Color Print

How long will your color prints last? Do some materials fade faster than others? Can you pick the most

In spite of the greatly increased interest in collecting photography in recent years, many photographers and collectors in the fine art field have avoided color photography. The reasons for this are numerous, but probably the most important shortcoming of color photography from a collector's point of view is its alleged lack of image permanence. Few collectors are willing to pay substantial sums of money for a photograph with the unhappy prospect that it might fade away in a relatively short period of time. This in turn has discouraged many photographers from working in color. As a result, the evolution of color photography as a fine art has been restricted, and even today most museums and archives have little, if any, color photography in their collections. However, in the past few years increasing numbers of photographers have produced substantial bodies of work in color (Stephen Shore, Marie Cosindas, William Eggleston, Joel Meyerowitz, Neal Slavin, Michael Bishop, Eliot Porter, and Christian Vogt, to name just a few). In general, the current generation of color photographers is very concerned about the instability of the prints they sell, but the fact that their color prints may have a much shorter life than silver-gelatin prints has not caused them to abandon their work in color.

Any discussion of color print stability must deal with three distinct and separate phenomena:

1. Image fading and/or staining caused primarily by the effects of light and UV radiation. Virtually all color print processes deteriorate on exposure to light in the visible part of the spectrum even if there is no UV radiation present. In general, the fading of most color materials is less dependent on the spectral composition of the light source than that of other types of artistic media.

2. Image fading and/or staining that takes place in the dark. The rate of dark fading for any given material is primarily a function of temperature, with relative humidity being an important factor, and pollutants, improper processing, omission of a final stabilizer bath,

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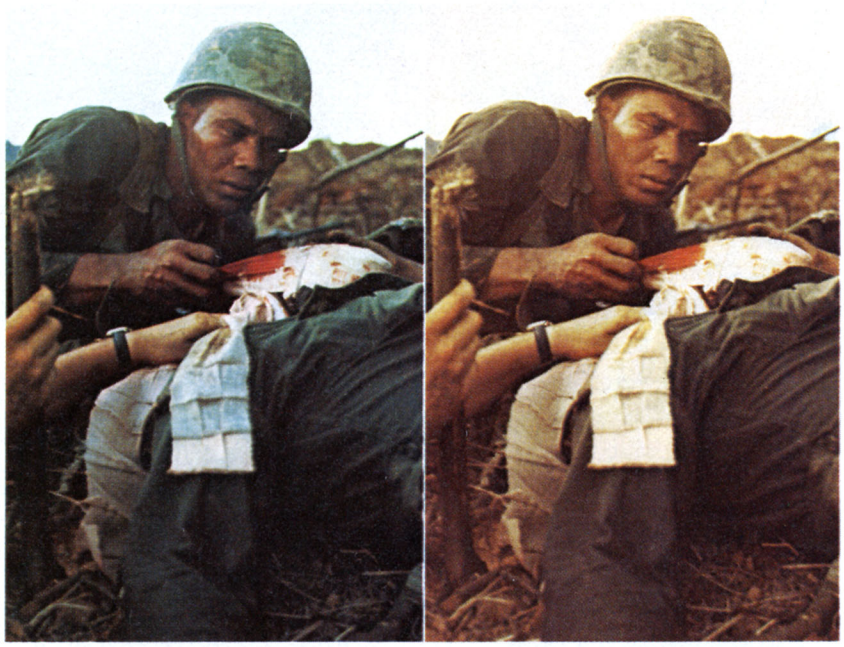

Kodak Ektacolor 74 RC: Note serious losses in overall density and the color shift toward magenta/yellow caused by cyan dye instability under our test conditions.

Kodak Ektachrome RC, Type 1993: Shows considerably less stability than Ektacolor above, in overall density and highlight loss. Note cyan dye loss, yellow stain.

Instability

by Henry Wilhelm

durable for your own pictures? Here's the latest, from a recognized expert.

Kodak Dye Transfer: Dark storage champ shows a serious shift toward cyan/magenta due to its relatively unstable yellow dye. Uniform fading with print density.

Cibachrome: Least change of all to date. Shows some slight loss of overall density—almost no change in color balance. Most permanent easily-obtainable print material.

Print Fading Comparison

During prolonged display of color prints, a variety of changes will occur in the color balance, contrast, and stain level of the color images. Loss of highlight detail and color balance shifts are usually the most easily noticed changes as print fading progresses. The faded examples illustrated here were exposed to 2000 footcandles of direct fluorescent light for 100 days. These prints exhibit, in a general way, the types of changes that can take place as a result of fading. The rate and characteristics of color-print fading will vary with each display situation. The lighting conditions of our tests are similar in spectral content to those often encountered in office and public display areas.

The light-fading stability of the cyan dyes, Ektacolor 74RC and, to a lesser degree, Ektachrome RC paper, Type 1993 can be improved by using glass over the print or light source to reduce UV radiation. This will not, however, greatly improve Dye Transfer stability. Cibachrome is relatively unaffected by UV radiation.

Most color print materials also fade in the dark, though the color balances shifts usually differ from those caused by light fading. Dye Transfer and Cibachrome show very good dark-storage stability, while 74 RC and Type 1993 do not. Ektacolor 74 RC prints treated with Ektaprint 3 Stablizer after processing in Ektaprint 2 chemicals may exhibit greater dark storage stability than prints given extended washing instead, though light-fading rates appear unaffected.

The photograph used for these visual tests was taken by Bob Hodierne on Kodak High Speed Ektachrome shortly after sunset, May 1967, on Hill 881 North, in Vietnam.

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inadequate washing, etc. being other potentially important variables.

3. Deterioration of the print support material on prolonged exposure to light and/or UV radiation or deterioration of the support during dark keeping caused by temperature and moisture fluctuations or other factors. Among current materials, support deterioration appears to be a serious problem only with RC prints. Collectors would be well advised to avoid all types of black-and-white and color prints made on present resin-coated supports.

Color print image deterioration may include any or all of the following:

1. Loss of highlight detail, usually with reduced overall density and contrast. In time, most color print materials will suffer almost total image loss.

2. Color balance changes caused by the cyan, magenta, and yellow image dyes or pigments fading at uneven rates. With any given material, the direction of the color balance shift is usually different with light fading and dark fading. Dark fading reactions continue during the time a print is exposed to light and undergoing light fading; The combined effects of light fading and dark fading are complex and difficult to predict.

3. Stain formation. In correctly processed current materials, stains are usually low-level yellow colorations which are most readily observed in highlight regions of a print. Such stains may significantly alter the color balance of low-density areas of a print in addition to yellowing the D-min areas. Yellow stain formation is a serious problem with many, but not all, of the currently used materials.

The visual changes that take place when a color print deteriorates are often difficult to describe, but are readily apparent if a faded print is directly compared to a non-faded print of the same subject. In the early stages of deterioration, a viewer may think there is nothing wrong with a print unless a comparison print is available. As fading advances, a point is reached where most people will say that the quality of the print is poor. Interpretation of the point when objectionable fading has occurred often varies depending on the subject matter of a particular photograph. For example, people usually have a rather fixed concept of what flesh tones should look like and will tolerate much less variation in these colors than they might with an abstract scene.

In many cases there is little relationship between light fading and dark keeping properties. Some materials have relatively good light fading stability but poor dark fading stability. A number of processes have excellent dark keeping stability but poor light fading stability. From a collector's point of view, excellent dark keeping stability is the most important requirement in selecting a color print material. As a general statement, it may be said that no current color material, with the probably exception of Fresson Quadrichromie (see page xxx), can be displayed for long periods of time without significant fading taking place. However, the requirements of most collectors will be satisfied if a color print is stable in the dark and is sufficiently resistant to light fading that it may be viewed from time to time and can be used for short term display (for example, a three- or four-month museum exhibition, illuminated with tungsten lamps with an intensity of about 50 fc—540 lux) with no significant deterioration.

It should be noted that even the most unstable color materials, when stored in the dark at very low (refrigerated) temperatures and low relative humidities, can be preserved for a very long time—hundreds, and perhaps even thousands, of years. Museums and archives will have to install color storage equipment in the near future if they intend to preserve color transparencies, negatives, motion-pictures, and most types of color prints. A small number of collecting institutions in the U.S. and Europe already have such facilities. However, most major institutions, such as the Museum of Modern Art, George Eastman House, The U.S. National Archives, and The Public Archives of Canada do not yet have cold-storage facilities for their collections.

Most private collectors will not want to go to the expense and trouble of maintaining a cold-storage vault. Preservation of color images by making silver separation negatives or positives—a procedure which has often been suggested by the photographic industry—has many serious drawbacks, in addition to high cost and potential image quality losses and, in the author's opinion, should not be seriously considered for most applications.

There are a number of color print processes currently in use by artistic photographers, and each has a distinct set of stability characteristics. It is important to collectors that photographers identify their color prints with the actual process name and the date the prints were made. For example: *Kodak Ektacolor 74 RC—Ektaprint 2 Chemicals with Ektaprint 3 Stabilizer—June, 1978.* The commonly used terms "Type C Print" and "Type R Print" are altogether incorrect unless a print was actually made on *Kodak Color Print Material, Type C* (a negative-positive chromogenic material; dyes formed in emulsions during processing) or *Ko-*

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A variety of light fading and dark keeping tests were used in the preparation of this article. The initial work was done using the test methods described in *ANSI PH1.42-1969—Method for comparing the color stabilities of photographs,* a Standard issued by the American Nationals Standards Institute. The tests were later expanded to include a wide variety of light intensities and light of different spectral content. Non-accelerated tests were also done in typical home and office display conditions. One of the most important conclusions drawn from these tests is the fact that most color print materials fade relatively *faster* at low light intensities (such as those found in the home) than would be expected from data produced in high intensity accelerated tests. That is, one-tenth the light intensity might be expected to produce only one-tenth the fading rate of a color print. In actual tests, prints illuminated with one-tenth the light intensity of that used to illuminate control samples, faded significantly faster than one-tenth the rate observed with the control prints.

The accompanying photograph shows one of the light fading tests used by the author. The sample plane is illuminated with 125 fc of fluorescent light modified for three different spectral contents. Daylight and tungsten illumination were also used in this testing program. Light fading can be slowed—but not eliminated—by illuminating color prints with tungsten lamps of relatively low intensity (20-50 footcandles). Below the light fading samples are a number of temperature and humidity controlled dark ovens used in dark storage tests. A color densitometer is used to measure changes in image characteristics during the tests.

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dak Color Print Material, Type R (a reversal chromogenic material) during the time these materials were available from 1955 to about 1959.

Following is a list of the most commonly encountered color print materials currently in use in the fine art field. Comments on the light fading stability and dark keeping stability of the materials are based on an extensive series of accelerated and non-accelerated natural aging tests conducted by the author during the past several years. A few of the comments given here are from industry data supplied to the author.

Kodak Ektacolor 74 RC Paper. Prints made on this chromogenic (integral dye forming) material are usually from color negative originals, or color internegatives made from original color transparencies. It is capable of excellent color and tone reproduction when used with original masked color negatives, but the paper has only moderate light fading stability and poor dark keeping stability. Significant fading will occur in the dark under typical conditions in less than 10 years' time. Current Ektacolor paper has image dyes of closely matched fading rates when exposed to most types of light sources if the print or the light source is covered with glass. In accelerated aging tests, conducted by the author, the use of Kodak Ektaprint 2 processing chemicals without Ektaprint 3 Stabilizer significantly increased dark fading rates. The paper has an RC support. It is not recommended for applications where non-refrigerated long-term keeping is required.

Kodak Ektachrome RC Paper, Type 1933. This chromogenic material is used to make prints directly from color transparencies without the use of an internegative; color and tone reproduction are generally inferior to those of prints made from masked color negative originals or internegatives. The paper is significantly inferior to Ektacolor 74 RC in light fading stability and has about the same, poor, dark keeping stability. Type 1993 is being replaced in the U.S. with Type 2203, early batches of which had extremely poor yellow dye light fading stability. Kodak has indicated that future batches of 2203 will have light fading stability similar to Ektacolor 74 RC. The paper has an RC support. Use of the paper is not recommended when non-refrigerated long-term keeping is required.

Agfacolor MCN 310–Type 4. This is a chromogenic negative-positive paper used to make prints from original color negatives or internegatives made from original transparencies. It is little used in the U.S., but is very common in Europe. This paper has poor light fading stability and very poor dark keeping stability. This is an RC support material, and appears to have inferior dark keeping stability compared to the Agfacolor MCN 111–Type 7 fiber-based papers it replaced in the mid-1970s. Use of this paper is not recommended when non-refrigerated long-term keeping is required.

Kodak Dye Transfer Prints. This is a survivor of the historic dye-imbibition process, and was introduced in essentially its present form in 1946. Dye Transfer is the successor to the Kodak Wash-Off Relief Process, introduced in 1935, which was Kodak's first color print process. Dye Transfer is currently Kodak's only color print process with a conventional fiber-based support. Dye Transfer prints are most generally made from original color transparencies, but can also be made from original color negatives or internegatives by any of several procedures, the most direct being with the use of Kodak Pan Matrix Film. Prints can also be made from color negatives with the use of interpositives or separation negatives made from separation positives which were prepared from the original color negative. Most photographers will find it much easier to make high-quality Dye Transfer prints from original color negatives using Pan Matrix Film (a process that does not require making separation negatives, color and contrast correction masks, etc.) than from original color transparencies. Dye Transfer is a complex and expensive process. Most prints of this type are made in commercial labs, but increasing numbers of photographers are learning to make the prints themselves. The process is capable of excellent color and tone reproduction; both color saturation and contrast can be extensively manipulated if desired. Kodak Dye Transfer prints are often incorrectly referred to as "Dye"

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A Profile of Natural Light Fading in the Home for One Year

Kodak Ektacolor 37 RC Low Print Density	R	G	B
Start:	.16	.18	.18
Aged:	.14	.18	.17
Loss:	.02	.00	.01

Kodak PR10 Instant Print Low Print Density	R	G	B
Start:	.37	.41	.36
Aged:	.28	.36	.34
Loss:	.09	.05	.02

Polaroid SX-70 Instant Low Print Density	R	G	B
Start:	.42	.42	.51
Aged:	.40	.40	.44
Loss:	.02	.02	.07

Medium Print Density	R	G	B
Start:	.34	.32	.28
Aged:	.32	.32	.26
Loss:	.02	.00	.02

Medium Print Density	R	G	B
Start:	.50	.71	.60
Aged:	.34	.56	.47
Loss:	.16	.15	.13

Medium Print Density	R	G	B
Start:	.69	.60	65
Aged:	.67	.57	.59
Loss:	.02	.03	.06

High Print Density	R	G	B
Start:	1.16	1.13	.109
Aged:	1.11	1.12	1.06
Loss:	.05	.01	.03

High Print Density	R	G	B
Start:	1.06	1.68	1.59
Aged:	.93	1.32	1.25
Loss:	.13	.36	.34

High Print Density	R	G	B
Start:	1.75	1.63	1.58
Aged:	1.72	1.60	1.57
Loss:	.03	.03	.01

One year of exposure (65-80F at 30%-70% RH), November, 1977 to November, 1978. Typically about 120 fc in the daytime—in-direct daylight illumination through window glass. Short periods of up to 230 fc exposure when snow is on the ground. Night illumination about 7 fc tungsten for several hours; dark remainder of time. PR10 and SX-70 processed 60 days prior to the start of the test. These figures show red, green and blue reflection densities from low density (highlights), medium and dark (high density) areas of the test samples. A density change of .1 from a base of 1.0 is just noticeable. A change of .3 can indicate a severe change in color balance.

Recommended Color Print Materials for Collectors

User or Lab Processed
- Cibachrome (non-RC support types only)
- Kodak Dye Transfer (paper support)

Lab Processing only:
- Fuji Dyecolor Print (paper support)
- Fresson Quadrichromie (paper support)

Instant Color Photography (if required)
- Polaroid Polacolor I (obsolete process)
- Polaroid SX-70 (tentative recommendation)

All of the six materials listed appear to have excellent dark keeping stability, but are subject to light and UV radiation caused deterioration: prints should be kept in the dark for long-term keeping. Prints used for display purposes should be monitored to prevent deterioration beyond pre-set limits. Fresson Quadrichromie prints appear to have excellent light fading stability and can probably be displayed safely for many years. However, Quadrichromie prints should also be monitored if very long-term display is planned. The recommendation for SX-70 is tentative as dark keeping test data is incomplete.

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prints. Kodak sells all the necessary materials and equipment for the process, but does not actually make prints for customers. The process almost disappeared from the market a few years ago, but it will probably see a major resurgence in the fine art field in the coming years. Dye Transfer prints have excellent dark keeping stability; they are far more stable in dark storage than any other Kodak color print process. They will almost certainly last most than 100 years with no significant change if kept in the dark except for occasional viewing or short-term display. At present, the prints have relatively poor light fading stability. The yellow dye in particular is unstable and, under typical display conditions, the prints will fade faster than current Ektacolor 74 RC prints. Kodak has indicated that new, more stable yellow dyes are in the works. However, because of its excellent dark keeping stability and freedom from stain with age, the process can be considered to be among the first choices for collectors. New prints normally smell of acetic acid. The prints should never be washed or otherwise treated in an attempt to remove the residual acetic acid.

Fuji Dyecolor Print. This is a dye-imbibition process quite similar in concept to the Kodak Dye Transfer Process. The prints are currently available only in Japan and are made only by a printing service of Fuji. At the present time Fuji does not sell the materials required to make the prints. The prints are available at low cost if large numbers of the same print are ordered. Transfers are made automatically on a special rotary machine developed by Fuji. Prints are made on a conventional fiber-based paper and visually appear nearly identical to Kodak Dye Transfer prints. These Dyecolor prints have been available only in the last few years. Like Kodak Dye Transfer prints, Fuji Dyecolor prints have excellent dark keeping stability, but relatively poor light fading stability. They are quite suitable for collectors and for edition printing.

Cibachrome CCP-A 182U and CCP-D 182U. Cibachrome prints are the only current example of the historic silver-dye-bleach process in which preformed dyes in the emulsion are selectively removed. There are several versions of the process, all of which are made on pigmented cellulose triacetate supports except for the recently introduced Cibachrome RC Paper photofinishing material. Cibachrome RC prints should be avoided by collectors because of potential instability of the support. The material was introduced in Switzerland in 1963, but did not come into wide use by artistic photographers until the introduction of the three-solution Type A process

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in 1974. This is, perhaps, the easiest of all color processes with which to make prints. It is used to make positive prints directly from color transparencies; however, it can also be used to make prints from color negative originals by the use of masked interpositives. Cibachrome produces prints of high color saturation and, objectively speaking, excessive image contrast. Many photographers object to Cibachrome because of the contrast problem. Some artistic photographers who work with this material take photographs only in situations with low-contrast lighting (such as overcast days when the sun is not shining) or restrict their work to studio situations where lighting contrast can be controlled. It is impossible to improve the color and tone reproduction of the material greatly by the use of contrast reduction and color correction masks or preflashing, a procedure which greatly complicates the process. Some commercial labs, such as Boris Color Lab of Boston, Mass., have specialized in high-quality masked Cibachrome printing. Availability of a negative-positive version of Cibachrome which could be used directly with masked color negatives would probably solve the contrast and color reproduction properties of the current materials. The prints have excellent dark keeping stability; like Dye Transfer and Dyecolor, they can be considered to be essentially permanent in dark keeping. This is the only simple process currently available that produces dark stable prints. Cibachrome has relatively good light fading stability, though it is by no means permanent on long-term display. It has better light fading stability than any other color print material tested by the author except Fresson Quadrichromie. For photographers who want to make their own prints and don't want to get involved with the complexities of the Kodak Dye Transfer Process, Cibachrome is the only process available that produces dark stable prints. Collectors should consider the prints to be quite acceptable for non-refrigerated long-term keeping. The prints should be handled carefully as they show fingerprints easily. Coating the prints with lacquer is not recommended.

Fresson Quadrichromie Prints. At the present time, prints made by the French Quadrichromie process are the only color prints available which may be considered to be essentially permanent both in dark keeping and on display under typical conditions for extended periods of time. High intensity accelerated light fading tests conducted by the author indicate that under typical conditions of display the prints will probably last for at least 50 years with only very minor deterioration. A more definite projection of the light fading stability of the prints cannot be made until lower light level long term tests have been completed. Other than slight yellowing of the conventional fiber-base paper support, the prints would appear to be essentially permanent in dark keeping. Quadrichromie prints have been produced only since about 1951, but the color process is based on the historic monochrome process used by the Fresson family for a great many years. The Quadrichromie process is so named because the prints are made with a fourth "black printer" image in addition to the usual cyan, magenta, and yellow colors, so as to produce dark tones of adequate density. (For the same reason, black ink plus the other three colors are generally used in the photomechanical color printing processes.) Quadrichromie prints are made of separate layers of pigments suspended in thin gelatin coatings. The composition of the pigments has not been made public, but they are probably inorganic pigments of the same types used in lightfast paints. At present, the prints are made only at the Fresson lab located near Paris, France. The materials for the process are not sold by Fresson and the exact methods of making the prints have not been disclosed. Unfortunately they are not soliciting foreign orders either. It is known that the prints are made from separation negatives (usually made from original color transparencies by contact printing, but sometimes made from original color negatives) and that the dichromated gelatin layers containing the pigments are coated, dried, exposed, and the non-hardened areas of the image are washed off with water containing sawdust as a mild abrasive, one layer at a time. In spite of the time-consuming nature of the process, Fresson supplies the prints at relatively low cost. Tone reproduction of the process can be quite pleasing, but by objective standards the saturation of the colors and the accuracy of color reproduction is rather inferior to most other color processes. Whenever 35mm transparencies or other small-format color films are used as originals, there may be a substantial increase in grain in the final enlarged print due to the use of contact-size separation negatives. However, for many artistic photographers, these shortcomings of exact color reproduction are considered to be an advantage as the prints have a certain mellow quality that cannot be obtained by any other process. The prints have a smooth non-glossy surface and, contrary to what one might expect with a process of this type, the image has no visible physical relief. A number of fashion photographers in Europe have made extensive use of the process because they believe the quality of the prints is better suited to their work than the high-saturation and sometimes harsh color prints obtained

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with the standard color processes. The excellent stability of the prints, combined with the soft colors produced by the process, will probably make it increasingly popular with artistic photographers. There are a number of photographers in the U.S. and Canada who have started to make use of the process. At present, this is the only color print process that can be considered if it is desired to display prints for long periods.

Hanfstaengl Tricolor Carbro Prints. Tricolor carbro prints made with the currently produced pigment tissues supplied by the Hanfstaengl firm of Germany probably have good dark keeping stability but, in accelerated light fading tests, the prints proved to be significantly inferior to Cibachrome prints in stability. The yellow pigment in particular is subject to light fading, and the prints exhibit serious color balance shifts as fading progresses. The tricolor carbro process is a complex and difficult-to-control method of print making; with the instability of the currently available pigments, there is probably little reason that a photographer would want to work with the process. However, the Hanfstaengl firm is said to be working on a new set of pigment tissues and it is probable that the light fading stability of the process can be greatly improved and could well become the equal of Fresson Quadrichromie. The Hanfstaengl tissues and other necessary supplies are distributed in the U.S. by Gallery 614 (614 West Berry Street, Ft. Wayne, IN 46802). There are a number of photographers in the U.S. and Canada currently using the process; however, at this time there is no commercial lab producing prints by this method. Tricolor carbro can be used with either original color transparencies or color negatives. The prints are most often made on 100% cotton fiber paper, but the color image can be applied to a wide variety of materials. Tricolor carbro images have an easily detected physical relief. Some very early tricolor carbro prints are thought to be very resistant to light fading. However, the majority of the tricolor prints in existence (made since the early 1940s—the process was in general use until the 1950s) were made with pigments which were improved in color reproduction at the expense of light fading stability. It would be very unwise to subject a tricolor carbro print to prolonged display unless it has been positively identified as having been made with a stable pigment set.

Kwik-Print. This is a contact speed color printing process using successively coated, exposed, and washed off pigment layers. The prints are normally made on non-plasticized pigmented white vinyl sheets, though other support materials,

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including cloth and paper, may be used. All the materials necessary for the process along with detailed instructions are available from Light Impressions Corp., 131 Gould Street, Rochester, NY 14610. Kwik-Print is a modification of the Kwik-Proof graphic arts proofing system made by Direct Reproductions Corp. of Brooklyn, New York. The mechanics of making a print with the Kwik-Print system are somewhat similar in general concept to the Fresson Quadrichromie process. The pigment solutions originally supplied for use with the Kwik-Print process had very poor light fading stability. Prints made with these pigments should not be displayed for long periods. In January of this year, a greatly improved pigment solution set, which produces prints with substantially better light fading stability, was introduced. Solution bottles are marked with an "Improved" label. The new pigments are not permanent in long-term display conditions, however. Both the old and new pigments probably have very good dark keeping stabilities. Direct Reproductions is continuing research with the goal of producing pigment solutions that are essentially permanent even under prolonged display. Extensive image and color manipulation is possible with the process—and this is one reason it appeals to many artistic photographers. Some photographers working with the process exercise so many creative controls in making a print that the result cannot be exactly duplicated and should be considered to be a unique print. At present there are no commercial processing labs making prints with the process. The author is not sufficiently familiar with the use of the process in non-manipulated color printing to be able to make specific comments on image resolution and the accuracy of color and tone reproduction of which the process is capable.

Polaroid SX-70 Instant Prints. SX-70 prints, unless they are duplicate photographs taken of a static scene, are unique prints with no negative or transparency which can be used to make additional prints. If SX-70 film is used to copy an existing SX-70 print, the resulting copy print will have severe color and tone distortions. Because SX-70 originals are unique prints, they must be handled with special care and should never be displayed for long periods of time. SX-70 prints are quite subject to light fading, and in a general way may be considered to be somewhat less stable than Ektacolor 74 RC prints. The yellow dye used with SX-70 prints is the least stable of the three image dyes, and color balance will shift toward a bluish-purple as light fading progresses. The dark keeping characteristics of SX-70 prints are not precisely

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known at present. Accelerated dark aging tests conducted by the author as well as tests conducted by the Polaroid Corporation indicate that, while the dyes themselves appear to be quite stable in the dark, the prints have a tendency to form yellowish stain which is very noticeable in D-min areas. Stain formation is accelerated by conditions of high relative humidity. It may be years before the actual behavior of the prints under typical conditions of dark keeping can be determined with certainty. Density measurement of four-year-old SX-70 prints stored in the dark in typical room conditions show that some yellow stain does indeed occur during natural aging; however, it is not yet known just how far the stain formation will progress. Until more is known about the keeping characteristics of the prints, valuable SX-70 prints should be kept in cold storage at low relative humidities. All SX-70 films produced before the introduction (late in 1977) of the rapid-developing type had somewhat yellow D-min areas immediately after processing. Study of the aging characteristics of both SX-70 and Kodak PR10 instant prints is complicated by the fact that all the processing chemicals and other components of the film remain in the film behind the image layer after processing is completed. Most of the moisture contained in the processing reagent diffuses through the polyester cover sheets during several months following processing. SX-70 was introduced in 1972; during the following years several improved versions of the film have been introduced, and the most recent type has significantly improved accuracy of color reproduction compared with the original 1972 film.

Polaroid Polacolor 2 Prints. Polacolor 2, using the same types of metallized image dyes used in SX-70, was introduced in 1975 as a replacement for the original Polacolor 1 film introduced in 1963. In spite of advertising by the Polaroid Corporation suggesting that Polacolor 2 prints are very resistant to light fading, a variety of accelerated and natural light fading tests conducted by the author and others indicate that, under typical display conditions, the stability of Polacolor 2 prints is relatively poor and is inferior to Ektacolor 74 RC prints. Like SX-70 and Kodak PR10 prints, Polacolor 2 prints are unique prints (unless they are duplicate photographs taken of a static scene) and do not have a usable negative or transparency which can be used to make additional prints. For this reason, they must be treated with special care and should not be displayed for more than several months. Like SX-70 prints, Polacolor 2 prints form objectionable stain in accelerated dark aging tests. The rate of stain formation is greatly increased in conditions of high relative humidity. While the actual keeping characteristics under typical dark storage conditions are not yet known with certainty, collectors would be advised to keep the prints in cold storage with low relative humidity. Polacolor 2 Type 808 prints in the 8 x 10 in. format were introduced in 1977, and this product is likely to become popular with artistic photographers. Stability studies with this new product are in progress. To date, there is no indication that Type 808 has better stability than other Polacolor 2 products, so all the precautions given previously should be applied to Type 808 prints also. Part of the appeal of the current instant color processes to artistic photographers is the fact that the prints are unique images. This gives the prints greater intrinsic value and increases their identification with many other types of artistic media, such as oil paintings. However, the very fact that the instant prints are unique images puts greater stress on the need for image permanence. Collectors and photographers should be keenly aware of the stability limitations of the currently available instant color materials.

Polaroid Polacolor 1 Prints. Polacolor 1 (known simply as "Polacolor") was introduced in 1963 and was the first instant color process marketed. It produced prints of pleasing tone reproduction but, by objective standards, had very unsaturated color reproduction of most colors. However, the soft color reproduction appealed to some artistic photographers. Marie Cosindas, for example, generally retains her Polacolor originals and thinks of them in the same way as most photographers think of their original color transparencies or negatives. Cosindas sells copy prints made from the Polacolor originals; most often the copies are made by the Kodak Dye Transfer Process using direct camera separation negatives made from the original Polacolor print. The Polacolor 2 process, which replaced most Polacolor 1 products in 1975, has much-improved color saturation and compares favorably with conventional color processes. Polacolor 1 prints have poor light fading stability and should not be displayed for more than short periods of time. However, accelerated aging tests conducted by the author, as well as examination of early Polacolor 1 prints, indicate that Polacolor 1 prints have excellent dark keeping stability and have almost none of the yellow stain formation evident with the newer Polacolor 2 materials. For this reason, Polacolor 1 prints can be considered quite suitable for collectors who do not have low-humidity, refrigerated storage facilities. The manufacture of Polacolor 1 for general applications ceased in 1976; it was last available as Type 58 film in the 4 x 5 inch format.

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Polacolor 1 had a strong tendency to curl toward the image side after processing, so Polaroid supplied cards coated with a pressure sensitive adhesive with the film for mounting the prints to keep them flat. The effects of the adhesive and card stock on the long-term keeping of the prints are not currently known. It is possible to remove the prints from the cards using special techniques.

Kodak Instant Print Film PR10. PR10 print film and cameras for use with the film were introduced by Kodak in 1976 to compete with the established Polaroid SX-70 system. Like SX-70, the prints are an integral sealed package with all processing chemicals and other components remaining in the print after processing. Also like SX-70, PR10 prints are covered on both sides with polyester sheets. PR10 has another plastic layer coated on top of the cover sheet which is embossed to give it a semi-gloss surface. Like all other instant color systems, PR10 prints are unique unless duplicate photographs have been taken of a static scene. For this reason, they must be treated with special care. The author does not know of any serious artistic photographer who has done extensive work with the PR10 system. While the Polaroid Corporation has encouraged artistic applications of its products, Kodak has made no such effort with the PR10 system. Instead, Kodak has aimed its extensive advertising campaign for PR10 toward the casual snapshot user, with no suggestion that the product might also be used by more serious photographers. PR10 prints have exceedingly poor light fading stability—probably much worse than any other currently manufactured color print material in the world—and in natural aging tests under typical home display conditions, severe dye fading and color shifts occurred in less than eight months time. PR10 prints also have poor dark fading stability with loss of dye density and stain formation occurring in a relatively short period of time. PR10 prints should be avoided by photographers and collectors alike. If a valuable PR10 print must be preserved, it should be kept in the dark at low temperatures and low relative humidity.

Photomechanical Color Printing Processes. The author has done only limited research into the stability of the four-color ink sets used with the photomechanical printing processes such as offset lithography, gravure, and letterpress printing. All of the samples tested thus far have poor light fading stability. Samples tested to date include randomly selected posters, book pages, postcards, catalog pages, etc., as well as ink company sample books. In spite of poor light fading stability, the few samples tested appear to have excellent dark keeping stability in accelerated aging tests. Examination of old books and magazines printed in color tend to support the general conclusions of these accelerated tests.

Due to the instability of most color camera films and photographic color print materials, it is obvious that most color photographs will not survive in any form unless they happen to be printed in color in a book, magazine, or other publication that is protected from prolonged exposure to light. Future reproductions will, in most cases, have to be made from the printed version, and not the original color photograph. Some photographers, particularly in Europe, have offered portfolios of color photographs printed by gravure or offset lithography on high-quality paper. Assuming that the printing paper is of a stable type, and that the printed sheets are kept in the dark except for occasional viewing or short term display, this use of printed reproductions is probably a reasonable method of collecting color photographs. However, many collectors have valid objections to collecting printed reproductions.

Conclusions

In conclusion, of the currently available color print processes, only a few are suitable for use when long-term non-refrigerated keeping is required with photographs of personal, family, historic, scientific, artistic, commercial, journalistic, and possible future economic importance as art objects.

It should be noted that none of the six recommended print materials make use of the common chromogenic development method of color image formation. All current chromogenic materials, such as Kodak Ektacolor 74 RC paper, have dark keeping stability which is not nearly adequate for the requirements of collectors. While the intensity and spectral content of the light in display locations can vary a great deal from place to place, Ektacolor 74 RC paper may be expected to exhibit significant light fading in three or four years and serious deterioration in 15 or 20 years when prints are displayed under typical conditions found in the home. Most other chromogenic and all current instant color print processes may be expected to deteriorate even faster than Ektacolor 74 RC under typical display conditions. The great majority of color photographs in existence today have been made on chromogenic materials. All color camera films currently in production, with the exception of the instant color materials, make use of chromogenic development.

The only currently available means of preserving chromogenic color photographs is to store them in the dark at very low temperatures and very low relative humidity. While to date only a few large-scale cold-storage facilities have been

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see a picture of anyone who "worked for a living" in the exhibition.

The fact that straight documentary work or reportage photography dealing with social problems has not been a major force in art photography during the 60s and 70s is obviously galling to such photographers. Theirs may be a legitimate point of argument, but this symposium seemed to me an inappropriate place in which to argue it. Their effect was to put the panel members in the position of defending and explaining the exhibition, rather than exploring further the issues they had raised.

Unfortunately, what happened at the New School is not an isolated incident in the field of photographic criticism. In some ways it is a symptom of the confusion that exists about the differences between the multiple roles that photography plays and in what contexts these roles are to be considered. To insist that any survey of contemporary art photography should include journalism, necessarily, is indicative of the confusion.

The bringing together of observers and commentators with relatively unbiased positions is certainly one way to begin to develop some of the definitions so needed for both the art and craft of photography. But such discussions cannot be a vacuum. Minor White once said that the goal of photographic education was to produce an educated audience for photography. The lack of such an audience was never more evident.—THE END

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constructed, progress is being made. The U.S. Library of Congress recently began operation of a large facility near Washington, D.C. for the storage of color motion pictures and still photographs; it has an operating temperature of 35° F (1.7° C) at about 30% relative humidity. The new John F. Kennedy Presidential Library now under construction near Boston, Massachusetts will have a 0° F (-18° C) 30% RH vault for the storage of its large collection of color negatives and other color photographs. Hopefully, this is just the beginning.

Obviously not every color print needs to be saved. But what we do need is a means to save the ones we value the most.

Henry Wilhelm, of the East Street Gallery, is a designer and manufacturer of archival processing equipment, and a researcher on image preservation. His definitive book, Preservation of Contemporary Photographic Materials, *co-authored by Dr. Klaus B. Hendriks of the Public Archives of Canada, is due this year from the gallery, 723 State St., Grinnell, Iowa 50112.*

—THE END

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MODERN PHOTOGRAPHY

February 1979, Volume 43, No. 2

THIS MONTH'S COVER Karen Truax went up against the wall to treat us to this hand colored fantasy from her "Paper Dolls and Wallflowers" series. She prefers outdoor natural light, so she slapped the wallpaper onto one side of her garage, positioned her model and snapped away in the open shade with a Pentax Spotmatic on a tripod, 20mm f/3.8 Vivitar lens, 1/60 sec. at f/8, Kodak Tri-X. For more hand colored work and to see how it's done, turn to page 84. © Karen Truax.

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