volatile or mobile. Because of this, there is little or no fear of plasticizer migration in polystyrene products as there is with poly(vinyl chloride)."

BEWARE OF PVC!

Caution, however, must be used in selecting a safe, chemically inert, slide page. Avoid pages made of polyvinylchloride (PVC) and choose, instead, those made of polypropylene or polyethylene. PVC products are known to cause an adverse reaction which results in damage to the emulsion layer of the film. In the examples I have seen, the uppermost yellow dye layer was absorbed into the plastic. A simple clue to the presence of PVC can be the "smell" of plastic. This is not to imply, however, that all slide pages that do not exude a strong plastic odor are safe. If you are in doubt about the chemical makeup of the slide storage pages you are using, it is better to do a bit of checking and inquiring than to ignore the possibility that your collection could be vulnerable to damage because of a PVC reaction. There are a number of companies manufacturing "safe" or "archival" storage pages. Check with a supplier of archival products such as the Light Impressions Corporation in Rochester, NY, if you are unable to locate these products locally.

Because most plastic slide pages enclose the slides in pockets which restrict air circulation, be sure your slides are stored in a dry environment. Moisture is easily trapped within the pockets causing the film to stick to the plastic surface. The film can be seriously damaged by this adhesion--the worst possible fate being that the emulsion can become permanently stuck or "ferrotyped" to the plastic!

Another type of slide page is the rigid frame. Made of a hard or high-impact plastic, these provide either fully or partially open frame slots for twenty 2-inch by 2-inch slides in the familiar loose-leaf format. The frames fit nicely into filing cabinet drawers without any additional bars or rods. One such rigid slide frame is made by the Plastican Corp. in New York.

SLIDE SLEEVES = MORE PROTECTION

If you are using any of the open frame storage devices but find that these do little to protect the exposed delicate surfaces of the film, a mylar or polyester acetate slide protector or sleeve may be just what you need for some added safety. The slide protector slips snugly over the slide but, like the film itself, it is easily marred and scratched. Nevertheless, the sleeve is useful in shielding the slide from dust and fingerprints. It is not only a chemically safe product but also one that is relatively

economical to use.

CABINETS, BOXES, AND DRAWERS

The best kind of container for storing slides is one made of either metal with a baked enamel finish or high-impact plastic. Slide cabinets come in many shapes, sizes, and colors and generally speaking they are an expensive yet efficient means for storing large numbers of slides. Cabinets are fitted with drawers or inserts that facilitate either individual or group filing. Because of the thinness of paper or plastic mounted glassless slides, one can usually fit two slides into a single slot in drawers designed for individual filing but this arrangement is seldom satisfactory unless both slides are of the same image. Group filing -- arranging slides in blocks between moveable dividers -- is probably the more efficient way to handle large quantities within a small space. However, over-packing should be avoided because a tightly packed container usually leads to disaster, not to mention frustration on the part of the user.

HANDY AND INEXPENSIVE PARTS CABINETS

In addition to the file boxes that one finds in most camera shops and the standard storage cabinets available through most office supply or archival products companies, there are products suitable for containing 2-inch by 2-inch slides offered through industrial equipment supply houses as well. Small parts cabinets, for example one called a "Slide-N-Lock Drawer Unit" made of high-impact polystyrene, with sixteen drawers, each measuring 2 5/8-inches W x 11 1/4-inches D x 2 1/2-inches H, costs a low $31.35 (available from the Global Equipment Co. in Hempstead, NY, toll-free telephone number 800-645-2986). This company also carries cabinets suitable for other sizes and formats as well. While the drawer is slightly higher and wider than a 2-inch by 2-inch slide, the extra space affords more maneuverability and head-room (for division markers) than is usually found in a typical slide cabinet.

PROJECTOR TRAYS AS FILING UNITS

Slides that are to be maintained in a fixed order, for example, slide-tape programs, may be stored in carousels or other types of projection trays. To insure that the slides are not rearranged either accidentally or deliberately, a locking device might

be needed on the tray.[12] Tray storage, while offering convenience to the user, nevertheless has a few drawbacks: trays take up a lot of space and they are easily damaged. Trays are also notorious as dust catchers if not properly covered while in storage.[13]

A few final words about slide storage: avoid the temptation to use boxes or drawers made of non-archival paper or wood products such as shoe boxes or wine crates. Consider your initial investment in film, processing, equipment, and time when making your selection of a suitable storage medium for your materials.

TRAVELING WITH SLIDES

Transporting slides from one place to another often requires extra protection and some precautions. Plastic slide boxes and zip-seal plastic bags are useful in all climates, even wet ones. If slides have been exposed to extreme cold or heat, remember to allow time for the film to acclimate before subjecting it to the opposite extreme. (The same is true for projection equipment.)

HOW TO CLEAN A SLIDE

Cleaning slide film within an open frame mount should be done only when necessary and then with great care. Avoid using chemicals whenever possible; try blowing the dirt away (using a child's ear syringe rather than your breath) or vacuuming it up instead of rubbing or pushing it with a brush or cloth. Pressurized or canned air is popular as a means for expelling dirt and dust from a surface, but be aware that the canned air is propelled by a chemical. Purists take note!

DISTILLED WATER VS. FILM CLEANERS

Based on my experience with cleaning slide film, I can assure you that the more

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[12]See "Controlling Security for Slides Set Out for Student Study in Carousel Slide Trays," International Bulletin for Photographic Documentation of the Visual Arts, Vol. 8, no. 3, p. 18.

[13]One of the faculty members at the University of Oregon has found that vacuuming his slide-filled carousel trays on a regular basis has solved his dust problem. In order to ensure that all is not lost at the turn of the switch, be sure the locking ring on the tray is secured before you turn the vacuum on.

you stroke the film, the worse your problem becomes. If your slide has only a few specks of dust or debris on the surface, often all you will need to do is tap the film in order to release the dust particle or fiber. If you use a brush, be sure it is clean. Swish it in denatured or ethyl alcohol periodically to remove the oils and dirt that have accumulated and then let it dry completely. Use the brush to lift off the offending particle or fiber rather than dragging it across the length of the film and chancing a scratch on the surface. Sterilized cotton -- sold in rolls -- is recommended if you must use a liquid cleaner to remove fingerprints and gummy substances. Use the cotton swab only once. Apply the liquid cleaner to the cotton, stroke the film quickly and only in one direction (do not rub!) and then throw the cotton piece away. If you haven't been able to remove all the debris on the first try, use a new piece of cotton and proceed as above. Avoid contaminating your film cleaner with a used cotton swab that may contain debris you have already dislodged.

Distilled water is often effective in cleaning non-greasy spots on the base (shiny) side of the film. Do not use water to clean the emulsion (somewhat duller, sometimes matte, with raised outlines) side; this will soften the emulsion and damage it. A film cleaner, generally the one recommended by the manufacturer of the film you are trying to clean, is suitable for removing greasy and gummy residues from both the base and emulsion sides of the film. Fingerprints can be successfully removed if they are cleaned immediately. A fingerprint that has been on the film for some time, especially if it is on the emulsion side, will probably not come off even with the best of cleaners. If you have a choice in cleaners -- with lubricant or without -- choose the latter for cleaning slide films.

THE IDEAL ENVIRONMENT

A safe environment for film materials is, of course, the best insurance that your investment will be protected. Excessive humidity -- moisture in the air -- and high temperature are probably the most common environmental factors contributing to serious film damage: fungus, dye deterioration, chemical reactions, warped film, to name a few. Low to moderate temperature (up to 70 degrees F.) and relative humidity between 30 and 50 percent, free of pollutants and harmful gases should be your goal in selecting a place to store your slides and other photographic materials. Freezing your slides in a frost-free environment offers you even better protection and ensures a longer

life for your film. While different products have somewhat different tolerances (the Kodak E-3 and E-4 Ektachrome and most Agfachrome films, for example, are less stable than Kodachromes and some of the more recent film emulsions) a basic rule of thumb for all film products is that the colder and drier the environment, the better.

X. POLAROID RECOMMENDS GOLD PROTECTIVE TREATMENT WITH ITS AUTOPROCESS 35MM TRANSPARENCY IMAGES

(Vol.11, No.4) Winter 1984

Since the introduction of the Polaroid Autoprocess 35 film group (Polachrome CS/Color Transparency; Polapan CT/Continuous Tone Black & White; Polagraph HC/High Contrast Black & White), the question of film stability has been a concern. In February of 1983, while members of the Visual Resources Association visited the campus of Princeton University as part of the activities held in conjunction with the annual College Art Association of America conference in Philadelphia, representatives of the Polaroid Corporation previewed these new films for us. Susan Filipiak, in her review of the proceedings, provided us with the following data based on what Polaroid revealed to us at that time:

> Stability tests are now being done by Polaroid and the results are reported to be very good, comparable to conventional slide films on the market today. Accelerated aging tests are now being performed in Puerto Rico under four different environments (heat and humidity, heat and no humidity, etc.) and the Polaroid slide film is standing up well. The shelf life of the film before exposure is 9-12 months.[14]

Some new information concerning the stability of Polaroid's Autoprocess 35 films has come to light. Recently Polaroid has published its recommendations for a gold protective solution as a treatment "to enhance the keeping qualities" of their films.[15] In a Technical Assistance Bulletin, "Gold Treatment of Polaroid Autoprocess 35 Transparency Images," they explain:

> Gold treatments deposit a very thin layer of metallic gold on the silver image of the Autoprocess 35 transparencies and thereby protect the image against adverse

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[14]Conference Report: Princeton Session, "Polaroid Instant 35mm Slide Films," by Betsy Fitzgerald and Cal Pratt, Polaroid Corporation, as reported by Susan Filipiak, International Bulletin for Photographic Documentation of the Visual Arts, Vol. 10, No. 1, p. 16.

[15]The use of gold on photographs first as a toning solution and subsequently as a protective coating for silver images is a process that has been used since the nineteenth century.

environmental conditions. These treatments reduce the effects on Autoprocess 35 transparencies that may be caused either by prolonged exposure to high temperature and high humidity environments, or by trace amounts of corrosive or harmful gases in the atmosphere.[16]

One of the gold protective treatments recommended by Polaroid is available from Light Impressions Corporation, P.O. Box 940, Rochester, NY. It is a five-liter kit with instructions (Code 5600) for $29.50.[17]

[16]In order to obtain a copy of the bulletin, call Polaroid's technical assistance toll-free number (800-354-3535) or write to the company at 575 Technology Square, Cambridge, MA 02139.

[17]My thanks to Nancy DeLaurier for sharing this information with me.

XI. SEASONAL CHECK-UPS FOR SLIDE ROOM EQUIPMENT

(Vol.10, No. 2) Summer 1983

Spring and summer in many areas of the country are synonymous with high relative humidity. Monitoring the environment where your slide collection is housed is the best way to know what conditions prevail. A hygrothermograph that automatically records both the temperature and humidity on a daily, weekly, or monthly basis is, perhaps, the most efficient way to do this, but be aware that precision instruments such as this need periodic inspection and, possibly, re-calibration. Check with your purchase agent or with the manufacturer of your equipment to find out the location of the nearest authorized service agency to arrange for a service analysis.

Similarly, air-conditioners require periodic inspection. Check the condition of the air filter (perhaps it is time to replace it) and examine the electrical cord and power switches for signs of wear. If your system includes a humidifier (in larger stand-alone systems, this is needed to keep the humidity at a constant level), have the demineralizing cartridge checked to determine if a new one is needed.

Door gaskets and fittings around window air-conditioners should be inspected to see that the closures are still functional and tight.

While on the subject of moisture and film collections, try to keep wet objects (rain-gear, umbrellas, and soaked people!) out of the collection storage area. There is usually enough moisture in the air without adding puddles to the problem!

XII. RELATIVE HUMIDITY: INSTRUMENTS AND PRODUCTS FOR MEASUREMENT AND CONTROL

(Vol.9, No.2) Summer 1982

Summer is here and with it comes a perennial problem for slide and film collections -- warmer temperature and higher relative humidity (RH). Though we welcome these conditions for our personal comfort (good-bye to parkas, boots, dry skin, and split fingernails until next winter!), slide and film collections benefit less (if at all) from such an environment. Now is the time to watch your thermometers and hygrometers with an eagle's eye.

Temperature is undoubtedly easier to control than relative humidity. For the former, a powerful air-conditioner will usually do the trick. However, the problem of high relative humidity may require additional equipment such as a dehumidifier.

Certain climate control systems provide both temperature and humidity control, but these may be expensive initially. If you need some ideas as to the types of environment control systems that are suitable for slide and film collections, look for information on systems designed for computer rooms. The environmental requirements in these areas are basically the same as those needed for slide and film collections.

Basic to understanding the problems brought about by excessive moisture in the environment is understanding relative humidity. Have you ever wondered how RH is figured in the first place? Here's how it is explained in a brochure published by the Taylor Instrument Company:

> The amount of water vapor in a unit volume of space compared to the total amount that could be contained in the same space under the same conditions of atmospheric pressure and temperature is the relative humidity and is expressed in percentage. For example, we know that under normal conditions of pressure at 70 degrees F., a cubic foot of space can hold 8 grains of water vapor [1 grain equals 1/7000th part of a pound of water]. Therefore, air with only 2 grains has only one-quarter of its maximum capacity -- that is, the relative humidity is 25 percent.

The total amount of water vapor that air can hold is dependent upon its pressure and temperature. At a pressure of 30 inches of mercury, air at 0 degrees F. will hold about one-half grain of water vapor per cubic foot; at 32 degrees F., about 2 grains; at 70 degrees F., about 8 grains; and at 100 degrees F., about 20 grains.

Measuring relative humidity is accomplished with instruments called psychrometers and hygrometers. These usually employ one of two basic systems for gauging atmospheric moisture: 1) wet-bulb and dry-bulb thermometers from which RH is determined by calculating the two readings; and 2) direct-reading types in which hygroscopic materials activate a mechanical device which translates the amount of moisture into direct indications of RH.

Sling psychrometers which have been called "the standard of accuracy" range in price from $30.00 to about $60.00. Direct-reading hygrometers (which are often combined with thermometers in a single unit) can be very inexpensive (under $10.00) although more sophisticated laboratory-type models may cost as much as $300.00. A hygrothermograph which provides a permanent record of humidity and temperature on a rotating chart is probably the best instrument of its kind for monitoring room atmosphere, especially if you suspect that conditions fluctuate throughout the day. Hygrothermographs record temperature and humidity on a daily, weekly, or monthly basis, depending on the model selected. They range in price from about $350.00 to more than $650.00.

For information about a complete line of temperature and humidity measuring instruments, including hygrothermographs, write to Science Associates, Inc., 230 Nassau Street, Box 230, Princeton, NJ 08540 (telephone 609-924-4470).

Another type of humidity indicator is in the form of a treated paper. Manufactured by Hydrion, "Humidicator Paper" (about $6.00 per roll) is designed for "the detection and estimation of moisture." It is probably most effective as a spot indicator, such as to demonstrate the low humidity of a "frost-free" refrigerator versus the high humidity of a regular refrigerator. In the presence of water or water vapor, the color of the paper changes from a deep blue to bright pink (20 percent to 80 percent

RH). Hydrion "Humidicator Paper" is available from Light Impressions Corporation, Box 3012, Rochester, NY 14614 (toll-free telephone 800-828-6216). For a catalog of the complete line of Hydrion products (which includes pH test papers), write directly to Hydrion, Micro Essential Laboratory, 4224 Avenue H, Brooklyn, NY 11210 (telephone 212-338-3618).

Humidity indicator cards are also available in four different styles from Multiform Dessicant Products, Inc. 1418 Niagara Street, Buffalo, NY 14213 (telephone 716-883-8900). For more information, write to this manufacturer, referring to product no. 7410 to help identify this item within their extensive line.

If an immediate stop-gap measure is needed to control excessive humidity in small spaces such as slide boxes, storage cabinets, or the like, silica gel (a colloidal form of silica) can be used. While not the most efficient means of controlling excessive moisture because it requires reactivation by heating once the moisture capacity is reached, it is, nevertheless, useful and effective if there is no alternative. Silica gel ($S10_2$ H_20) is chemically inert and according to John S. Cullen ("The Right Dessicant: Your Weapon Against Moisture's Ravages," in Package Engineering, February 1975), it "has a pore value of about 40 cubic centimeters per 100 grams, which will hold approximately 40 cubic centimeters of any condensed vapor at 100 percent relative saturation." Mr. Cullen goes on to say that while silica gel has a relatively high capacity for moisture at temperatures below 77 degrees F. with relative humidity concentration about 40 percent, it loses its water capacity as temperature rises.

Silica gel is available in bulk form and in various types of packaging. According to Warren D. Shipp ("How to Keep Gear and Film Bone-Dry," in Modern Photography, Vol. 45, No. 10, October 1981, p. 136), one one-pound jar of indicator-type silica gel, purchased from a chemical supply house, cost him $20.00. With this stock, Mr. Shipp has devised his own containers -- plastic jars with screw-on caps perforated with a hand-held drill for ventilation. Reactivation of the crystals is accomplished in a ceramics kiln set on high (600 degrees F.) but an oven will ultimately produce the same results. He warns the reader not to use a microwave oven for drying.

Pre-packaged silica gel is available from the following (by no means an exhaustive list):

Dri-Can - Mfgr: Multiform Dessicant Products, Inc. [address given above]; sold by Light Impressions Corporation; about $5.00.

Davison Air Dryer - Mfgr: Davison Chemical Division of W. R. Grace & Company, 10 East Baltimore Street, Baltimore, MD 21202; sold by Jensen Tool Inc., 1230 South Priest Drive, Tempe, AZ 85266 (telephone 602-968-6231); about $6.00.

Drierite - Mfgr: W. A. Hammond Drierite Company, Xenia, OH 45385; packaging: 1 lb., 5 lb., 25 lb.; regular or indicating type.

One final word on the subject of silica gel. While it may be useful as a stop-gap measure for a small space, it is certainly not the answer for a slide collection any larger than a shoebox. Other measures to control moisture should be considered such as a self-draining dehumidifier or, better yet, a stand-alone environmental control system.

XIII. TEMPERATURE FLUCTUATIONS IN THE SLIDE STORAGE AREA -- HOW CONCERNED SHOULD WE BE?

(Vol.10, No.1) Spring 1983

Should an institution be advised against turning off the heat in a building housing a film collection which would result in a temperature low of around 55 degrees F. for about 10 days? What damage can occur when the heat is turned on again and the temperature reaches 70 degrees F. in a relatively short period of time?

Actually, subjecting the slides to lower temperatures for ten days could, possibly, be beneficial for them. Also, reheating the building to 70 degrees F. should not affect the film material since this will be a gradual warming compared to putting a slide acclimated to 70 degrees F. into a projector that heats up to 145 degrees F. in a matter of seconds.

However, one factor that must be considered very seriously before allowing such a heating shutdown is the ambient moisture quotient. If the temperature is lowered, will the moisture level (RH) drop with it? If not, you will be faced with a condition where the percentage of RH will rise as the temperature drops. The benefits of lower temperatures are then questionable.

Keeping track of the percentage of RH in the storage area under "normal" circumstances for a period of several months (spanning two or more seasons) is strongly recommended. This could provide a better argument against any budget/energy saving measures than the temperature factor alone. The first step is to try to enlist the help of the heating/air conditioning specialist employed by your institution. Ask how the proposed energy-saving measures would affect your environment, especially with regard to relative humidity. If the engineer is able to reduce the moisture content in the slide storage area to an acceptable level (between 30 and 50 percent) when the temperature is lowered, then by all means enjoy the cooler temperatures. Unfortunately, lowering the RH is not always an easy procedure. If the RH cannot be reduced with existing equipment, find out what you should purchase to achieve your goal and what this would cost. The next step would be to submit a proposal to your administrator outlining your

specific needs along with any documentation that would help to support your request.

It is not unusual for administrators to lose sight of the actual monetary investment made over a period of years in establishing and maintaining a film or slide collection. You may be able to help realign their viewpoints if you can present them with hard facts and figures. For example, if the replacement cost of a slide is calculated (market value of an original + materials and labor + cost of housing [cabinet, filing accessories, catalog and guide cards, etc.]) and then multiplied by the number of items in the collection, the estimated replacement cost is usually staggering. Add to this fact that the collection probably contains irreplaceable, historical records and, most importantly, it provides a service without which many people would be unable to perform their assignments, you may be able to gain administrative favor and support for the necessary environmental requirements for the proper storage of your film materials.

XIV. PROJECTORS -- TROUBLESHOOTING PROBLEMS

(Vol.7, No.3) Fall 1980

Projectors need attention and periodic maintenance in order for them to function flawlessly. Occasionally problems occur. Can you recognize the source of the problem? Here's a checklist of likely causes of projector malfunction:

1. IS THE HEAT FILTER OR CONDENSER LENS IN PLACE AND UNBROKEN?

   If this lens is not positioned properly in the slot designed to hold it or if it is missing or broken, lamp heat will damage the slide. If your equipment is constantly being transported, check to see that the heat filter hasn't fallen out. A broken or missing heat condenser will invariably cause the slide and probably its mount to melt. Review the instruction manual for your projection equipment to determine where the heat filter is located. [Some of the newer projection systems have eliminated the need for the condenser lens entirely; learn how your projector's system works.] Broken or missing filters can be replaced without any technical or mechanical ability. It is advisable to keep a few spares for such emergencies.

2. IS THE FAN REVOLVING? ARE THERE ANY OBSTRUCTIONS SUCH AS DISLOCATED WIRES, FOREIGN OBJECTS, ETC. IMPEDING ITS MOVEMENT?

   On the subject of fans, here's something else to consider. Recently we found that a few of our old [manual] projectors which had just been returned from service were actually performing worse than before they were sent away for repairs. Why? The fans which were thought to be at fault in the causing the machines to overheat were replaced, but they were installed upside-down! The reason for this mistake was that the replacement fans were actually designed for use in the newer model projector (same company) in which the heat is drawn down and carried out the bottom instead of forced upwards and out the top as in the older models. The replacement fans were thus incompatible with the older motors; furthermore, they were smaller, in keeping with the size of the more compact, newer machines. A similar case involves the positioning of the motor in relation to the lamphouse. While this situation may have been unique

to only certain types of projectors, once identified and corrected, the overheating dilemma in about three-fourths of the problematic projectors was solved. Again, it was in repairing and replacing parts that the original alignment was changed. The difference of 1/8-inch to 1/4-inch in the position of the fan next to the lamphouse raised the temperatures to unacceptable levels.

3. IS ANYTHING BLOCKING THE AIR SUPPLY OR EXHAUST VENTS OF THE PROJECTOR?

Blockage of the air vents can be easily avoided since it is often the result of careless clutter around the projector. Disastrous results can also be experienced in using hastily assembled risers, such as small books, paper boxes, etc., which may work to raise the projector to the desired level, but which obstruct the ventilation system often provided in the construction of the base of the machine. It is something of a comfort to know that many of the newer projector models are now equipped with automatic thermal fuses. This device shuts off the projector if conditions cause it to overheat. But overheating can still occur even if this device is present. Nevertheless, according to the Kodak AV Equipment Memo, S-80-6, "Ventilation, Noise Control, and Heavy-Duty Operation of Kodak Projectors," "overheating will shorten motor life and may reduce lamp and slide life."

4. IS THE MOTOR RUNNING SMOOTHLY? WHEN WAS IT LAST CLEANED AND LUBRICATED?

Another variable which can ultimately contribute to temperature differences is motor pitch or revolutions per minute (RPM). This is something which has been adjusted in our machines with varying success. However, the fewer the RPM, the louder the motor, and the harder it is to hear the lecturer over the roar of the projector.

Supply voltage may also be a factor in erratic performance of equipment. Most equipment made for use in the United States and Canada is regulated for 60-Hz and 110- to 125-volt single-phase electric current. Overheating and erratic operation can result from voltages greater or less than those recommended. A power failure caused by an overloaded circuit can result in costly damage to the projector or any other equipment for that matter. Periodic inspection and lubrication is the best safeguard for the efficient operation of all equipment. Scheduled servicing by qualified specialists helps to avoid radical breakdowns

and costly repairs.

5. AN ALTERNATIVE...

If routine repairs prove to be ineffective, another method for reducing lamp heat might be tried. One solution, suggested to me by Alan Tull of England calls for the conversion of the lamphousing of the projector to take a lamp of lower wattage and more intensity such as an arc lamp. Mr. Tull gives the following example: "Nearly ten years ago at the Royal Photographic Society, we converted a Leitz "Prado" projector to take the minuscule "CSI" arc lamp made by Thorn Electric here. This is still in use on an 8-foot screen and provides the best illumination we know within the compass of standard equipment, giving 1,500 screen lumens (or to about 1,000 with double heat filter)." These figures stand in comparison with the lamp normally used in the Leitz "Prado," a 250-watt, 24-volt lamp, which provides for an illumination of 315 lumens, according to Mr. Tull. A few words of caution are necessary. Slides mounted in most commercial glass mounts may be damaged by a projector employing an arc or other high intensity lamp [see article following for further discussion]. Consult the manufacturer of the lamp or projector for information and recommendations.

XV. LIGHT VS. HEAT -- IS THERE A LESSER EVIL?

(Vol.10, No.1) Spring 1983

Light in the form of ultraviolet (UV) radiation is the factor responsible for most damage incurred by slides during projection. In addition to being directly linked to image dye fading, light as energy rather than radiant heat is also the cause of most physical damage to the film in a projection situation. As explained in my article, "Mounting Slide Film Between Glass: For Preservation or Destruction," (Visual Resources: An International Journal of Documentation, Vol. II, Nos. 1/2/3, pp. 37-62), light energy more so than radiant heat was responsible for higher surface temperature in the film (p. 50). For example, a slide projected with a 1000 W lamp could register a lower surface temperature than a slide illuminated by a 300 W lamp because the ultraviolet emission and light energy absorption are the significant factors here in producing these results. An important variable affecting the amount of light energy being absorbed is the density of the slide. If the slide image is predominantly color-dense (dark colors, large areas of black) rather than transparent (light colors, mostly white areas), then the film will be absorbing more light energy and it will, therefore, be hotter on the surface. Darks absorb while lights reflect.

High temperature in storage situations must be avoided, however, because constant exposure of film materials to such conditions will accelerate cumulative dye fading, even without exposure to light. This is known as dark storage fading. Therefore, it is recommended that film materials be housed in low temperature (the lower, the better is the general rule as long as a low relative humidity (RH) level is also maintained). Eastman Kodak charts the rate of density loss in image dyes in its publication "Storage and Care of Kodak Color Materials," (Pamphlet No. E-30), with the following conclusions: assuming the norm to occur at 70 degrees F. and 40 percent RH, density loss of 0.1 would be seen in only half the normal time when the temperature is 86 degrees F. (48 percent RH), but it would take four times as long to reach 0.1 density loss at 55 degrees F. (40 percent RH) and sixteen times longer at 39 degrees F. (40 percent RH)! In other words, with cooler temperatures, dye fading occurs at a slower rate than it would under the same conditions with higher temperatures. Concerning ourselves with the problem of dark storage fading should be among our priorities because most slides, even those in active (non-archival) collections, spend the greater

part of their useful lives in storage.

XVI. RUNNING THE LAMP FAN -- NECESSARY OR EXCESSIVE?

(Vol.7, No.4) Winter 1980

When watching people at the end of their slide presentations systematically turn their projector's lamp switch off while keeping the lamp fan on, one usually assumes that these are necessary steps -- requirements -- before turning the power off completely. But are they? What happens if you don't fast cool the lamp? Will the lamp explode or worse?

Fan and lamp switches are common features on many projectors including the Kodak Carousel and other manual or cartridge-type projectors. However, despite what most of us have come to think is standard practice -- running the fan for a few minutes before switching off the motor -- there are actually only a few instances when this is required.

Generally, running the fan to accelerate cooling is necessary only if the machine must be handled immediately after use, e.g., if the projector is to be moved or stored or if the lamp must be replaced quickly. While fast cooling may be used in these instances, it is far more beneficial to wait until the machine reaches a temperature equilibrium on its own before moving, storing, or changing the lamp.

Under normal circumstances, fast cooling is not recommended for the following reasons: (1) rapid temperature changes shorten the lamp life and (2) the motor is likely to wear out faster with the extra running time used to cool the lamp.

From the literature available on the subject,[18] the benefits derived from rapid cooling seem to be insignificant. Projector motors and internal wiring can withstand temperatures much higher than those reached during projection. It is obvious, therefore, that once the motor is turned off, no appreciable increase in heat will be realized within the projector with or without the aid of the fan.

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[18]See the following: Eastman Kodak, Kodak AV Equipment Memo, "Ventilation, Noise Control, and Heavy-Duty Operation of Kodak Projectors," Rochester, 1978, Publication No. S-80-6; and "Kodak Slide Projector Lamp Data and Light Output Modification," Rochester, 1978, Publication No. S-80-2.

It is also interesting to note that many of the newer projector models designed for heavy use, such as Kodak's German-made carousels (the S-AV line), and the Leitz Pradovit among others, are equipped with only one power switch. The fan lever for rapid cooling has been eliminated, no doubt, for the reasons indicated.

XVII. FLUORESCENT LAMPS AND COLOR SLIDES

(Vol.8, No.2) Summer 1981

Many factors contribute to dye fading in color slide film, but perhaps one of the most frequently overlooked sources of possible damage in visual resources collections is fluorescent lighting. This light source, used in light tables, illuminators, viewers, visual display rack-type storage cabinets, and the like, is favored for its bright, even display. Furthermore, it has been shown to be a reliable light source for evaluating "correct" color in transparencies. The ANSI standard (publication Ph2.32)[19] for color-corrected viewing of transparencies requires a fluorescent lamp with a color temperature of 5000 degrees K. and a Color Rendering Index (CRI) of 91+.

However, if the emission level of ultraviolet (UV) radiation in a fluorescent lamp is high, what may be gained in brilliance and accuracy could be lost in dye fading due to overexposure. The emission level of ultraviolet radiation can vary considerably even among lamps of the same color temperature and CRI. Careful selection, therefore, is important, and, perhaps, crucial if fluorescent lamps are being used to illuminate slides for extended periods of time (in display cases, for example).

According to Raymond H. Lafontaine and Patricia A. Wood in the Canadian Conservation Institute's Technical Bulletin No. 7 (January 1980), "Fluorescent Lamps," lamps that emit low levels of ultraviolet radiation while still providing the needed color temperature and light quality are available. These have been specially designed for applications where dye loss in color materials is a significant concern, for instance, in clothing and department stores, museums, and art galleries. Such lamps are usually more expensive than conventional ones, but the added safety feature of low ultraviolet radiation emission make them a worthwhile investment.

Because information about the actual quantity of ultraviolet given off by fluorescent lamps is usually not supplied by lamp manufacturers, Lafontaine and Wood conducted tests on fluorescent lamps using a Crawford UV Monitor Type 760. A

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[19]American National Standards Institute (1430 Broadway, New York, NY 10018, telephone 212-354-3300), publication Ph2.32, "Viewing Conditions for the Appraisal of Color Quality and Color Uniformity in the Graphic Arts."

description of their testing methods and a full list of lamps evaluated is contained in their publication which is available free of charge upon request from the Canadian Conservation Institute.[20] The following data, summarized from Table I in this publication, provides a sampling of the differences in 5000 degree F. fluorescent lamps. The authors specify that ultraviolet emission should not be above 75 to be within the range of acceptability "where photochemical deterioration is of some concern." (p.6)

Manufacturer/Model	UV	CRI	Lumen Output
Philips (Norelco)			
F40: Color-matching 47	33	98	1830
Westinghouse			
F40: Ultralume 5000	51	85	2900
Verd-A-Ray			
F40 (5100 K.) North White Fadex	46	91	2740
F40 (5100 K.) North White	107	91	2740
F15 (5100 K.) North White Fadex	68	91	not available
F15 (5100 K.) North White	125	91	not available
Duro Test			
F40: Optima 50	107	91	2200
F15: Optima 50	100	91	640
Sylvania			
F40: Design White	112	82	2300
General Electric			
F40: Chroma 50	102	92	2200

[20]The Canadian Conservation Institute, The National Museums of Canada, 1030 Innes Road, Ottawa, Canada, K1A 0M8, offers an impressive series of Technical Bulletins and Journals at no charge:

#1: Relative Humidity: Its Importance, Measurement, and Control in Museums
#2: Museum Lighting
#3: Recommended Environmental Monitors for Museums, Archives and Art Galleries
#4: Care of Musical Instruments in Canadian Collections
#5: Environmental Norms for Canadian Museums, Art Galleries, and Archives
#6: The Care of Black-and-White Photographic Collections: Identification of Processes
#7: Fluorescent Lamps
#8: The Care of Wooden Objects
#9: The Care of Black-and-White Photographic Collections: Cleaning and Stabilization

Macbeth

F40: 5000 F40	237	high	not available

This list, limited to the lamps included in Lafontaine and Wood's study, is, therefore, not all inclusive.

Another means of eliminating ultraviolet radiation from fluorescent light sources is by using ultraviolet shields. One such popular device is the bulb jacket or sleeve[21] for fluorescent lamps. These are made of acrylic and carry a UVA-7 designation; they are available in clear or amber. Bulb jackets are relatively inexpensive; one manufacturer suggests a price of $30.00 per sample order of 24 units of one color (each unit is 48-inches long). Bulb jackets are reusable. They are not color corrected for transparency viewing.

UF-3 and UF-4 Plexiglas is also effective in filtering out ultraviolet radiation. It is said to eliminate more ultraviolet emission than sleeves made of UVA-7. A sheet of UF-3 Plexiglas could be installed under the opalescent covering of a viewing box or light table, but, again, the light will not be color corrected for viewing transparencies. Plexiglas sheets are available in 1/8-inch and 1/4-inch thicknesses.

The actual effects of ultraviolet radiation on glass-mounted slides is still a matter deserving closer study. One assumes that the glass of the mount provides some degree of protection (probably minimal) from ultraviolet radiation. But specific information on this subject is, to my knowledge, absent in the literature. Unbound slides, on the other hand, would be directly affected by excessive exposure to ultraviolet radiation. Because we know photochemical deterioration to be a serious problem in preserving color slide material, every effort should be made to try to eliminate as many hazards as we know exist in order to ensure the prolonged usefulness of the color slide.

[21]Bulb jackets are sold by companies specializing in archival products such as the following: Solar Screen, 53-11 105th Street, Corona, NY 11368 (telephone 212-592-8223) and Conservation Resources International, Inc., 1111 North Royal Street, Alexandria, VA 22314 (telephone 703-549-6610). Conservation Resources International has offices in London, Caracas, Brisbane, and Ottawa.

XVIII. RE-EVALUATING YOUR INSURANCE COVERAGE

(Vol.6, No.2) Summer 1979

Your slide and photograph collection is undoubtedly covered under an institutional insurance program. Are you aware of how well and how much coverage is provided for your collection?

While we will probably all agree that the loss of a collection through fire or any other means is a permanent loss, sufficient monetary compensation may be, perhaps, the only positive aspect in the rebuilding process. Each item in your collection should be estimated at its fair commercial market value, plus the cost of labor and materials used in the preparation of the item for its place in the collection. [A reasonable estimate in 1989 might be $8.00 per slide and $10.00 per photograph.] Insurance coverage should be evaluated and upgraded annually to include the new accessions and to re-evaluate the market values assigned to these items.

Each piece of equipment used in most institutions having a certain dollar value, for example, $100.00 or more, is usually assigned an inventory number. Inventoried items are fully described by physical features as well as their location within the institution. These records are kept in the central inventory office which could be a purchasing department or the risk management office. Items under $100.00 usually fall under a general heading such as supplies or disposable materials, and their value is the aggregate of the individual items. The total value of equipment and supplies is calculated annually and added to the same insurance coverage report that includes slides and photographs.

Equipment fabricated within a department which might incorporate inventoried items as well as additional supplies (a custom-built copy stand, for example), should be estimated in yet another manner. While the materials for a fabricated item are probably sufficiently covered under the insurance plan, the cost of labor used to produce the piece may not be. The total cost/value of fabricated equipment should be adjusted annually to keep pace with rising costs of both merchandise and labor.

Insurance needs are never the same for everyone. However, when a catastrophe occurs, the strengths or weaknesses of your coverage will become evident all too soon. The time spent re-evaluating your insurance coverage may be the best investment you and your institution can make.

PHOTOGRAPHS

I. RESIN-COATED PAPER: POTENTIAL PROBLEMS FOR COLLECTIONS?

(Vol.13, No.3) Fall 1986

A colleague writes to inform me that ink from an identifying stamp placed on the back of photographs printed on resin-coated paper is bleeding **through** the photograph and appearing on the surface! To her dismay this seems to be happening only on the "newer resin-paper stock." To understand the reason for her concern, let us review the characteristics of resin-coated paper.

Anyone actively collecting photographs from contemporary sources is aware that resin-coated or water-resistant base paper has almost completely replaced fiber or conventional paper-based stock in the industry.

Water-resistant base photographic paper has been around since the 1940s. These early manifestations, for example, Kodak Resisto and Kodak Resisto Rapid, were used by the Armed Forces. They were coated with baryta and then covered again with a cellulose ester in a solvent. Today's resin-coated papers, known as RC papers to most, are coated with polyethylene. This substance is applied to both sides.

The reason for the change from fiber or paper-based stock to RC paper is ultimately moisture-related. Paper's affinity for moisture means that it requires extended time for fixing and washing, is weakened in photographic solutions, and takes a long time to dry. Similarly, humidity affects the dimensions of paper, expanding it when wet and shrinking it when dry and it causes surface problems such as roughening and ferrotyping, for example. Extreme dryness, on the other hand, causes paper to curl while the rapid loss or gain of moisture (severe cycling, 20 to 70 percent RH, for example) may cause the surface to crack.

Polyethylene is an excellent coating to ensure waterproofing. Furthermore it is inert to most solvents and chemicals and while impermeable to water, it is quite flexible without curling. Quicker processing time, less time for drying, controlled curl, easier handling when wet, greater resistance to tearing, more dimensional stability: these are the reasons photographers prefer RC papers.

When using RC paper for making photographic prints, it is important that the recommended time for fixing the print be observed. Too much time in the fixer could lead to detrimental results because if the fixer is allowed to penetrate between the polyethylene layers, the removal of the silver compounds during the washing phase becomes extremely difficult. Short times for both fixing and washing are properties developed for RC papers; overdoing either defeats their purposes.

Because RC papers have not been around long enough, it is difficult for us to know how well they will hold up under average long-term keeping conditions. According to Eastman Kodak, "reliable long-term keeping data are not yet available."[22] Studies do indicate, however, that when "black-and-white prints are stored in the dark, with only occasional viewing, and when storage conditions are uniformly maintained near 21 degrees C. (70 degrees F.) and 50 percent relative humidity, the useful life of RC prints can be equal to the life of prints on conventional paper base."[23] The most common problems with RC papers appear when they are displayed. When prints on early RC paper types were exposed to "active oxidants at low concentration...colloidal silver spots [could occur]."[24] To prolong the life of all photographic prints, treatment with toners is recommended.

The water-resistant nature of RC prints necessitates that a permanent-type marking pen be used to make notations or to write numbers on the back of the print. To ensure that bleeding will not occur on the image, make your marks or notations only in the border areas of the print or on a label with a removable adhesive if the markings are indeed temporary notations until the print can be fully cataloged and properly mounted. For the latter, it is further suggested that the label be affixed around the border of the print since it has been known that indelible inks even penetrate labels.

I have been informed by a staff member at the University of Michigan that new photographs ordered from outside sources "arrive without a stamp of any kind." That is

[22]Eastman Kodak, Conservation of Photographs, Rochester, 1986, p.39.

[23]Ibid.

[24]Ibid.

definitely one way to alleviate the problem.

II. HYPO ELIMINATOR: TO USE OR NOT TO USE?

(Vol.12, No.1) Spring 1985

In reporting on the proceedings of the Society of Photographic Scientists and Engineers and the Public Archives of Canada "International Symposium: The Stability and Preservation of Photographic Images," August 29 to September 1, 1982, in Ottawa, Ontario (International Bulletin for Photographic Documentation of the Visual Arts, Vol. 9, No. 4, p. 6-7), I indicated that new theories on the effects of hypo residue in black-and-white silver images were presented and discussed. One of the theories delivered and explained by Dr. William Lee of Eastman Kodak was that the removal of all residual hypo from prints could render the prints more susceptible to damage from the environment than if a hypo residue had remained. For this purpose, Kodak's chemists suggested that Hypo Eliminator not be used on black-and-white silver prints when long-term keeping was the desired end. Recently, the reasons behind these recommendations were presented in an article in Kodak Tech Bits (No. 3, 1984, pp. 4-5) In case you are not on Kodak's mailing list to receive this publications, I offer the following summary of what I found to be useful information if one is involved in the maintenance, management, or production of photographs.

Since the beginning of photographic time -- almost 150 years ago -- photographers have made photographs in many different forms using materials, processes, and formulae that often were as unique as the individuals themselves. Of the media used, silver has been shown to be one of the most durable and lasting while proper processing is what ultimately contributes to long-term stability. Any serious deterioration of the photographic image is more likely to be caused by careless processing and the presence of residual chemicals. Such damage or deterioration is ultimately brought about by conditions in the storage environment -- excess heat and moisture plus atmospheric pollutants. Proper storage -- temperature below 70 degrees F. and relative humidity between 30 and 50 percent (the lower the better for both) -- will ensure that any deterioration that is possible will occur at a much slower rate than if environmental controls were not in effect. To guarantee unlimited stability, frost-free refrigeration is required.

As a result of the recent work on the effects of residual hypo on the long-term keeping ability of silver paper, film, and plates, we now know that some hypo residue may be beneficial in certain silver images as a screen against the effects of atmospheric pollutants; thus the advice to abandon the use of Hypo Eliminator. During the study, when all the hypo was eliminated from certain black-and-white photographic prints and photographic plates and films, the silver was more susceptible to attack from pollutants. How much hypo should remain and on which films, prints, or plates "cannot be easily specified or measured," according to Eastman Kodak, because not all products benefit in the same ways nor enjoy the same degree of stabilization from the presence of a hypo residue; therefore, any generalization covering all photographic prints, films, and plates is impossible given the diversity of products, processes, and conditions.

When maximum stability is the goal, total hypo elimination followed by the application of a toning agent is the procedure recommended by Eastman Kodak. However, certain precautions must be observed. Use an appropriate test to determine if all hypo has been removed. For films and fiber-content papers, this is outlined in the ANSI Standard PH4.8-1978; for resin-coated papers, follow the iodide-amylose test (Daniel Owerbach, "A Colorimetric Determination of Residual Thiosulfate [Hypo] in Processed Paper," Journal of Applied Photographic Engineering, Vol. 9, No. 2, April 1983, pp. 66-70). Remove the hypo either by washing the print according to the product's recommendations or by using Kodak Hypo Clearing Agent. Do not over-wash; this could physically damage the print. Kodak Hypo Eliminator may be used **only** if traces of the thiosulfate ion would hinder the subsequent toning application; otherwise it should not be used on films or prints that are destined for archival storage. Toning agents are used to protect silver images from damage caused by pollutants and if the bare images are exposed or displayed under strong illumination. The toners that Kodak recommends "for the greatest protection of the image" are: Kodak Rapid Selenium Toner, Kodak Poly-Toner, Kodak Sepia Toner, Kodak Brown Toner, Kodak Sulfide Sepia Toner, Kodak Sulfide Sepia Toner T-7a, Kodak Polysulfide Toner T-8, and Kodak Gold Toner T-21. Kodak offers more information on toning in a new publication, "The ABC's of Toning," publication no. G-23, 8 1/2 x 11 inches, 24 pages, list price $3.50.

If you would like to receive Kodak Tech Bits on a regular basis, write to the Editor, **Tech Bits**, Eastman Kodak Company, 343 State Street, Rochester, NY 14650.

To obtain a free copy of the issue on which this article is based, write to Eastman Kodak Company, Department 412-L, Rochester, NY 14650, and ask for pamphlet no. P3 (84-3).

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