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Color Photographs and Color Motion Pictures in the Library:
For Preservation or Destruction?

INTRODUCTION

Kodachrome, the first practical color film, was introduced in 1935. "Becky Sharp," the first full-color Technicolor feature film, was released the same year, and Kodacolor film, a color negative film for ordinary, fixed-exposure box cameras, was put on the market in 1942. Nonetheless, it took until about 1965 for the mass conversion from black-and-white to color photography to begin in earnest. Today, an overwhelming majority of photographs and motion pictures are made with color materials. In some branches of photography—portrait and wedding photography, for example—a black-and-white photograph is now almost unheard of.

With the change to color, however, a heavy price was paid. The images of most color photographs are composed of organic dyes that are inherently far less stable than the (potentially) long-lasting silver images of correctly processed black-and-white photographs. Color photographs fade when exposed to light, whereas the metallic silver images of black-and-white photographs are, in themselves, largely unaffected by light. Most types of color photographs gradually fade and stain even when kept in the dark; this can be prevented only by low-temperature, humidity-controlled storage.

Color Print Materials

Prints made on current Kodak Ektacolor papers and similar color negative print materials supplied by other manufacturers may exhibit objectionable fading, color shift, and/or yellowish stain in less than ten years under typical indoor display conditions. The rate of fading is
more or less proportional to the intensity of illumination; prints displayed in a very bright area will fade much more rapidly than those exposed to lower levels of light. Some products last longer on display than others. Fujicolor Paper Super FA paper, introduced in 1990, is perhaps the most stable color negative print paper currently available. No color paper, however, is sufficiently stable to permit long-term display.

Since their introduction in 1942, color negative print papers traditionally have had poor dark-storage stability. In most cases this is manifested by progressive cyan dye loss (resulting in a color shift toward red) and yellowish stain formation, which is most apparent in the whites and lighter parts of the image. Not a single print from the first decade of Kodacolor is known to have survived in good condition; thus, this entire era of amateur color prints has been totally lost.

Beginning with the introduction of Konica Color Paper Type SR in 1984, the dye stability of color negative papers in dark storage has been significantly improved compared with that of earlier materials, but the prints still require refrigerated storage for long-term keeping. Corresponding improvements in light fading stability (and, in most cases, rates of yellowish stain formation in dark storage) have not yet been achieved.

**Color Motion Pictures**

The stability of color motion pictures, most of which are now made with a negative/positive color process that is in most key respects similar to that used with still-camera color negatives and prints, has, with some exceptions, been significantly improved in the last few years; however, color motion pictures continue to require low-temperature, humidity-controlled storage for long-term preservation. Most motion picture color negatives and prints made between the introduction of the Eastman Color process in 1950 and until about 1985 (when improved products were introduced) have by now suffered significant fading. Most Eastman Color prints made between 1950 and around 1970 have now lost nearly all of the cyan dye component of their images and usually much of the yellow dye as well, so all that remains is a ghastly reddish-magenta reminder of what once were brilliant, full-color images.

**Color Slides**

Color slides can fade rapidly when subjected to the intense illumination of a slide projector. Kodachrome film, for example, suffers a noticeable loss of magenta dye after only about twenty minutes of intermittent projection. The loss of image detail and the color shift toward green are especially noticeable in highlight portions of the image.
HUMIDITY-CONTROLLED COLD STORAGE
FOR LONG-TERM PRESERVATION

The stability shortcomings of color photographs present special problems in library collections. With the exception of post-1939 Kodachrome films that have been kept in the dark, most color photographs and non-Technicolor motion pictures made from 1935 until perhaps 1980 have by now suffered significant, even catastrophic, fading. To prevent further losses, librarians should identify important and/or irreplaceable color prints, slides, and motion pictures in their collections and make copies for use purposes; the originals must be placed in humidity-controlled cold storage. A temperature of 0°F (−18°C) or lower and a relative humidity of 30 percent are recommended.

Institutions currently operating cold storage facilities meeting these requirements include the John Fitzgerald Kennedy Library, Boston, Massachusetts (1979); the National Aeronautics and Space Administration (NASA), Houston, Texas (1982) and White Sands, New Mexico (1987); the Historic New Orleans Collection, New Orleans, Louisiana (1987); and the Biblioteca Nacional in Caracas, Venezuela (projected for 1991).

Estimates based on data from “Arrhenius-type” accelerated dark fading tests conducted by the major photographic manufacturers (including Eastman Kodak Company; Fuji Photo Film Co., Ltd.; Konica Corporation; and Agfa-Gevaert AG) indicate that, when stored at 0°F or lower with controlled relative humidity, color materials can be considered to be “permanent,” with even the most unstable products probably lasting longer than 1,000 years before a 10 percent, or “just noticeable,” dye loss occurs. Cold storage preserves not only the dye image but also the base material and gelatin emulsion as well. Kept at 0°F, color photographs can be expected to far outlast black-and-white photographs stored under normal room temperature conditions. An Arrhenius-type accelerated test is specified in the new IT9.9-1990 American National Standards Institute (ANSI) standard for test methods for measuring the stability of color photographic images.

Compared with storage at a more moderate temperature (e.g., 35°F), storage at 0°F offers a tremendous increase in the life of color materials and is well worth the small additional costs associated with constructing and operating a 0°F vault. Controlling the relative humidity in a cold storage vault is, in the long run, a more effective and less expensive storage method than sealing films and prints in vapor-proof containers and keeping them in a non-humidity-controlled vault.

Frost-free, home-type refrigerators have provided a low-cost cold storage option for institutions such as the Academy of Natural Sciences
in Philadelphia, where the VIREO collection uses a number of these refrigerators in its well-managed collection of bird photographs. Institutions that temporarily are unable to provide cold storage for their collections can rent refrigerated space (38°F and 40 percent RH) by the cubic foot at moderate cost from the Records Center of Kansas City, a high-security underground storage facility located in Kansas City, Missouri.

The Peabody Museum of Archaeology and Ethnology at Harvard University has developed a compact, low-cost, slide-based visual reference system for color slides kept in its cold storage vault. The preservation program for original spaceflight color films at NASA is particularly noteworthy and can serve as a model for other institutions. The NASA program is especially applicable for institutions holding large collections of valuable color motion picture film.

**Preservation of Cellulose Nitrate Film in Cold Storage**

Because of the relatively poor stability of cellulose nitrate film and the fire hazards associated with the film, it has often been advised that all nitrate films be duplicated and the originals disposed of. However, nitrate still-camera negatives and motion picture negatives and prints (both black-and-white and color) that are still in good condition can be preserved almost indefinitely—perhaps more than 1,000 years—by placing them in humidity-controlled cold storage at 0°F (−18°C). John M. Calhoun (1953) of the Eastman Kodak Company explained:

The rate of decomposition of cellulose nitrate is also very dependent on temperature and moisture content. The temperature coefficient of the reaction is about 4 per 10°C, or 2 per 10°F, which means that the rate of decomposition approximately doubles for every 10°F increase in storage temperature. Moisture absorbed from the air, the amount of which is determined by the relative humidity, also accelerates the decomposition reaction. (p. 5)

Based on these figures, nitrate film should last about 32 times longer when stored at 25°F, and approximately 180 times longer when stored at 0°F, than when the film is stored at 75°F. These figures are only estimates, but they do illustrate the dramatic increase in the life of nitrate films afforded by low-temperature, humidity-controlled storage. It seems clear that the common belief that nitrate films "cannot be preserved" is simply not correct. It further appears almost certain that nitrate films that are still in good condition when placed in 0°F storage will last much longer than conventionally processed duplicate negatives made on modern safety-base film kept under normal room-temperature conditions. Indeed, if Calhoun's estimates of the influence of temperature on the rate of decomposition are even remotely correct, low-temperature storage of nitrate film will preserve it for many hundreds
of years—and possibly even for several thousand years. In this respect, the temperature coefficient of cellulose nitrate decomposition appears to be not unlike that of the fading of color photographs: both types of materials benefit greatly from low-temperature storage.

It is much less expensive to preserve original nitrate materials in low-temperature storage than it is to copy them onto modern safety film; in addition, image-quality losses are unavoidable in the copying process and it is always best to be able to go back to the original (or as close to the original as possible) when making use copies. With the availability of improved, electronic defect-suppression and image-enhancement techniques, access to original materials for making copies will become even more crucial in the future.

It is recommended that current nitrate duplication efforts be halted. Instead, a nationwide effort should be launched to construct a large-scale, safe, humidity-controlled 0°F (or lower) cold storage facility to preserve all of the cellulose nitrate motion film and still-camera negatives that still remain in collections. This project should proceed with the utmost urgency and should enlist the support of museums and archives, federal and state governments, and the entertainment film industry. With the films safely in low-temperature storage—and steady deterioration and continuing loss of the films halted—production of copies for projection and study purposes can proceed on a more timely basis.

Even when nitrate films have already been copied for preservation purposes, the originals should never be discarded unless they have reached an advanced stage of deterioration. It is particularly important that original Technicolor prints made on nitrate film be preserved in the best possible condition. (They should never be projected.)

DISPLAY OF COLOR PRINTS

For display of color prints, 300 Lux (28 fc) glass-filtered tungsten illumination is recommended; lower light levels, while slowing the rate of fading, generally are inadequate for proper visual appreciation of color images. (The length of time that original color prints can be displayed safely will, in any event, be limited.)

When most types of color prints are displayed, visible light—not ultraviolet radiation—is the primary cause of image fading. Most modern color print materials are made with UV-absorbing emulsion layers and, therefore, framing the prints with Plexiglas UF-3 or other UV filter (or placing a UV filter over the light source) generally affords little if any improvement in light fading stability.

Facsimile copy prints should be employed for routine display and
Conserving and Preserving Materials in Nonbook Formats

reference. (Ilford Cibachrome materials used with Cibachrome camera/processors are recommended for this purpose.) When original color prints or other types of unstable photographs, such as albumen prints, are to be displayed, the photographs should be monitored with an electronic densitometer, and fading and/or staining levels should not be permitted to exceed predetermined limits (Wilhelm, 1981). The Art Institute of Chicago has implemented such a monitoring program for sensitive materials in its collection (Severson, 1986, 1987).

CONCLUSION

Libraries and other collecting institutions should keep up to date on the stability characteristics of available color print and film materials (Wilhelm & Brower, 1991), both to select the most stable products for in-house use and to be able to offer advice to others about which products will best meet their needs.

Polaroid Permanent-Color prints are the first color prints that can be considered to be truly "permanent," both when exposed to light during prolonged display and when stored in the dark. Permanent-Color prints, which can be made from color negatives, transparencies, or existing color prints, have images formed with special, highly stable color pigments instead of the dyes used in other types of color photographs. Making the prints is a fairly complex procedure that is best handled by specialized processing labs.

The classification of "ultra-stable" was proposed to describe the outstanding stability characteristics of the then-new Polaroid ArchivalColor process (later renamed the Polaroid Permanent-Color process) and to differentiate this extraordinary level of stability from the less stable ANSI "archival" classification that is applied to acetate- or polyester-base silver gelatin films. Materials included in the proposed "ultra-stable" group were black-and-white photographs on polyester-base film or fiber-base paper with toned silver gelatin images (light and dark storage); Polaroid Permanent-Color prints (light and dark storage); Ilford Cibachrome, Kodak Dye Transfer, and Fuji Dyeecolor (dark storage only). Black-and-white RC prints, acetate-base films, and polyester-base films or fiber-base papers with untoned silver images were excluded from the ultra-stable classification (Wilhelm, 1987).

Although subject to light fading, Ilford Cibachrome polyester-base prints and color microfilm also can be considered permanent when kept in the dark; this property makes Cibachrome unique among conventional (simple to process) color materials. Under commonly encountered dark-
storage conditions, Cibachrome polyester-base materials should last far longer than most black-and-white photographs.

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REFERENCES


