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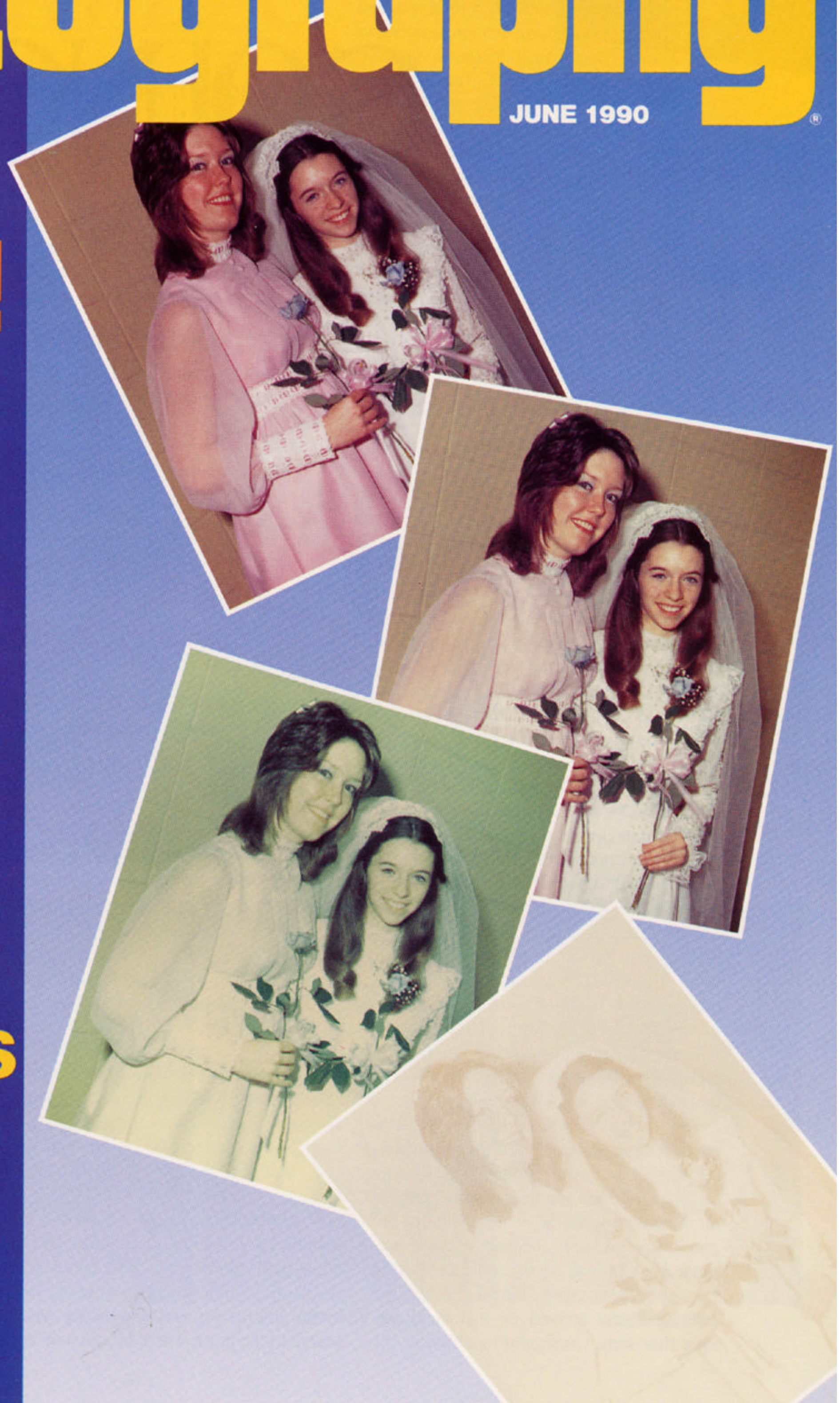
How Long Will It Take???

What Films And Papers Are Best?



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GOING! GOING!! GONE!!!

Which color films and papers last longest? How do the ones you use stack up?

By Bob Schwalberg with Henry Wilhelm and Carol Brower

The fact that color images can and do fade with time and exposure to light is hardly news—such fateful knowledge is enshrined in disclaimers, like the one shown below, found on or in virtually every box of color film and paper sold. Indeed, serious photographers have long known that color prints, slides, and negatives are usually far less permanent than their black-and-white counterparts. When displayed or improperly stored, they can fade noticeably in as little as a few years, and even when optimally stored in cool, dry, dark places, some color images may show marked deterioration in less than a decade. While this dire truth hasn't stopped knowledgeable people from shooting increasing numbers of pictures and taking measures to preserve them, the world's rank amateurs are in a predicament. Most of them assume (dangerous word) that their color snapshots will survive in albums, shoe boxes, and picture frames just as well as their black-and-white photos of yore.

Since color dyes may in time change, this film will not be replaced for, or otherwise warranted against, any change in color.

Before the arrival of Henry Wilhelm on the scene some 25 years ago, the impermanence of color images was, despite all the fine-print warnings, something of an industry secret. So when Wilhelm began independently researching color permanence and making noises about family portraits that could vanish before the grandchildren arrived or historical images that were consigned to oblivion, he was greeted with almost universal scorn by film manufacturers, photofinishers, and their spokesmen. Fearful of anything that might hurt the expanding sales of color materials, they were determined to keep color fading a hidden characteristic to be discovered years later. Initially, they did their best to keep a lid on his bad news and attacked Wilhelm's qualifications, findings, and research methods.

Fortunately for all of us, Henry Wilhelm is a determined, dedicated, and distinguished individual. His inspired response to harsh criticism was to dig in his heels, improving and expanding his research to the point where he can now aptly be described as one of the world's leading independent experts on color permanence. And he has not been shy about publishing his findings. If today's average point-and-shooter is more keenly aware that color pictures don't last indefinitely; if film manufacturers now provide data on color permanence and talk openly about this sticky subject; if the stability of color films and papers has been vastly improved over the last decade, you can thank Henry Wilhelm for providing much of the impetus.

In addition to developing a standardized test procedure for rapid light fading, helping to establish an accepted system of evaluating the permanence of various films and papers, and publishing numerous research reports, Wilhelm has been working on The Book*, a compilation of years of research that includes hard test data on the permanence of most current and many past color processes. We are pleased to present on the following pages the key results of his lifetime research into a subject of abiding concern to everyone who loves color photography.

The Editors

The Permanence and Care of Color Photographs: Prints, Negatives, Slides, and Motion Pictures,** ***by Henry Wilhelm with contributing author Carol Brower, to be published this summer by Preservation Publishing Co., P.O. Box 567, Grinnell, IA 50112.

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The Disappearing Image

We all know that color photos fade, but why does it happen and what can we do about it?

Color images deteriorate because of the destructive action of light and the damaging effects of temperature and humidity.

(Black-and-white negatives and prints use silver images that are virtually unaffected by light and heat. When properly fixed and washed—and additionally protected by selenium or sulfur toning—black-and-white images can actually be more stable than the paper or film base upon which they are coated.)

Light fading—the damage that occurs when color prints are displayed—is the result of accumulated exposure to light and ultraviolet (UV) radiation; that is, light intensity multiplied by time. But it's more complicated than this because color pictures subjected to a very low level of illumination for a very long period will usually suffer more damage than color prints given very short exposures to extremely high light levels, even when the two exposures are identical (that is, multiplying intensity times time results in equal values). This is Henry Wilhelm's "reciprocity failure" for light fading, which he first reported in 1978.

The spectral composition (distribution of various wavelengths) of the light can also be important.

Dark fading—changes that happen to color images stored in darkness—is much slower than light fading (assuming reasonably "normal" conditions). Dark fad-

When you display prints from color negs, they fade like this

Current Ektacolor Plus and Professional papers: accelerated tests under high-intensity light (21,500 lux)

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Unfaded control print

After 60 days

After 180 days

After 1,000 days

But even when stored in the dark, prints do fade

Discontinued Ektacolor 78 and 74 RC papers: accelerated dark-fading tests (144° F and 45% RH)

Unfaded control print

After 60 days

After 120 days

After 240 days

ing is also usually less damaging than light fading because it tends to be more even in high-density shadow and low-density highlight areas. In light fading, the bright highlights go first, giving a characteristically washed-out look.

When pictures are displayed, temperature and humidity take a backseat to light levels and exposure time. The situation is quite different when color pictures are stored away from light. In dark fading, temperature and humidity become the only conditions that really matter, and with most current color materials, *temperature* is much more critical than humidity.

In dark storage with Kodak Ektacolor, Kodacolor, Ektachrome, and most other chromogenic materials, magenta dyes have been traditionally the most stable, fading much more slowly than cyan (the least stable) and yellow dyes. But some new color materials now have such improved cyan dyes that this image layer has become the most stable of the three dyes—even more stable than magenta. In the dark, yellow dyes are now the least stable in many modern color-print materials and films. In fact, Wilhelm now believes that the biggest problem in dark storage of chromogenic papers may not be dye fading but the staining of unreacted color couplers, which produces overall yellowish discoloration. But this requires additional research.

In light fading with Ektacolor and most other chromogenic materials, magenta is generally the least stable of the three dyes and cyan the most stable. It is the more rapid loss of magenta that gives displayed color prints those sickly greenish flesh tones. (Caucasian skin tones are a combination of yellow and magenta, with a small amount of cyan dye.)

Ultraviolet radiation, the powerful part of sunlight that produces painful sunburns, is commonly thought to be the major cause of deterioration of displayed color prints. This would probably be true, except for the fact that all current chromogenic papers—the materials used for printing color negatives—are already well protected by built-in UV-absorbing filter layers. Because of this protection, UV is no longer a significant danger in normal indoor display, and color deterioration is dependent on the level of visible light and time of exposure.

The least stable color materials are called chromogenic because they employ color couplers that produce the yellow, magenta, and cyan dyes right in their emulsion layers during processing. Chromogenic materials include all of the papers used for printing color negatives, some papers used for printing from positive color slides, and all color films, negative and positive. (Kodachrome differs in that the colors are inserted by processing solutions instead of built-in color couplers; and one black-and-white film, Ilford XP1 400, is really a chromogenic negative.)

Much more stable color-print materials use preformed color layers that are built

Three classic examples of faded slides


THOMAS T. HILL

Ansco Color ca. 1945


RUSSELL LEE, 1939 (COURTESY LIBRARY OF CONGRESS FSA COLLECTION)

Original Kodachrome, 1939


COURTESY DR. KLAUS B. HENDRIKS

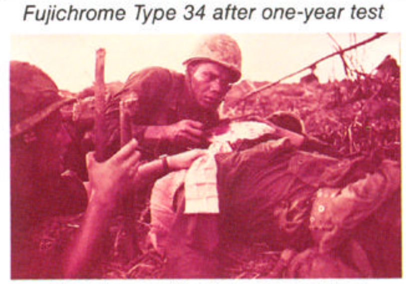
Early Agfa Color, 1937

Dark fading of reversal prints: Some are more stable than others


Unfaded control print on Cibachrome


Cibachrome after one-year test


Fujichrome Type 34 after one-year test


Ektachrome 22 after one-year test


Kodak Dye Transfer after one-year test


ALL PHOTOS BOB HODIERNE

Ektacolor Plus after one-year test

into emulsion layers (as in Cibachrome) or contained in separate dye baths (dye-transfer prints). These nonchromogenic color prints have unusually long dark-storage stability and are roughly two times better than the best chromogenic prints in terms of light fading. Far more stable is the new Polaroid Permanent-Color process, described on page 46.

The least stable of all color schemes are instant color-print films, which (when the images are important) should immediately be duplicated onto some more permanent color process. In fact, this is an excellent idea for all valuable pictures—one print for enjoying in the light of day and a second backup for dark storage. The tables beginning on page 42, summarizing Henry Wilhelm's many years of research, show what can be expected in the real world.

GOING!
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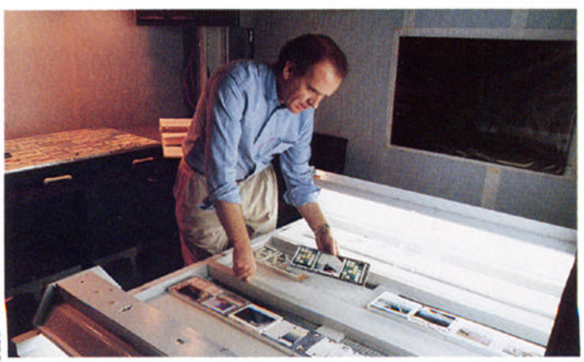
The Great Fade Test!!

Which color films, papers, and processes yield the longest-lasting images? A leading expert gives us his results.

Now that you have a clearer idea of what the different kinds of color fading look like, let's examine the methods used to quantify this information and make it useful to photographers and others who collect and store color images. Even a brief glance at the six specific test methods described on these pages is quite an eye-opener. It's immediately clear that determining how fast various materials fade under different circumstances is time-consuming and tedious. But that is the price one must pay to get results that are scientifically valid and meaningful. The battery of tests includes accelerated aging tests designed to speed up the processes under investigation, and "real-time" tests simulating real-world conditions.

Fading by the numbers

These six tests show which films and papers hold up best



ALL PHOTOS BOB SCHWALBERG

TEST NO. 1

Light fading with high-intensity fluorescent lamps

Conditions:

- Color prints exposed to 21,500 lux, at 75° F, 60% RH.
- Fluorescent tubes approximately two inches away from print surface, with high-velocity forced-air cooling.
- Three samples exposed: a) directly to source; b) through window glass; c) through sharp-cutting UV filter (Plexiglas UF-3).
- Short-term test, about three months. Multiple-print samples are run for greater accuracy.

Henry Wilhelm comments: My basic idea in all of these tests is to quickly recreate what happens in the real world, and this is my best (and most readily reproducible) light-fading test. It gives a lot of information very quickly. I can see the fading rates for the three dyes, any resulting color imbalance, and the sensitivity to UV radiation, and I can make comparisons with other materials for which we have data on file. Keep in mind that light fading is the chief problem today, particularly with the kinds of papers used for printing color negatives.

TEST NO. 2

Light fading with low-intensity fluorescent lamps

Conditions:

- Color prints exposed to 1350 lux, at 75° F, 60% RH.
- Illumination level adjusted by length of hanging chains.
- Three samples exposed as in Test No. 1.
- Long-term test, up to 10 years so far.

Henry Wilhelm comments: This would be my favorite test, except that it takes too long. It shows the effects of light fading as well as light-induced staining. By comparison with results from the high-intensity test (No. 1), it also reveals the very important reciprocity effect in light fading. What this means is that the deterioration resulting from short doses of bright light is usually less than that produced by long exposure to normal household illumination, even when the total exposure (lux × hours) is the same. To a greater or lesser extent, this applies to all color-print materials.

TEST NO. 3

Light fading with low-intensity incandescent lamps

Conditions:

- Color prints exposed to 1350 lux, 2800/2900 K color temperature, 75° F, 60% RH.
- Standard 75-watt reflector floods.
- Three samples exposed as in Test No. 1.
- Long-term test, up to 7 years so far.

Henry Wilhelm comments: I run this test primarily for museum and gallery people who use these lamps almost exclusively. Ultraviolet used to be blamed for all fading, and color prints were thought to be safe with low-intensity tungsten illumination. Tests like this one revealed that extra UV protection is of little or no practical value, and that the real cause of color deterioration is exposure to visible light. Tungsten lamps have an undeservedly good reputation for being safe for color prints, and except that they tend to be brighter, fluorescents get an unfairly bad rap for doing the damage. Incidentally, Cibachrome prints actually fade faster in tungsten illumination than under fluorescent.

TEST NO. 5

Projector fading of color slides

Conditions:

- Kodak Carousel (Ektagraphic) slide projector with 300-watt EXR quartz lamp.
- Slide-gate illumination approximately one million lux (about 10 times that of average daylight).
- Slide subject is Macbeth ColorChecker chart.
- One slide exposed uninterruptedly for six hours, with before and after densitometer readings of 11 color and monochrome patches.
- Identical second slide is given six 30-second exposures per day for 120 days (to equal 6-hour exp. of first slide).

Henry Wilhelm comments: We've proved that slide-projector heat is almost irrelevant, until the point at which physical damage (like melting emulsion) occurs. Projector fading is a matter of lux/hours, light multiplied by times, and there's a very serious reciprocity effect; so the series of short projector exposures is far more damaging than the single long projection period, even though the lux × time exposures are equal. Kodachrome, which has unrivaled dark-storage stability, gives the worst projector fading of all slide films. Incidentally, the slide films with the best projector-fading stability are the "standard" Fujichrome films of all speeds, including Fujichrome Duplicating Film. The new Fujichrome Velvia film is less stable when projected, but still better than Kodachrome.

TEST NO. 4

Light fading with north daylight

Conditions:

- Color prints exposed to 780 lux, averaged over a 24-hour period, 75° F, 60% RH.
- Prints positioned close to window to maximize direct UV radiation.
- Two samples tested: a) under glass and b) under UF-3 filter.
- Long-term test, about six years to date.

Henry Wilhelm comments: Real north daylight tests resistance to strong UV and blue components of the spectrum and helps determine value (if any) of additional UV protection. Artificial sources such as filtered xenon lamps do give better repeatability, and I may use them in the future. The thing to remember is that most home fading is caused by weak daylight, and there just isn't any specific low-light level at which color fading doesn't occur.

TEST NO. 6

Accelerated dark fading of color materials

Conditions:

- Temperature- and humidity-controlled laboratory ovens keep color film and print samples at 144° F, with 45% RH, in total darkness.

Henry Wilhelm comments: The dark fading of color prints is not nearly as serious as it once was; however, yellowish stain formation in dark storage remains a serious problem with most chromogenic print materials. But things are getting better as evidenced by Fuji's new Fujicolor Super FA and Fujichrome Type 34 papers, which are much improved in this respect. Overall, with prints today, dark fading is much less of a problem than light fading. I test at 144° F and 45% RH to get comparative data in a short period of time. Hopefully before the end of the year we will have the equipment to run multi-temperature Arrhenius tests. These are predictive tests that indicate, in years, how long a material will last under normal storage conditions.

How to Read the Tables

Products are ranked according to their image stability, with #1 being the most stable. Letters in parentheses identify the least stable dye or indicate a color imbalance between the most stable and least stable dyes.

(−C): Cyan is the least stable dye
(−M): Magenta is the least stable dye
(−Y): Yellow is the least stable dye

We have here three categories of tests. **In the color-slide projector-fading table** (Table A), **actual projection times are given** for a 20 percent magenta dye loss from an initial neutral density of 0.6 to occur or, in the case of two of the films, to reach a 12-percent cyan/magenta color imbalance (C–M). With a 30-second projection period every four hours, this is a real-time test of intermittent projection (for a given projection time, *continuous* projection usually results in less dye fading and different color-balance shifts).

In comparing the stability of color prints on display (Tables D, F, and H), data from (21.5 K lux glass-filtered fluorescent) **accelerated light-fading tests have been extrapolated into "years of display,"** based on an average display illumination intensity of 450 lux (42 footcandles) for 12 hours a day. The initial density, dye fading, and color-imbalance limits used with the projector-fading tests were also employed here; print samples were kept at 75° F and 60 percent RH throughout the tests. Long-term light-fading tests with much lower illumination levels indicate that with most current chromogenic materials, these estimates of display life are reasonably good approximations of what will occur under normal display conditions.

For the accelerated dark-storage tests (Tables B, C, E, G, and I), the time given in days may be multiplied by about 130 to give an approximation of real-world conditions. Results are based on the least stable image dye fading 20 percent from an initial neutral density of 1.0, when the products are kept at 144° F and 45 percent RH. This is a single-temperature comparative test, similar to that described in American National Standard PH1.42-1969, which was in effect at the time these tests were performed. This test indicates, in a general way, how one product compares with another in terms of overall dye stability.

Yellowish stain formation, which occurs primarily in dark storage, is given as a density increase (+Y) after 180 days in the test. Particularly with color prints, yellowish stain formation during long-term storage is often visually more objectionable than dye fading itself. Stain robs color images of their sparkle and brilliance, giving them a dull, muddy look.

Long-term data based on evaluating products stored at normal room temperature, together with data from several manufacturers, suggests that this test increases the rate of fading between 90 and 150 times—depending on the specific product—compared with "normal" storage at 75° F and a relative humidity of 45 percent. (Adding to the difficulty of predicting how long a product will last is the fact that some products are much more humidity-sensitive than others, and actual conditions of storage vary widely.)

This single-temperature test does not provide a good assessment of changes in color balance, nor does the indicated rate of yellowish stain increase necessarily relate to the rate of dye fading that would occur at room temperature.

A much more complete assessment of dark-storage changes can be obtained with the complex, multi-temperature Arrhenius test specified in the new ANSI IT9.9-1990 color-stability test-methods standard, which is expected to be published before the end of the year. The Arrhenius test is a *predictive* test that allows one to estimate, in years, how long it will take for a specified amount of dye fading, color imbalance, or stain level to occur. (Exactly *what* limits are most appropriate is a controversial topic that we won't attempt to address here.)

In the old days of color photography (before around 1980), stain wasn't of much concern because the dye stability of most products was so poor—it was simply a question of what was the weakest link. Now, however, with many products having greatly improved dark-storage dye stability, concern about yellowish stain, both in its own right and in terms of its influence on color-balance changes, is starting to come out of the closet!

Kodak, Fuji, Konica, and Agfa have all reported Arrhenius test data for the dark-storage dye stability of some of their products (mostly color papers), but to date none of the manufacturers have supplied data on color-balance changes or (with the exception of Fuji with its new Fujicolor Super FA and Fujichrome Type 34 papers, both of which have comparatively low stain levels) of stain characteristics. Because of these omissions, many of the advertised claims about the life of various color products in dark storage are probably too optimistic.

While the performance of products stored and displayed in the wide variety of conditions that one might encounter in the real world may differ from that indicated in these tables, the data presented here represent the best currently available information. The light-fading data for color-print materials and projected color slides are particularly important and fill a major gap in previously available information.

H. Wilhelm

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TABLE
A Life of current color-slide films when projected

PROJECTION STABILITY RATING	COLOR-SLIDE FILMS These data are actual results based on intermittent projection of the test films listed.	PROJECTION TIME TO REACH OBJECTIONABLE LOSS OF DYE DENSITY OR COLOR SHIFT
1	Fujichrome Amateur and Professional Films Fujichrome Duplicating Films	5 hours, 20 minutes (−M)
2	3M Scotch Chrome 100, 400, and 800/3200 (improved 1988 types)	3 hours, 30 minutes (−M)
3	Fujichrome Velvia Professional (introduced in 1990)	3 hours, 20 minutes (-M) (tentative)
4	Kodak Ektachrome Films, including new Ektachrome Plus and Ektachrome HC Films Kodak Ektachrome Duplicating Films	2 hours, 40 minutes (−M)
5	Agfachrome Professional 50 RS, 100 RS and 100 CT, 200 RS and 200 CT (improved 1988/89 types); Professional 1000 RS	2 hours (C–M)
6	Kodachrome Amateur and Professional Films	1 hour (C–M)

TABLE

B

Comparative stability of current color-slide and transparency films stored in the dark

(Tested at 144° F and 45% RH)

DARK STABILITY RATING	COLOR-REVERSAL FILMS These results are based on accelerated aging tests. See "How to Read the Tables" for details.	DAYS FOR 20% LOSS OF LEAST STABLE IMAGE DYE	YELLOWISH STAIN DENSITY AFTER 180 DAYS
1	Kodak Kodachrome Amateur and Professional Films	580 (−Y)	+0.00Y
2	Kodak Ektachrome 100 Plus Professional Kodak Ektachrome 50 HC and 100 HC	225 (−C)	+0.28Y
3	Kodak Ektachrome Amateur and Professional Films Kodak Ektachrome Duplicating Films	210 (−C)	+0.19Y
4	Fujichrome Velvia Professional (introduced in 1990)	185 (−C) (tentative)	+0.24Y (tentative)
5	Fujichrome Amateur and Professional Films, including improved Fujichrome 50 D and 100 D (introduced in 1988) Fujichrome Duplicating Films	185 (−C)	+0.24Y
6	Agfachrome Professional 50 RS, 100 RS, 100 CT, 200 RS, and 200 CT (improved 1988/89 types)	140 (−Y)	+0.10Y
7	3M Scotch Chrome 100, 400, 800/3200, and 640T (new in 1988)	95 (−C)	+0.21Y
8	Agfachrome 1000 RS Professional	75 (−Y)	+0.07Y
9	3M Scotch Chrome 1000 Polaroid Presentation Chrome	45 (−C)	+0.09Y

Tables A and B, Wilhelm Comments: *If you use E-6 films, Fujichrome is the obvious choice. Its resistance to fading during projection is the best of all slide films, and its stability in dark storage is roughly equal to that of Ektachrome. (Tests with Fujichrome Velvia Professional Film, a very sharp, extremely fine-grain, 50-speed film introduced in February, showed that its projector-fading stability was less than that of other Fujichrome films. According to Fuji, the dark-storage dye stability of Velvia is similar to that of other Fujichrome films, but Velvia has improved dark-storage stain characteristics.)*

In spite of Kodachrome's unequaled dark-storage dye stability and total freedom from stain formation, it has the worst projector-fading stability of any slide film on the market. Kodachrome is a very good illustration of how a dye, in this case magenta, can have very good dark-fading stability but comparatively poor light-fading stability (with some dyes, the opposite is true). Kodachrome is a great film to use if projection can be avoided; but if projection of originals sometimes is a must, and time or money keeps you from routinely duplicating originals, you will probably be better off with Fujichrome.

Even if you use Fujichrome, it is good advice to make duplicates for projection if significant use is expected. For that matter, it is a good insurance policy to duplicate all *valuable slides and store the originals in the dark in a safe place.*

TABLE

C

Comparative stability of current color-negative films stored in the dark

(Tested at 144° F and 45% RH)

DARK STABILITY RATING	COLOR-NEGATIVE PRINT FILMS These data are actual results based on accelerated aging tests. See "How to Read the Tables" for details.	DAYS FOR 20% LOSS OF LEAST STABLE IMAGE DYE
1	Kodak Vericolor III Professional, Type S	215 (−Y)
2	Kodak Vericolor 400 Professional Kodak Ektapress Gold 1600 Kodak Kodacolor Gold 1600 Kodak Ektar 1000	200 (−Y)
3	Konica Color Super DD 400 (tentative) Konica Color SR-G 400 Konica Color SR-G 3200 Professional	180 (−C)
4	Kodak Ektapress Gold 400 Kodak Kodacolor Gold 400	175 (−Y)
5	3M ScotchColor 100	145 (−Y)
6	Konica Color SR-G 200 Konica Color SR-G 160 Professional	140 (−C)
7	Fujicolor Super HG 1600 Fujicolor Super HG 400 Fujicolor Super HG 200 Fujicolor Super HG 100 Kodak Ektar 125	130 (−Y)
8	Konica Color SR-G 100 Kodak Kodacolor VR 100 Kodak Kodacolor VR 200 Kodak Kodacolor VR 400	110 (−Y)

DARK STABILITY RATING	COLOR-NEGATIVE PRINT FILMS These data are actual results based on accelerated aging tests. See "How to Read the Tables" for details.	DAYS FOR 20% LOSS OF LEAST STABLE IMAGE DYE
9	Agfacolor XRC and XRG 400 Agfacolor XRS 400 Professional	100 (−Y)
10	Fujicolor 160 Professional, Type S Fujicolor 160 Professional, Type L Kodak Ektar 25 and 25 Professional	90 (−Y)
11	Fujicolor Reala (100) Kokak Ektapress Gold 100 Kodak Kodacolor Gold 100 Kodak Kodacolor Gold 200 Kodak Vericolor HC	85 (−Y)
12	Agfacolor XRC and XRG 100 Agfacolor XRS 100 Professional Agfacolor XRC and XRG 200 Agfacolor XRS 200 Professional	75 (−Y)
13	Polaroid OneFilm (200) 3M Scotch HR 200 (improved versions of these films will be introduced in late 1990)	55 (−C)
14	Agfacolor XRS 1000 Professional	45 (−C)
15	3M Scotch HR 400	37 (−C)
16	Kodak Vericolor II Professional, Type L	30 (−C)

Table C, Wilhelm Comments: *The good news here is that in the last six years the dark-fading stability of most color-negative films has been substantially improved. (For all practical purposes, light fading is not a factor with color negatives—light exposure in the enlarger just doesn't amount to very much, even if you are making a lot of prints from the same negative.) As a group, the Kodak and Konica 400 and higher-speed films are the best. (There is no particular reason that a high-speed film should be more stable than a low-speed product; it just happened to turn out that way with these particular products.) Kodak Vericolor III Film, Type S, a "professional" film designed especially for portrait and wedding photography, proved to be the most stable of all color-negative films.*

There are a lot of considerations that go into making a choice about which color-negative film is best for a particular job, and a photographer may decide to select a less than the most stable film to gain some other advantage; Fujicolor Reala, which has excellent color and tone reproduction and gives exceptionally good results with difficult-to-photograph fluorescent illumination, is a case in point. But I would stay away from the very worst products, like Kodak Vericolor II Type L, Polaroid OneFilm, and the older-type 3M Scotch color-negative films.

TABLE

D Display life of current chromogenic papers for printing color negatives

LIGHT STABILITY RATING	COLOR-PRINT PAPERS These results are based on accelerated aging tests. See "How to Read the Tables" for details.		ESTIMATED TIME TO REACH OBJECTIONABLE LOSS OF DYE DENSITY OR COLOR SHIFT
1	Fujicolor Super FA Type II Fujicolor Professional Super FA	(RA-4)	24.2 years (−M)
2	Konica Color QA Type A2 Konica Color QA Professional Type X1	(RA-4)	20.5 years (−M)
3	Fujicolor Type 03 Fujicolor Professional Type 02-P	(EP-2)	15.8 years (−M)
4	Agfacolor Type 9	(RA-4)	15.3 years (−M)
5	Konica Color Type SR Konica Professional Type EX	(EP-2)	13 years (−M)
6	Kodak Ektacolor 2001 Kodak Ektacolor Portra Kodak Ektacolor Supra Kodak Ektacolor Ultra Kodak Ektacolor Royal	(RA-4)	12.7 years (−M)
7	Kodak Ektacolor Plus Kodak Ektacolor Professional	(EP-2)	11.8 years (−M)
8	Agfacolor Type 8 Agfacolor Type 8 ML	(EP-2)	11.5 years (−M)

TABLE

E Comparative stability of current chromogenic papers for printing color negatives stored in the dark

(Tested at 144° F and 45% RH)

DARK STABILITY RATING	COLOR-PRINT PAPERS These results are based on accelerated aging tests. See "How to Read the Tables" for details.		DAYS FOR 20% LOSS OF LEAST STABLE IMAGE DYE	YELLOWISH STAIN DENSITY AFTER 180 DAYS
1	Fujicolor Super FA Type II Fujicolor Professional Super FA	(RA-4)	370 (−C) (tentative data)	+0.08Y (tentative data)
2	Konica Color QA Type A2 Konica Color QA Professional Type X1 (Processed with Konica Washless Stabilizer)	(RA-4)	370 (−C)	+0.20Y
3	Agfacolor Type 8 Agfacolor Type 8 ML	(EP-2)	360 (−Y)	+0.23Y
4	Konica Color Type SR Konica Color Professional Type EX (Processed with Konica Washless Stabilizer)	(EP-2)	315 (−C)	+0.11Y
5	Agfacolor Type 9	(RA-4)	305 (−C)	+0.21Y
6	Kodak Ektacolor Plus Kodak Ektacolor Professional	(EP-2)	230 (−C)	+0.25Y
7	Kodak Ektacolor 2001 Kodak Ektacolor Portra Kodak Ektacolor Supra Kodak Ektacolor Ultra Kodak Ektacolor Royal	(RA-4)	200 (−C)	+0.25Y
8	Fujicolor Type 03 Fujicolor Professional Type 02-P	(EP-2)	155 (−C)	+0.20Y

Tables D and E, Wilhelm Comments: *Introduced at the PMA show in February, Fujicolor Super FA Type II paper wins this category hands down. In fact, considering the paper's very low stain level in dark storage combined with its superior light-fading stability, this is the best chromogenic paper of any type on the market—negative or positive. The color reproduction and sharpness of this new product are also outstanding for a color-negative paper. Super FA Type II paper and its lower-contrast counterpart, Fujicolor Professional Super FA paper, are particularly recommended for portrait, wedding, and fine-art photography—markets where long-lasting prints are a must.*

Fast-processing RA-4 compatible papers have now largely replaced the older EP-2 papers in minilabs, and in the next year or two will become standard in large photofinishing and commercial labs. Among the EP-2 papers, Konica Type SR paper is recommended—the long-term light-fading stability of this product is clearly better than Ektacolor Plus or Professional papers.

GOING!
GOING!!
GONE!!!

TABLE

F Display life of current reversal papers for printing color transparencies

LIGHT STABILITY RATING	COLOR-REVERSAL PAPERS These results are based on accelerated aging tests. See "How to Read the Tables" for details.		ESTIMATED TIME TO REACH OBJECTIONABLE LOSS OF DYE DENSITY OR COLOR SHIFT
1	Ilford Cibachrome II Ilford Cibachrome-A II (Prints on polyester base with glossy surface; semigloss "Pearl" RC prints have similar dye stability but are subject to base cracking and yellowing, and are therefore not recommended for long-term applications.)	(P-3/P-3X) (P-30/P-30P)	28 years (−M)
2	Fujichrome Type 34	(R-3)	19 years (−M)

TABLE

F *continued*

LIGHT STABILITY RATING	COLOR-REVERSAL PAPERS These results are based on accelerated aging tests. See "How to Read the Tables" for details.	ESTIMATED TIME TO REACH OBJECTIONABLE LOSS OF DYE DENSITY OR COLOR SHIFT
3	Kodak Ektachrome 22 and Ektachrome Prestige (R-3) Not recommended due to very bad dark fading compared with Fujichrome and Agfachrome R-3-compatible reversal papers	15 years (−M)
4	Agfachrome Type 63 (R-3)	10 years (−M)

TABLE

G Comparative stability of current reversal papers for printing color transparencies stored in the dark

(Tested at 144° F and 45% RH)

DARK STABILITY RATING	COLOR-REVERSAL PAPERS These results are based on accelerated aging tests. See "How to Read the Tables" for details.	DAYS FOR 20% LOSS OF LEAST STABLE IMAGE DYE	YELLOWISH STAIN DENSITY AFTER 180 DAYS
1	Ilford Cibachrome II (P-3/P-3X) Ilford Cibachrome-A II (P-30/P-30P) (Prints on polyester base with glossy surface; semigloss "Pearl" RC prints have similar dye stability but are subject to base cracking and yellowing, and are therefore not recommended for long-term applications.)	More than 2,190 days	+0.00Y
2	Fujichrome Type 34 (R-3)	370 (−C)	+0.08Y
3	Agfachrome Type 63 (R-3)	63 (−C)	NA
4	Kodak Ektachrome 22 and Ektachrome Prestige (R-3) Not recommended: very poor dark-fading stability compared with other current R-3-compatible processes	28 (−C)	+0.26Y

Tables F and G, Wilhelm Comments: *Among conventional, easy-to-process color-print materials, Cibachrome is the only product that can be considered absolutely permanent (with essentially zero stain levels) in normal room-temperature dark storage. Here we see the great advantage of the Cibachrome preformed dye system compared with the chromogenic processes. It would be great if Ilford would offer a negative-printing version of Cibachrome for color-negative users (Ilford knows exactly how to do it). Such a new "Cibacolor" would be a fabulously successful product in the portrait, wedding, and fine-art fields.*

Among the Process R-3 products, Fujichrome Type 34 reversal paper is by far the best choice. With its low stain level in dark storage together with good light-fading stability, this is the slide-printing counterpart to Fuji's new Fujicolor Super FA Type II paper for printing color negatives. Kodak's Ektachrome 22 paper, with its very poor cyan dark-fading stability, is a relic from the previous generation of color papers and is not recommended. As in all of the other tests, the fading data reported in this table was obtained from critical neutral gray patches.

TABLE

H Display life of color-print materials using costly, special processes

LIGHT STABILITY RATING	COLOR-PRINT MATERIALS These results are based on accelerated aging tests. See "How to Read the Tables" for details.	ESTIMATED TIME TO REACH OBJECTIONABLE LOSS OF DYE DENSITY OR COLOR SHIFT
1	Polaroid Permanent-Color Prints (Pigment process on polyester base; new in 1989)	More than 500 years
2	Kodak Dye Transfer Prints (On fiber-base paper, with high-stability MX-1372 yellow dye; new in 1988)	45 years (−M)
3	Kodak Dye Transfer Prints (On fiber-base paper, with standard Kodak film and paper dyes)	32 years (M–Y)

Tables H and I, Wilhelm Comments: *On long-term display, and we are talking about centuries, Polaroid Permanent-Color prints are in a class by themselves. Accelerated test data suggest that they will last as long as (or quite possibly even longer than) the best archivally processed, fiber-base black-and-white prints. This is the Rolls-Royce of the color-print field—a material against which all others must be compared. Although Polaroid Permanent-Color and Kodak Dye Transfer prints are both permanent when kept in the dark, Kodak Dye Transfer prints don't hold a candle to Polaroid Permanent-Color prints when it comes to light-fading stability on display.*

TABLE

I Comparative stability of color-print materials (stored in the dark) using costly special processes

(Tested at 144° F and 45% RH)

DARK STABILITY RATING	COLOR-PRINT MATERIALS These results are based on accelerated aging tests. See "How to Read the Tables" for details.	DAYS FOR 20% LOSS OF LEAST STABLE IMAGE DYE	YELLOWISH STAIN DENSITY AFTER 180 DAYS
1	Polaroid Permanent-Color Prints (Pigment process on polyester base, new in 1989)	More than 2,190 days	+0.00Y
2	Kodak Dye Transfer Prints (On fiber-base paper with standard Kodak Film and Paper Dyes)	More than 2,190 days	+0.02Y
3	Kodak Dye Transfer Prints (On fiber-base paper with high-stability MX-1372 yellow dye)	More than 2,190 days (estimated)	+0.02Y

What's the Bottom Line? The Longest-Lasting Films and Print Materials

TRANSPARENCY FILMS
Best overall
Fujichrome films of all types, including Fujichrome Velvia and Fujichrome Duplicating Films
Best if projection can be avoided
Kodachrome films of all types

COLOR-NEGATIVE FILMS
ISO 25:
Kodak Ektar 25 and Ektar 25 Professional
ISO 100–125:
3M ScotchColor 100
ISO 160–200*:
Kodak Vericolor III Professional, Type S
Fujicolor 160 Professional, Type L
Fujicolor Super HG 200
Konica SR-G 200
ISO 400:
Kodak Vericolor Professional 400
Kodak Ektapress 400
Kodak Kodacolor Gold 400
Konica Super DD 400
Konica SR-G 400
ISO 1000–3200:
Kodak Ektapress 1600
Kodak Kodacolor Gold 1600
Kodak Ektar 1000
Konica SR-G 3200 Professional

COLOR INTERNEGATIVE FILM
Fujicolor Internegative Film IT-N

COLOR-NEGATIVE PAPERS
Best overall
Fujicolor Super FA Type II
Fujicolor Professional Super FA
Best Process EP-2 Papers
Konica Color Type SR
Konica Color Professional Type EX

PAPERS FOR PRINTING COLOR TRANSPARENCIES
Best overall
Cibachrome II (glossy polyester base)
Cibachrome-A II (glossy polyester base)
Best Process R-3 Paper
Fujichrome Type 34

MOST PERMANENT COLOR-PRINT PROCESS OF ANY TYPE—BUT COSTLY
*Polaroid Permanent-Color***

** The four films listed in the ISO 160–200 group are intended for different applications, and we have included the most stable products of each type. Kodak Vericolor III Professional Film, Type S is a daylight/electronic-flash film intended primarily for professional portrait and wedding photography. Fujicolor 160 Professional Film, Type L is a tungsten-balanced color-negative film generally used for studio portrait and product photography (this film is considerably more stable than Kodak's equivalent tungsten-balanced color-negative film, Vericolor II Professional Film, Type L). Fujicolor Super HG 200 and the pleasingly lower-contrast Konica SR-G 200 are daylight films intended for the general amateur market.*

*** Process may be used to make prints from color transparencies, color negatives, or already existing prints.*

Color Prints Forever?

A new process produces color photographs that promise to last as long as oil paintings

To a greater or lesser degree, all of the organic dyes used to form the images in conventional color films and prints gradually fade when exposed to light. Even Cibachrome and dye-transfer prints, both exceedingly stable when stored in the dark, will fade to an objectionable degree after relatively few years of display. In long-term display, no current color material with a dye image can even approach the stability of the silver image of a carefully processed black-and-white photograph made on fiber-base paper. (Only fiber-base prints can be included in this comparison because, for various reasons, the life of displayed black-and-white RC prints may fall considerably short of that of fiber-base prints.)

So how can a truly permanent color print be made? The answer is to do what Louis Ducos du Hauron, the French pioneer of color photography, did when he made the first real color prints around 1870—form the image with *pigments* instead of dyes. Ducos du Hauron used a three-color adaptation of the well-known carbon process to make his color prints; in those days, long before the development of the modern, easy chromogenic process with its lovely but all too fleeting color dyes, making a color print with separate color pigment layers was the most obvious approach.

Tricolor pigment prints continued to have some use all the way into the 1950s. Glamorous portraits of Hollywood stars and lush advertising photographs from this era that were printed with the tricolor carbro process can be found in the collections of George Eastman House, the Smithsonian, and other institutions. The color-pigment processes eventually died out, however; they were first replaced with the easier-to-manage dye-transfer process, more recently with Kodak Ektacolor and similar chromogenic processes, and with Cibachrome.

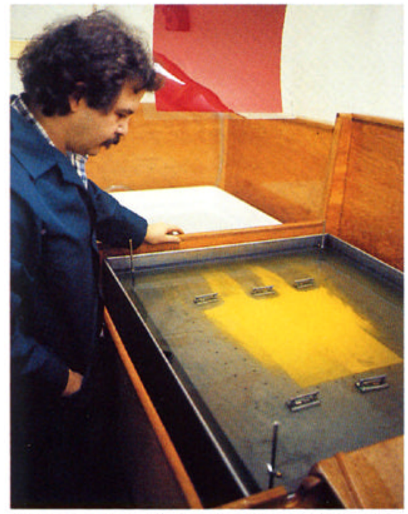
Along came Charles Berger. A fine-art photographer who has published several books of photographs and whose work is in the permanent collection of the Museum of Modern Art in New York, Berger was frustrated with the lack of anything permanent on the market with which he could print his own color photographs. By 1980, after several years of experimentation, Berger had developed a modern, pin-registered, high-resolution version of the classic tricolor carbon process. Berger not only made the process simpler to use—although the print-making procedure remains a relatively complex task—but more importantly, he came up with cyan, magenta, yellow, and black pigments that had really extraordinary light-fading stability. The pigments are similar to those used in automobile paints, which must be able to tolerate years of outdoor sun exposure under the harshest conditions.

Producing the prints requires that full-size separation negatives be made from an original color transparency, print, or negative. The separations are normally produced on a high-resolution graphic-arts laser scanner. These negatives are individually contact printed on dimensionally stable plastic sheets that have been coated with a pigment-containing gelatin layer. After exposure, the pigment layer is transferred in exact register to an opaque white polyester support. Following transfer and a warm-water wash-off, a positive relief image is formed; the thickness of the gelatin at any given point is a function of optical density. This procedure is repeated for each of the four pigment colors. At the end is a brilliant, full-color print.

Color Prints That Last 500 Years? New Polaroid Permanent-Color Does It!

ALL PHOTOS HENRY WILHELM

Assembly line: *Separate pigment relief images (left) are assembled in precise register to make final Polaroid Permanent-Color print (extreme right).*



Living color: *Separate-pigment images (yellow shown here) suddenly come to life in a warm-water bath after exposure.*

The process is more difficult than Kodak Dye Transfer, and at present only a few labs offer the prints on a commercial basis (see list below). As might be expected, the prints are not inexpensive, with a 16 × 20 costing roughly $1,000 (additional prints of the same image cost much less). In 1985 Berger contracted with Polaroid Corporation to manufacture the four-pigment sheets, and the prints are now known as Polaroid Permanent-Color prints.

Henry Wilhelm's accelerated light-fading tests indicate that, under typical indoor display conditions, the prints should last for many hundreds of years with no discernible fading or staining. They are, simply stated, the world's only permanent color prints. And when they are properly made, the prints are breathtaking to look at. It is expected that they will become the material of choice for portraits of presidents, kings, and important and well-known people of all sorts, all over the world. The prints satisfy a long-felt need in the fine-art field. And for the average person, a family portrait or two printed on Polaroid Permanent-Color will have immense appeal as an heirloom that can be displayed and handed down generation after generation.

Inventor of the process, *Charles Berger assembles the separate pigment layers on the way to making the final print.*

Berger, now living in California (his lab, located in a redwood forest only a few miles from the epicenter of last October's earthquake, survived the jolt with only minimal damage), has now joined forces with Richard N. Kauffman; the latter is a long-time environmentalist, photographer, and skilled carbro printer (Kauffman is also chairman of the huge California-based H.S. Crocker printing

How Permanent Are Polaroid Instant Prints?

The dyes in Polaroid instant prints are extremely stable in dark storage. However, when discussing the stability of Polaroid SX-70, Spectra, and Polaroid 600 Plus prints, dark-storage dye stability is only half the story. The problem with these prints is that in normal room-temperature dark storage they develop an objectionable yellowish overall stain in a relatively short period. In nonaccelerated "real-time" tests, the stain levels exceeded Wilhelm's limits in only a few years. The stain is produced by slow migration of non-image dyes and/or other chemical constituents residing in the lower layers of the tightly sealed Polaroid print package.

Polaroid Spectra and 600 Plus prints also have poor light-fading stability. When displayed, these prints fade significantly faster than typical chromogenic papers. Polaroid color prints have no usable negative (like daguerreotypes, each exposure produces a unique image). If important pictures have been made on these materials, the best policy is to make two copies on a more stable print material (Polaroid itself offers good-quality copies made on chromogenic paper at reasonable cost). Keep one of these copies in the dark and use the other for display.

Polaroid peel-apart prints (such as Polacolor ER and Polacolor 2) do much better in dark storage than Spectra and other Polaroid integral prints because with the peel-apart prints, the negative layer with its unused image-forming dyes and other chemicals is stripped away after processing. But these prints also have poor light-fading stability and should be displayed with caution. Copies should be made for long-term display.

company). Their goal is to develop improved materials for making pigment color prints.

These new products, which will be sold by Berger and Kauffman under the name of UltraStable Permanent Color Materials, are said by Berger to be easier to work with and to offer improved color and tone reproduction. In addition, according to Berger, the process will be completely nontoxic. These new materials are expected to be available later this year.

For more information, contact: Charles Berger, UltraStable Color Systems, P.O. Box V-2, Felton, CA; (408) 335-2169.

Henry Wilhelm

Labs Offering Polaroid Permanent-Color Prints

Collectors Color Prints, Ataraxia Studio
2301 York Rd., P.O. Box 343
Jamison, PA 18929; (215) 343-3214

Limited Edition Photographics
136 Doyle St., Santa Cruz, CA 95062
(408) 423-6453

GOING! GOING!! GONE!!!

What to Do with What You've Got

The most important thing you can do to insure that your color photos will last as long as possible is to shoot and print them on the most stable films and papers that meet your needs. But what about all the color slides, prints, and negatives that you already have, many of which are on materials that are far less stable than you imagined? How can you help preserve them? Here are a few guidelines.

1. Light is the great enemy of color photographs. It is visible light that does the damage. Ultraviolet radiation contributes little if any to the fading of most current color prints displayed indoors under average conditions—even under fluorescent illumination. Invariably, color photographs last far longer when stored in the dark than they do on display.

2. Color prints: Extended display, especially under bright light, will destroy color prints. Unfortunately, the photographs most people display are those that are most valuable to them. So if a photograph is important to you, make two copy prints (Fujicolor Super FA, Cibachrome, or Fujichrome Type 34 papers are recommended for this). Store the original and one copy in the dark and use the other copy for display. If the original negative or transparency is available and still in printable condition, use it to make the new prints. Because instant color prints are one-of-a-kind images that have no negatives, they should never be displayed for long periods. Use copy prints instead.

3. Color slides: Projection of original color slides should be minimized—especially if they were made on Kodachrome or older Agfa, GAF, or Ansco films. Valuable slides should always be duplicated (Fujichrome Duplicating Film is recommended) and the duplicates used for projection. Don't leave color transparencies on light tables or sitting on desk tops any longer than absolutely necessary. Any older color transparencies that appear to have faded or suffered a noticeable shift in color balance should be duplicated promptly. With the notable exception of post-1939 Kodachrome, almost all of the color-transparency films manufactured until around 1980 had poor dark-storage stability.

4. Color negatives: Prior to the mid-1980s all color-negative films had poor dark-storage stability. Some are still very poor. If you have valuable older negatives, print them on Fujicolor Super FA paper, if it isn't already too late. But even if they are too far gone to make good prints, don't throw them away. Electronic image-enhancement systems are now becoming available, such as the Agfa Digital Slide Printer and the Kodak Premier Image Enhancement System, which will, at reasonable cost, allow substantial corrections to be made when printing faded negatives and transparencies.

5. Handling: All films and prints need to be protected from scratches, cracking, fingerprints, and other physical damage. Valuable prints should be matted and mounted with nonbuffered museum board. Depending on the type of print, dry mounting, corner mounting, or hinge mounting may be used to secure the print to the backing. When matting is not feasible, prints can be given considerable protection by placing them individually in sleeves made of 3 to 5 mil uncoated polyester (Dupont Mylar D or ICI Melinex 516). Matted and/or sleeved prints should be stored in suitable boxes, such as those sold by Light Impressions, Conservation Resources, and University Products. Slides should be stored in boxes or polypropylene slide pages, and negatives should be kept in polyester or high-density polyethylene sleeves.

6. Storage: Store all color photographs in a cool, dry place. Basements should be avoided because they are too humid during warm months. Attics are bad because they get too hot. A shelf in a closet in an air-conditioned bedroom is often a good location. Don't store photographs on the floor, which in many houses becomes too humid during at least part of the year. Even the most unstable types of color films and prints can be preserved for centuries or even thousands of years in humidity-controlled cold storage. NASA preserves the Ektachrome transparencies taken by the Apollo astronauts on the surface of the Moon at 0° F and 25 percent relative humidity in a vault at the Lyndon B. Johnson Space Center in Houston, TX. A number of other museums and archives, including the John F. Kennedy Library, the Art Institute of Chicago, the Smithsonian Institution, the Peabody Museum at Harvard University, the Library of Congress, and the Historic New Orleans Collection, also have cold-storage facilities to preserve their color photographs.

Henry Wilhelm and Carol Brower

Where to buy archival storage and display materials

Conservation Resources Internat'l, Inc.
8000-H Forbes Pl.
Springfield, VA 22151
(800) 634-6932 In VA: (703) 321-7730

Light Impressions Corp.
439 Monroe Ave., Rochester, NY
14607-3717
(800) 828-6216
In NY State: (800) 828-9629

University Products, Inc.
517 Main St., P.O.B. 101
Holyoke, MA 01041-0101
(800) 628-1912 In MA: (800) 336-4867

Who Is Henry Wilhelm...

. . .and why is he saying that you'll probably outlast your color prints?

Grinnell, Iowa—Tucked away in the heartland of North America, Grinnell is in a slow-paced time warp of clean air, rolling cornfields, safe streets, homes with unlocked doors, and a population of 8,868 friendly folk who inhabit the ideal environment for the long-term, measured fading of color photographs.

The prime mover of this enterprise in color mortality is Henry Wilhelm, a 46-year-old transplanted Virginian who was attracted to the town by Grinnell College, which he attended in the 1960s. As a Peace Corps volunteer in the jungle, Wilhelm became alarmed by the loss of valuable historical records through photographic impermanence. When this became the focus of his life, and a personal crusade, Wilhelm headed to Grinnell. He credits the college community with having helped his research into the hows and whys of color fading and staining.

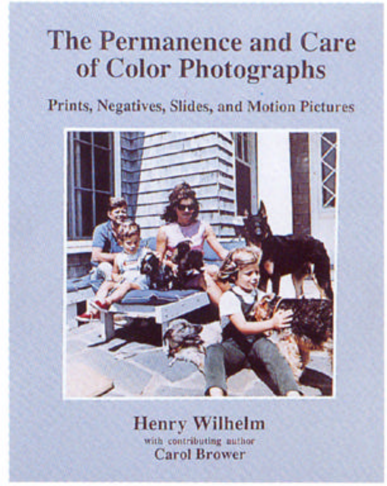
Wilhelm is often chided for the tortuously slow delivery of his long-awaited book, *The Permanence and Care of Color Photographs: Prints, Negatives, Slides, and Motion Pictures,* which has been promised for at least a dozen years and finally will see the light of day later this year.

Wilhelm's tongue-in-cheek explanation is that "the only thing about color permanence that doesn't take longer than people expect is the deterioration of color prints on display." He points out that the original ANSI (American National Standards Institution) standard for color-stability test methods was replaced after an unusually long life of 20 years. "This proves that ANSI is only marginally faster than I am," says Wilhelm, who happens also to be the secretary of the color-stability task group that wrote the new standard.

Henry Wilhelm's color research began in 1974 but really got serious in 1977, when he got his first color densitometer and started taking readings. Since then, he has made more than a million readings, most from the patches of Macbeth ColorChecker charts. At first, these findings were laboriously written into notebooks by hand. But in 1983, June Clearman, a mathematician and computer wizard at the Grinnell College computer center, wrote a series of programs for Wilhelm's data recording and analysis.

BOB SCHWALBERG

***Up against the densitometer:** Hard-working Henry Wilhelm has made over a million color density measurements of fading color materials over the last decade. It's a bit easier now that readings are fed directly into the computer.*



***The Book:** Wilhelm's authoritative tome on color permanence will finally be published this summer by Preservation Publishing Company.*

Now, critical color densitometer measurements flow directly from the instrument to the Hewlett-Packard computer, with three decimal places.

Today, these data (plus six years of readings taken from the old notebooks) are stored on about 200 floppy disks. A complete backup set is kept in New York City and another set is lodged in a Grinnell bank vault. (Wilhelm has not forgotten the tornado that leveled most of Grinnell on June 17, 1882, or the Great Fire of June 12, 1889.)

Preservation Publishing Company was founded in 1982, when Sharp Lannom, an industrial idealist in Grinnell who believes in the importance of color-preservation research, took over the financial responsibility for the completion of the book. Wilhelm's other close collaborator is Carol Brower, a New York specialist in conservation matting for leading photographers, collectors, galleries, and museums. Brower has dedicated at least nine years to The Book and wrote Chapter 12 on "The Presentation, Handling, and Conservation Matting of Prints," which must be considered *the* definitive work on the subject. She is listed as contributing author and, along with Sharp Lannom and editor John Wolf, deserves credit for bringing the effort to publication.

One recurring cause of delay has been that whenever a new color film or print material appears on the market, Wilhelm's far-flung friends send samples to Grinnell, where he and his crew begin the process of taking the material through five light-fading tests and the dark-fading ovens. This means months and even years of testing and many thousands of addi-

continued on page 60

GOING! GOING!! GONE!!!

continued from page 49

tional densitometer readings. (For this reason, Wilhelm confesses to a certain affection for fast-fading, quick-staining color materials that reveal a lot of data in a short time span!)

Why is all this documentation of dye destruction done? Is Henry Wilhelm really the Guru of Grinnell or photography's reversed image of Ralph Nader? "Absolutely not," exclaims Wilhelm. "In the first place, fading images are very real, and it doesn't take a Ralph Nader—whom I admire very much—to know that all of the billions of color pictures made each year are very important to the people who took them."

Wilhelm is a man with three missions. The first of these is to make color-image stability a more visible factor—even a competitive feature—in the photographic industry. "I'm not out just to make trouble," he explains, "but I *know* that all of those brilliant people in the big companies can do a lot better than they've done up to now."

His second goal is to provide photographers—both amateur and professional—with reliable comparative data so that they can choose the most stable materials that fit their other photographic criteria. The trouble is that permanence has never really made it as a strong sales argument, and a lot of photographers and museum people have operated within a framework of misconceptions. The optimists believe (quite wrongly) that there's some specific low-light level in which color prints can safely be displayed. The pessimists take the equally erroneous view that all color is transitory and that there's nothing worth doing or discussing. Wilhelm's goal is a wider and more accurate knowledge of the scientific facts of color preservation.

Finally, Wilhelm wants to convince museums, archives, and all other holders of large photographic color collections that they must install refrigerated, humidity-controlled storage rooms. More than this, these institutions must monitor the ongoing condition of color images in their care, or as Wilhelm says, "They're just not doing their jobs." ✪

cover

What happens to your color prints when they're put on display? If they've been printed on most conventional color papers, they'll eventually fade away, and in considerably less than a lifetime. On this month's cover you can see four stages of the disappearing act, from "unfaded control print" to practically gone. The pictures shown are part of a controlled light-fading test by color-permanence expert Henry Wilhelm. His extensive research provided the basis for what is probably the most comprehensive article on color fading—and what you can do about it—ever printed in a magazine (see "Going! Going!! Gone!!! beginning on page 37). The original picture was shot by wedding photographer Max Brown, who hails from Story City, IA, not too far from Wilhelm's home and research facility in Grinnell.