THE DYE TRANSFER PROCESS

by Henry Holmes Smith

Note: These procedures are adapted from many sources. The result is a simplified method that offers great versatility of color expression with minimum technical equipment. For these reasons the methods described are recommended to beginners. This should not be interpreted as advocating changes in the methods used by experienced workers. I try to observe the rule never to interfere with a practice that works, until a superior method is disclosed.

Exposure to the separation negatives is made through the base of the relief films so that the exposed portion (dotted area in the diagram) of the emulsion is next to the base, and will cling to the base when the unexposed portion is subsequently washed away.

The emulsion, sensitive only to blue and blue-violet rays, contains a yellow dye which limits the penetration of the printing light in accordance with the density of the negative. A highlight in the original subject will produce a high density in the negative, and the small amount of light passed by this high density penetrates the Wash-Off Relief emulsion only a short distance. A shadow in the original subject produces a low density in the negative, through which the printing light penetrates deeply into the emulsion.

Development is carried to completion so that practically all the exposed silver halide grains are developed to silver. The depth from the support of the resulting silver image (black area in the diagram) is greater wherever there are greater densities. A tanning bleach then converts the silver to silver chloride and hardens (tans) the gelatin wherever there is metallic silver, but does not harden the gelatin where the silver halide grains were not developed.

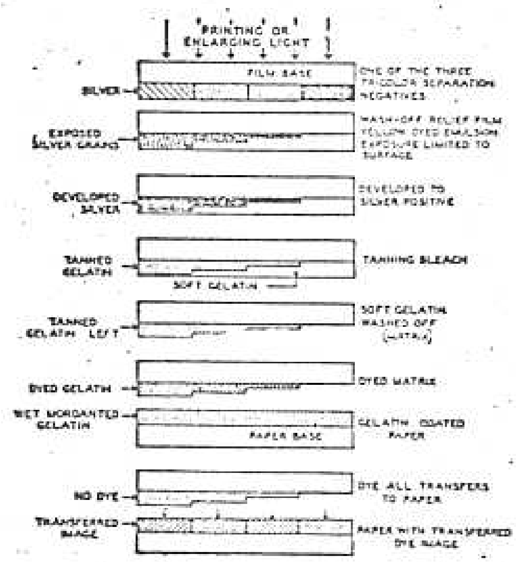
The tanned gelatin (shaded area in the diagram) is insoluble in warm water, while the unaffected gelatin can be washed off as shown in the next step in the diagram. Thus, the actual thickness of the gelatin is made to vary according to the density of the image.

After treatment to remove the silver chloride produced by the bleach, the relief films, or matrices, are washed and dried, then soaked in the appropriate dye solutions. The amount of dye taken up by a matrix is proportional to the height of the relief image. If necessary, adjustments in the dye images can be made at this point.

The dyed matrices are then placed successively in contact with a suitable gelatin-coated paper, previously mordanted so that the dye transfers to the gelatin of the paper. Kodak Imbibition Paper is made especially for this purpose.

Register of the successive transfers is accomplished before contact of the matrix by adjusting the matrix while it is separated from the paper by a thin sheet of transparent plastic or Wash-Off Relief Film from which the emulsion has been removed by washing in hot water. The three dye images combined in the gelatin on the paper form the final color print.

STEPS IN THE WASH-OFF RELIEF PROCESS



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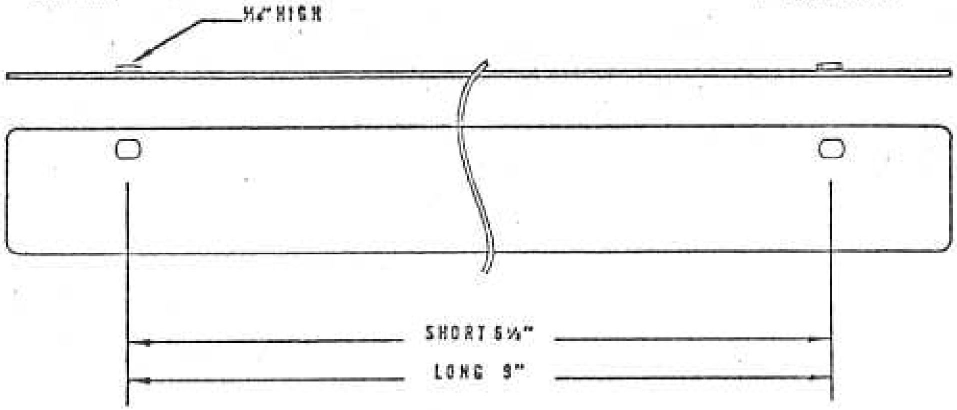

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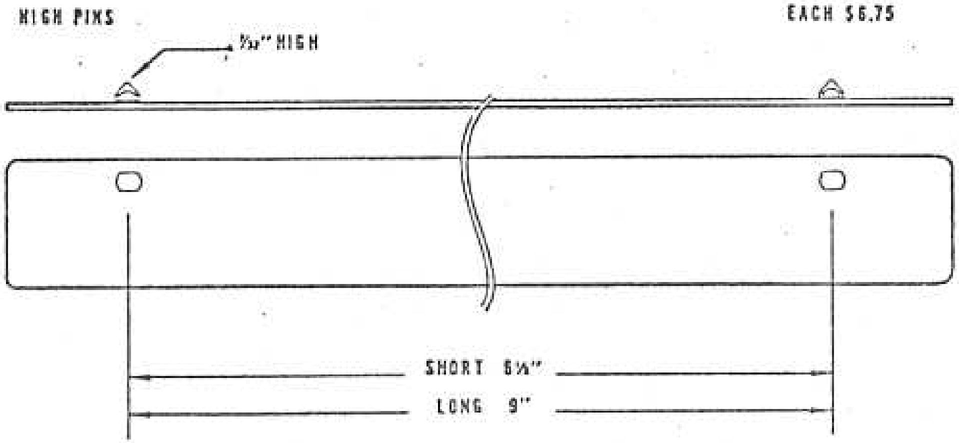
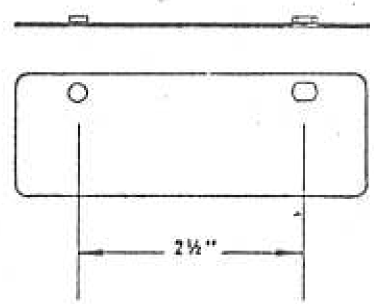


2½" SHORT STRIP FOR EASTMAN PUNCH



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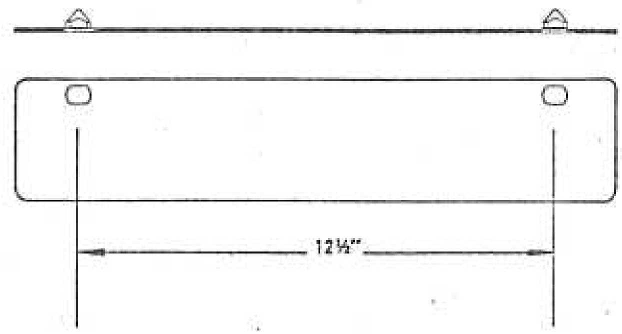

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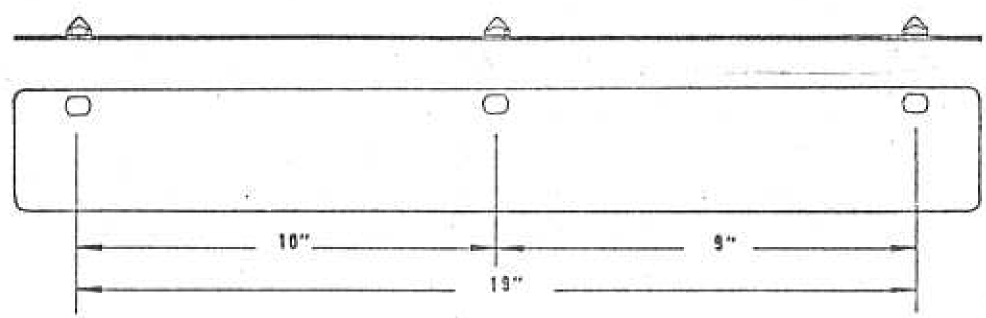

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The Process

The Dye Transfer Process (or Wash-Off Relief Imbibition Process) is based on the transfer of dye from a gelatin relief printing matrix to a properly prepared gelatin-coated paper. Once the matrices have been made, a number of nearly identical duplicate prints can be made with no additional material costs except for the paper and dye and a few inexpensive chemical solutions.

Materials needed include

Matrix Film (Eastman Kodak Company)
Dye Transfer Paper (Eastman Kodak Company)
D K-50 Film Developer (Eastman Kodak Company)
Kodak Bleaching Solution R-10a (See formulas)
Tricolor dye set (Kodak or equivalent)
Acetic Acid (28%) prepared with distilled water
Citric Acid (10% solution in distilled water)
Dye Transfer Aid (See formula)
Kodak Mordanting Solution M-1 (See formulas)
(For use with paper other than Dye Transfer Paper)
Sodium Thiosulfate Crystals (Hypo Rice) 5-10 lbs.
Sodium Acetate
Distilled water (several gallons)

Variations

Kodak Matrix Film is used for making gelatin relief positives or matrices which are dyed, the dye image then being transferred to a suitably prepared gelatin surface, usually plain gelatin-coated paper. The transfers may be made to a piece of regular black and white photographic paper which has been printed, developed, fixed, well-washed and mordanted, or to a piece of otherwise useless "out-of-date" regular photographic paper which has been fixed, washed and mordanted for this particular use.

In conventional dye transfer printing, the tri-color dyes of the subtractive synthesis (cyan, magenta and yellow) are printed in register to reproduce with more or less accuracy colors of the original subject matter before the camera.

There is no reason, except minimally valid esthetic ones, for hewing to this line of "depictive" color, and the same process, freed from such commitments, may be used with a variety of colorless or indifferently colored objects photographed in monochrome, to yield brilliant colored images that have an esthetic value of their own. Some individuals will find this approach liberating, and they are the ones for whom this discussion is primarily intended.

Not to say, however, that depictive color may not be incorporated into the same program. It is not the main program, however, since concentration on accuracy of depictive color will restrict the color imagination too greatly, and introduce distractions of a highly technical order into a program intended to free the "color eye" rather than inhibit it.

In addition to the standard color separation method, and photography in monochrome of ordinary subject matter, colorless or colored, patterns of many other sorts may be used. One, which may appeal to the daring, is the production of shadow pictures directly on the matrix film. Another is to reproduce refraction images, either on some convenient photographic material which is then copied on film or printing it directly on the matrix. For the beginner, however, control of the medium and practice of color printing is more important than these more daring gambits. They can be practiced later, or by those who already have some experience in printing from dyed matrices.

Matrices from Negatives

I have made negatives ranging in size from 35mm. to 5x7-inch. I have worked with direct color separation negatives made with a Leica, and others made with a 4x5 graflex and 5x7 Deardorff. All of them have registered in the final print. Of course, some detail and textural differences are to be found when comparing enlargements from the small negatives to those from the large. The procedure in printing matrices by enlargement is the same for every negative size. Exposure is made through the base of the matrix film. The negatives should be oriented to project so that each matrix image will appear in its correct left-to-right position when seen through the base of the film.

As each matrix is exposed, I identify it with a notching punch as follows: one notch for cyan printer (from red-filter negative); two notches for magenta printer (from green filter negative); and three notches for yellow printer (from blue filter negative). Other ways of identification may be preferred, but the way mentioned above makes certain that I have not forgotten to identify a matrix and helps me keep track of what I am doing. As I identify the negatives specifically in the same way, I have an unmistakable set.

Separation Negatives. Color separation negatives are optional. These may be derived from a one-shot color camera, from three successive red, green and blue record negatives made in an ordinary view camera or they may be made by copying or printing from color film transparencies.

Density Range. Negatives having density ranges of from .80 to 1.20 may be used for printing with a modern condenser enlarger. If a diffused light enlarger is preferred, somewhat higher density ranges are indicated. The ideal range is 1.00 with condenser light source.

Matrix Film. Matrix Film is a specially prepared type in which a completely unhardened gelatin emulsion is coated on an acetate film base. This emulsion is unhardened in order that when the film has been exposed through the base and developed either in a self-tanning developer or in a non-tanning developer followed by tanning in a separate hardening bleach, all of those portions which have not been exposed will be soluble in hot water.

The matrix, after processing, consists of a series of elevations or thicknesses of residual gelatin which elevations are controlled automatically by the light which is passed by the respective tones of the negative. This provides a gelatin relief image capable of absorbing dye in proportion to the gel thickness. By such means, the original tonal range of the subject may be reproduced.

Three such matrices are used, - one for the cyan (blue-green) which is made from the red record negative, one for the magenta made from the green record negative and one for the yellow which is made from the blue record negative.

The above dye images, when printed one upon the other in succession, will reproduce with commercially acceptable accuracy the entire range of common colors or hues. The process is capable of reproducing all common colors with a fidelity not excelled by any other known printing process.

Making the Matrices. While there are many variations of the basic gelatin relief process used in dye transfer printing, two only are in common use today:

(1) The Self-tanning Developer Method

(2) The Non-tanning Developer Method

While either method can be used, there are certain very useful attributes in the second or non-tanning developer method which causes this system to be preferred by many workers. Among these advantages are:

(1) An extraordinary richness and depth of shadow tone without filling up the middletones, while preserving with the utmost delicacy the important highlight details.

(2) The ability to "lay-down" the previously stained matrices in register on a white glass with an excellent preview of the color balance that will be found in the transferred print.

Processing Steps. Only the non-tanning developer method will be described since by using a separate developer and hardening bleach, excellent prints can be made with less uncertainty and with greater dependability than is usual with tanning developers.

The processing steps are as follows:

(1) Expose matrix film through the base with orientation of subject correct as you look upon the easel of the enlarger.

(2) Develop matrices in DK-50 undiluted for 3 minutes at 70°F, preferably using three separate trays, one film per tray, emulsion side up.

(3) Pour off developer and replace with water, doing this quickly to each mat in turn. No stop bath should be used.

(4) Wash matrices for about three minutes in running water at temperature as nearly 70° as possible. Lower temperatures prolong the removal of developer, while higher may swell the emulsion undesirably.

(5) At end of wash, pour on Hardening Bleach R 10a and treat for 3 minutes.

(6) Wash-off in hot water. This is best done by successive replacements of hot water in the trays. Occasionally lift each mat by its safe-edge to drain off the dissolved gelatin. When no turbidity remains in the drainings, the hot water treatment is finished. This requires about five minutes.

(7) Chill matrices in cold water, then fix out the silver halide residue in F-6 fixer.

(8) Wash in running water for five minutes, rinse in distilled water to prevent scum and hang up to dry. Matrices will now be clear and colorless.

(9) When dry, stain up in the respective dye baths preparatory to registration and punching for transfer.

Precautionary Notes. The matrices when placed in the hot water bath become very delicate and must not be touched at all in the picture area. For this reason, it is desirable to leave a generous safe-edge all around to facilitate safe handling.

After processing, and particularly after once drying, the gelatin relief is much harder and more durable but since it is but a few tenths of one-thousandth of an inch thick in the lighter tones, it will be apparent that all handling must be done by the safe-edge only.

Notwithstanding the delicacy of the printing matrices, they are capable of making from twenty to thirty perfect color prints before showing signs of failure, providing the operator has gained some experience.

FORMULAS FOR MATRICES

KODAK BLEACHING SOLUTION R-10a

STOCK SOLUTION A	Avoirdupois U.S. Liquid		Metric
Water	16	ounces	500 cc
Kodak Ammonium Bichromate	290	grains	10.5 grams
Kodak Sulfuric Acid	1	dram	4.0 cc
Water to make	32	ounces	1.0 liter
STOCK SOLUTION B			
Water	32	ounces	1.0 liter
Sodium Chloride	1½	ounces	45.0 grams

For use, take 1 part Solution A, 1 part Solution B, and 6 parts water. Bleach the silver image completely at 68°F (20°C). This will require about 4 minutes.

KODAK FIXING BATH F-5

Dissolve chemicals in the order given:	Avoirdupois U.S. Liquid		Metric
Water, about 125°F (50°C)	80	ounces	600 cc
Kodak Sodium Thiosulfate (Hypo)	2	pounds	240.0 grams
Kodak Sodium Sulfite, desiccated	2	ounces	15.0 grams
*Kodak Acetic Acid, 28%	6	ounces	48.0 cc
**Kodak Boric Acid, *crystals*	1	ounce	7.5 grams
Kodak Potassium Alum	2	ounces	15.0 grams
Cold water to make	1	gallon	1.0 liter

*To make approximately 28% acetic acid from glacial acetic acid, dilute 3 parts of glacial acetic acid with 8 parts of water.

**Boric acid should be used in the crystal form; the powdered variety is difficult to dissolve.

Discard the bath after eighty to one hundred 8 x 10-inch films, or their equivalent in other sizes, have been fixed per gallon (4 liters).

KODAK DEVELOPER DK-50

Dissolve chemicals in the order given:	Avoirdupois U.S. Liquid		Metric
Water, about 125°F (50°C)	64	ounces	500 cc
Elon	145	grains	2.5 grams
Kodak Sodium Sulfite, desiccated	4	ounces	30.0 grams
Kodak Hydroquinone	145	grains	2.5 grams
Kodalk	1 oz 145	grains	10.0 grams
Kodak Potassium Bromide	29	grains	0.5 gram
Cold water to make	1	gallon	1.0 liter

For Kodak Wash-Off Relief Film, use without dilution and develop 5 minutes at 68°F (20°C).

Note: To obtain lower contrast and increased highlight detail, add about 5 cc of a 50% sodium thiocyanate solution to each 8-ounce (250 cc) portion of Kodak Developer DK-50. Larger or smaller amounts of thiocyanate can be added to produce greater or lesser effects, but the use of more than 8 cc of 50% sodium thiocyanate solution in 8 ounces (250 cc) of Kodak Developer DK-50 is not recommended.

Kodak Developer DK-50, in prepared powder form, is available in several package sizes.

KODAK MORDANTING SOLUTION M-1

	Avoirdupois U.S. Liquid		Metric
(A) Water	32	ounces	1.0 liter
Kodak Aluminum Sulfate	6¾	ounces	200.0 grams
(B) Water	16	ounces	500 cc
Kodak Sodium Carbonate, desiccated	1 oz 145	grains	40.0 grams

Add B slowly to A, stirring well while mixing. A white precipitate is formed at first, but this dissolves upon further stirring. If a trace should remain, it can be filtered out with a rapid filter paper.

5% Sodium Acetate Solution

Dissolve Kodak Sodium Acetate, desiccated, 50 grams in 750 cc of water and add water to make 1 liter; or dissolve Kodak Sodium Acetate, desiccated, 1 ounce 290 grains in 24 ounces of water and add water to make 32 ounces.

Preparation of Paper

Prepare paper in advance or during the dyeing of matrices.

1. Bathe Kodak Imbibition Paper (or a smooth or fine-grained white photographic paper which has been fixed in plain hypo and washed) in Kodak Mordanting Solution M-1 for 5 minutes.

2. Wash 5 minutes in running water.

3. Bathe in 5% sodium acetate solution for 5 minutes.

4. Wash 5 minutes in running water; then use immediately, or dry for future use. If dried, the paper must be soaked 10 to 20 minutes in water at room temperature before use.

5. Just before transfer is made, place the paper, gelatin side up, on a slightly larger sheet of plate glass. Stretch the paper to its maximum size (so that it will not change size between transfers) by laying a sheet of .005-inch plastic on the paper, and then drawing a wet squeegee across the plastic in all directions, gently at first and then with considerable pressure. Finally, peel off the plastic, starting at one corner to avoid disturbing the paper, and remove any droplets of liquid from the paper with a viscose sponge or a wad of cotton.

The above steps are not needed with Dye Transfer Paper that has been mordanted in the manufacturing process.

Dye Transfer Aid

Sodium Acetate Anhy	10 grams
H_2O to make	1 gallon

The solution made by dissolving this compound in tap water is used for soaking dye transfer paper (either hand-mordanted gelatine-coated paper or the Eastman Kodak Dye Transfer Paper which has been mordanted in process of manufacture) prior to making the dye transfer print.

The solution greatly facilitates transfer of suitable dyes without bleeding or diffusing the image.

Mixing. For most types of tap water throughout the United States, the solution should be made of the strength given above.

If your water is unusually pure (low in mineral constituents) you may find it advantageous to increase the quantity of compound to double the above. The need for this greater concentration is shown if transfers are sluggish or mottled.

Soaking Time. The use of Dye Transfer Aid solution for soaking the transfer paper makes it unnecessary to time the soaking accurately. Paper may be left in the solution for several hours without loss of mordant. In fact, soaking of an hour or more is desirable in order to insure thorough stretching, thus facilitating perfect register.

Since Dye Transfer Aid solution is weakly alkaline, it is necessary to wipe off the slip-sheet before laying down the matrix to avoid bleeding of the dye upon contact with the solution. A quick pass of a damp, clean towel over the slip sheet will adequately remove droplets of Dye Transfer Aid solution.

Keeping Qualities. Dye Transfer Aid solution keeps for many days and it may be used until transfer becomes sluggish. However, it is recommended that the solution be made up a quart at a time and thrown out after the current run is made since exposure to the air and long continued use may sufficiently change the chemical balance to deplete the effectiveness.

Preparing Dyes

	CYAN	MAGENTA	YELLOW
Pigment	5 grams	5 grams	5 grams
Sodium Acetate	15 "	15 "	10 "
Formaldehyde	5 cc	5 cc	10 cc
Glacial Acetic Acid	-	-	8 cc
Distilled H_2O	1 gallon	1 gallon	1 gallon

For acidifying the dyes:

Use 5% Acetic Acid for Cyan and Yellow Dyes
Use 10% Citric Acid for Magenta Dye

Preparation of Dyes. The dyes are a dry powder in a state of the highest purity and concentration.

The containers for the dye solutions should be perfectly clean one gallon bottles or jugs. These can usually be obtained from any drug store or chemical supply house. Bottles that have contained vinegar are satisfactory if they are well cleaned. New bottles are, of course, to be preferred and some wholesale jobbers listed under "bottles" in the classified telephone directory are willing to help out the poor color photographer who usually finds it impossible to obtain such much-needed but mundane supplies from his photographic dealer.

For mixing the dyes, as well as for most other photographic chemical mixing in small quantities, the finest vessels are Pyrex chemical beakers which can be obtained from a chemical supply house selling laboratory equipment. Pyrex beakers are so easily cleaned that if thoroughly rinsed after use and then dried with a towel (to prevent contamination from water salts), the same beakers may be used for all solution preparation. This heat-resisting glassware will resist boiling water poured into it but care should be taken to use an asbestos pad beneath the glass vessel if you attempt to heat water in the beaker.

Our own preference is to set aside a new enameled cooking vessel holding something over two quarts, expressly and solely for boiling distilled water. Such a vessel is perfectly safe and will last a lifetime in a chemically sterile condition if dried with a towel after each use.

Steps in Preparation of Dyes

1. Place something over two quarts of distilled water in the enameled container on a hot plate and bring to a brisk boil.

2. Empty contents of the cyan and magenta dye packets into the bottom of separate Pyrex beakers or other clean containers that will stand boiling water.

3. Pour on each dye powder approximately a quart of boiling distilled water and stir with a glass rod. Let stand for a few minutes while you prepare the next step.

4. Place about two quarts of cold distilled water in each of the two clean one gallon bottles. Insert a Pyrex funnel and pour the hot dye solution through funnel into the cold distilled water. The resulting warm solution will not break the bottle if you pour deliberately and slowly.

5. Fill each bottle to within a few ounces of the neck with cold distilled water and empty the appropriate Activator solution in each color. Rinse Activator bottle and fill stock bottle to the ring with cold distilled water.

6. Prepare the yellow dye by exactly the same procedure as for the cyan and magenta but use cold distillled water throughout. There is no need to heat any part of the water for the yellow dye. Add the Activator at the last when the bottle is nearly full.

What You Must Not Do

1. Never use any substitute for pure distilled water in mixing dyes of any make or kind. In most cities, pure distilled water can be obtained from suppliers of spring water or from makers of artificial ice.

2. Never attempt to add the dye powder to the water. To do so will result in dry lumps that seldom if ever dissolve. Pour the boiling water on the dye as directed above.

3. Do not add the Activator to the dye until you have added nearly enough water to make up the gallon. By adding cold water, you will cool down the solution to a safe temperature before adding Activator.

4. Never use a container for mixing or storage that has contained a strong alkali, a bleaching compound such as Clorox, or that shows a trace of water scale or scum. The secret of long life in printing dyes is unending cleanliness.

5. Do not return partially used dye to the stock bottle. Use a separate container such as a Mason jar for each lot of dye that is in use but not exhausted.

Controlling the Vigor of the Dyes. One of the unique and invaluable features of dye transfer processes is the facility with which the strength or vigor of the color may be altered at will. Until one has worked with the process, he is inclined to discount this claim.

While there are a number of methods of altering and controlling the dye potency and all are quite convenient, it has been our experience that the best control of duplicate print quality is obtained if the method depending upon alteration of dye pH is employed. A contemporery method is to use a constant pH or acid concentration and to depend upon a partial "washing back" or controlled rinsing out of a part of the dye after staining and before transfer. This wash back method can be used with these dyes if desired by those skilled in that procedure. Only the variable pH method will be discussed, since it is quite reliable.

The intensity of the dye image with these dyes is almost directly proportional to the amount of acid which has been added to a unit quantity of dye solution. A small quantity of acid produces a weak, soft image lacking in brilliance and "punch." As the acid is increased, the vigor of the image shows progressively greater and greater vigor and color saturation. This is one of the most important features of this kind of control.

If too much acid has been added in the attempt to balance the hues of a given subject, then the vigor of the dye can be reduced by adding a counter buffer (Sodium Acetate in a 10 percent solution). While it is not recommended that this facility be used as an excuse for "playing a tune" with the dye as one facetious worker has expressed it, nevertheless, the extraordinary control that is thus offered enables one to achieve a very satisfactory and lasting balance with a minimum of time and effort.

Suitable Types of Acidifier. Acetic Acid (pure Reagent Grade) is the most suitable acid for the cyan and yellow dyes, while the magenta responds best to pure citric acid. The acetic is made up as a 5 percent solution while the citric, being a weaker acid, is made up in a 10 percent solution. These acidifiers are, of course, made up with distilled water.

If acetic acid is added to the magenta solution, early precipitation is likely to ensue. Only citric acid should be used in the magenta dye.

The dyes should be acidified only as required for printing. No acid should be added to the stock bottle since different subjects may require varying amounts of acidifier to produce the most pleasing prints. Furthermore, the storage properties of the dyes are improved without acid.

If a long run of prints is forecast, it is desirable to set out the total quantity of dye at the rate of one pint for each ten prints 8 x 10 or their equivalent in square inches. Then one pint may be taken for test and balance, and when its acidification has been determined, the balance of the dye may be similarly acidified. This method is conducive to uniformity of prints.

The effective range of acid additions is from about 2 ccs. per pint to about 20 ccs. per pint. The low concentrations will prove very useful with subjects of high contrast. Sometimes it is possible to obtain a very pleasing print from strong and vigorous mats by holding the acid to a low concentration. Conversely, if the matrices are soft in gradation and the print appears "smoky," by increasing the acid concentration to 10, 15 or even 20 ccs. per pint a very beautiful and rich print can be obtained.

Color Balance. With a set of well balanced matrices processed in accordance with these instructions for matrix making, a visually neutral scale of grays will result if the acid concentration is Cyan-5, Magenta-7 1/2 and Yellow-5 ccs. of acid per pint. With higher or lower concentrations of acid, this same ratio will as a rule maintain neutral balance.

Where some error in color balance of the original transparency must be partially corrected by alteration of the dye balance, it is entirely feasible and indeed very useful to effect such correction by varying the quantity of acid in the dyes from the normal 5-7 1/2-5 ratio to that which accomplishes its purpose.

The color balance, gradation, vigor and general print quality can be forecast to a considerable extent by staining, rinsing, and laying down the matrices in register upon the white surface of the transfer desk. The finished print will be much richer and more saturated in color than this "laydown" indicates but the relative color balance will be quite comparable to that seen in the laydown. This practice is especially useful in saving the making of many experimental prints on a difficult or out-of-balance subject.

Staining the Matrices. Printing matrices must be stained always face up to avoid scratching of the gelatin relief which is much more sensitive to abrasion than is regular photographic film.

The mats are stained merely by bathing them in suitable quantities of dye solution. Typical would be 12 to 16 ounces of dye for 8 x 10, 32 ounces for 11 x 14, 64 ounces for 16 x 20, etc. The main requirement is that there shall be sufficient dye to cover well the gelatin relief image which must not be permitted to dry in spots.

Staining is considerably accelerated by gentle, automatic agitation such as is afforded by a Curtis Automatic Tray Rocker. Restaining is well done in two to three minutes with this device.

Equally uniform and satisfactory staining can be done in still trays which are given a tip and tilt every few seconds by hand providing the dye solution is sufficiently deep to insure that the mats are well covered at all times except when actually being rocked. Such still staining takes from 5 to 10 minutes depending upon how much hand rocking is done.

Rinsing the Stained Mats. In this process, the rinse bath is a solution of acetic acid in one-half of one percent strength. This is made by adding 5 ccs. of glacial acetic acid (pure) to each quart of water. If your tap water is clean and not heavily chlorinated or copper sulfated, it may be used for the acid rinse only. However, if you run into dye or transfer difficulties despite diligent efforts to follow these directions, one of the first places to look for trouble is in the tap water. You can test this by substituting distilled in your rinses for a few days.

The rinse bath in this process is used mainly to remove excess dye which has not been absorbed by the gelatin relief image. To conserve both acid and time, it is satisfactory to provide two trays of acid rinse. The matrix, upon lifting from the dye and draining for a few seconds to remove most of the free dye solution, is placed in the first acid tray and rocked for about 15 seconds. The time is not critical but it should be comparably close to insure uniformity. This first rinse will remove nearly all of the free dye and therefore it soon becomes tinted but this is not harmful if the dirty rinse is discarded at the first indication of color degradation.

Lifting the mat from the first and dirty rinse, immerse it in the second tray of acid rinse which will keep clean for many successive prints. When the first tray becomes darkly stained, discard the acid and substitute the solution from the second tray, replacing it with fresh. By this rotation, a great many prints can be made with a few pints of acid rinse.

Coming from the second rinse of 1/2 percent acetic acid after about 15 seconds of rocking, the matrix will be charged with dye but because of the acidity of the water, this dye will be locked in the gelatin until it contacts the slightly alkaline Transfer Aid solution in the paper. Therefore, there should be little or no tint to the drainings from a corner of the matrix.

Steps in Making the Dye Transfer

1. Prepare Kodak Dye Transfer Paper by soaking for at least 20 minutes and up to several hours in Dye Transfer Aid solution using 5 grams of the powder to each quart of water. If tap water is unclean, use distilled.

2. Lay paper face up on a smooth register surface (glass, formica or other). Place right-hand end near the register pins. Swab off with wet cotton soaked in clean water.

3. Roll out the paper with a roller squeegee (Kodak Professional Print Roller) in both directions which stretches paper and locks it to glass Desk.

4. Holding matrix by its narrow safe-edge with left hand, place the round hole on the upper pin, then swing the mat to allow the slot to be placed on the other pin. During all of this operation, the left hand should hold the mat high to avoid contact.

5. Place the roller upon matrix safe-edge close to both pins and pull the film up tightly against roller with left hand. Then, while holding the mat well up against the roller, slowly pass the roller across the matrix, rolling it down in one, slow, smooth pass. Very heavy pressure is not required nor is it desirable.

6. In dry weather or if the mat tends to curl before transfer is completed, cover the mat with the Vinyl Cover Sheet supplied. This will prevent all tendency to curl.

7. Very rapid transfer can be obtained if the temperature of the transfer surface is maintained at between 80 and 90° F. This can be accomplished by suspending the transfer surface on wooden struts over a large tray filled with warm water or other source of uniform heat.

Clearing the Matrices. After each transfer, there is a slight tendency for each matrix to pick up a tint of dye from the paper. This gradually contaminates the dyes and tends to "block" the gelatin reliefs. To obviate this difficulty, especially in long runs, each matrix should be rinsed in Kodak Matrix Clearing Bath for ten to thirty seconds and then washed in running water for a minute or so before being returned to its dye tray. The clearing treatment will greatly improve uniformity of successive transfers and prolong life of matrices. When ready to store mats after use, they should be cleared, washed, rinsed in distilled water, squeegeed face down on clean glass to remove excess water, then hung to dry.

Order of Transfer. The order of transfer is immaterial but is usually magenta, cyan and yellow last. The advantage of bringing the two most important colors close together is to minimize the danger of further paper stretch between transfers which may occur if the paper is not thoroughly soaked or is not well rolled out. Register of the yellow image is not nearly so critical. In addition, visual registration is easier with the cyan following the magenta and yellow last.

Additional Controls. While the major controls in the Dye Process are by regulation of the acid strength in the dye or by neutralizing the acid through counter buffer additions, there remains still another final and at times very important control which combines the variable pH of this process with the variable rinse of other processes.

While we never recommend the rinsing of a matrix in tap water since this produces a violent and extremely variable method of reduction, it is quite satisfactory to employ a very weak acid rinse after the regular clearing rinse to effect a reduction of the color in any one mat to compensate for bad balance in an original subject.

The effect of this weak acid rinse, which may be of 1/10 to as low as 1/50 of one percent of acid, is to gradually and uniformly reduce the charge of dye with a slight increase in contrast at the same time. The dye is removed from the thin highlight portions more readily than from the shadows.

One valuable use for this technique is to correct a bad yellow overcast which ruins so many Ektachromes that have been processed in over-age solutions. While it is always debatable whether it is worthwhile to attempt printing such poorly balanced transparencies, most commercial laboratories do the best they can to minimize the errors and to emphasize desirable features of the subject.

Extra controls such as the above should not be resorted to in routine printing since they consume much extra time and at best are useful as salvage measures. They are not necessary with well exposed, correctly balanced mats from good transparency or color camera subjects.

Multiple Transfers. A still more remarkable control which is very useful in reconstructing color balance from a subject photographically good but somewhat deficient in color is the multiple transfer. The corrective transfer is usually made in less than two minutes additional time.

Let us say that the subject suffers from badly balanced color layers in a transparency, resulting in a false rendering of highlights while shadows are good, or the reverse. To fortify the shadows of a given hue, a second mat is made from that same negative, but with half or less than that of normal exposure. By staining this supplementary matrix in the same dye and by making a second transfer of only the shadow values, the deficiency can be corrected with great exactitude by the skilled operator.

Naturally, if the error lies in the highlight portion of the scale, the reverse procedure is used. The second mat of a color is given somewhat higher than normal exposure to supply the deficient record in the highlight, processed normally and is then stained in dye having very low acidification. The result of this is that the deficiency in the highlights and middletones is corrected without recognizably affecting the shadow hues.

Such manipulative measures may assume very great importance in salvaging color photographs that cannot be replaced and in such cases well justify the extra trouble and cost. In advanced color reconstruction practice in aerial color photography, the method, if intelligently used, can reconstruct with remarkable fidelity hues that could not be identified by the human eye from a visual observation of the scene.

After-Treatment of Dye Prints. Bathing or swabbing the Prints with a 10 percent solution of glycerine helps to remove brittleness and curl and has never been found harmful. After the treatment the prints can be blotted and dried between blotters under pressure to make them perfectly flat.

Prints can be mounted with the hot press and dry mounting tissue and if the temperature is kept at or near the minimum required for good mounting, no ill effects are to be expected.

Formulas for Special Dye Transfer Solutions

1 Percent Acetic Acid Solution

Add 1 part Kodak Glacial Acetic Acid to 100 parts water or 1 part 28 percent acid to 28 parts water. Use 1 1/4 fl oz (40 ml) of glacial acid per gallon (4 liters) of water, or 4 1/4 fl oz (140 ml) of 28 percent acid per gallon (4 liters) of water.

Kodak Matrix Highlight Reducer R-18

Add 18 grains (1.2 grams) of sodium hexametaphosphate or Calgon to 32 fl oz (1 liter) of water at about 90 F.

Kodak Matrix Clearing Bath CB-5

To prepare stock solution, add 4 oz (120 grams) of Kodak Anti-Calcium and 1 1/4 fl oz (48 ml) of ammonium hydroxide to 32 fl oz (1 liter) of water at 90 F. To prepare working solution, dilute 1 part stock solution in 11 parts water.

5 Percent Sodium Acetate Solution

Dissolve 5 grams of Eastman Sodium Acetate (anhydrous) (Cat. No. T227)* in a small amount of warm water and add water to make 100 ml; or dissolve 1 oz Sodium Acetate in a small amount of warm water and add water to make 20 fl oz.

Formula for Black Dye

cyan	333 cc.
magenta	125 cc.
yellow	42 cc.

Use without dilution.

acidifier: 10 cc. to 20 cc.
10% Citric Acid to 500 cc. dye.