In-Camera Separation Negatives on KODAK T-MAX Professional Films in Roll Sizes

by Charles Luce

Beginning Dye Transfer

Would you like your students to take a single course that focuses their understanding of the Zone System, improves their manual darkroom skills, teaches applied color theory, makes them better color negative printers, and heightens their knowledge of chemistry and math? There is such a course—it's called dye transfer.

When your students make full-color dye transfer prints from monochrome separation negatives, they put to use a complete collection of photographic skills and knowledge. Filter selection and color segregation, precise control of exposure and contrast, and careful handling of accurately registered materials are but some of the requirements.

The realization that so much of photography is systematically used in dye transfer is leading many schools to incorporate a course in this process into the curriculum. Fortunately, the advent of KODAK T-MAX Professional Films gives educators the opportunity to approach dye transfer from a more accessible starting point than ever before. The reason? Two T-MAX Professional Films have color response and characteristic curve properties that allow them to be used to make direct, roll-film color separations. In-camera separations provide the basis for a logical, simple, yet uncompromising entry into the technology of dye transfer.

Neither institutions nor students should attempt a dye transfer course without some preparation. Students need to have a solid background in darkroom work and at least one semester of color, including theory and practice. They should also have had at least a college-level algebra course and a semester of photo science.

Institutions need to have sufficient equipment and a space that can be dedicated to the process. Each student will need at least 4 hours of darkroom time per week—about 75 percent of this can be accomplished in a large "gang" facility. You can anticipate first student prints in about 3 weeks and high-quality finished work in about 5 weeks. A great deal of expensive equipment is not necessary, but students must use a densitometer to analyze negatives and a prepared enlarger to project separations.

This article provides photographers with methods for producing in-camera separation negatives, directly from the scene, that can be used to make quality dye transfer prints. Testing film, filters, and development helps to establish the representational limits of dye transfer prints from in-camera separations. Understanding these limits makes it possible to control materials to achieve an imagined result.

Limits and Requirements of Separation Negatives

To make a dye transfer print that closely resembles the scene, the photographer must have separation negatives with certain characteristics: adequate exposure, a specific contrast, and precise "separation." The photographer must:

1. Make exposures through narrow-band red, green, and blue filters.
2. Make exposures to render dark, detailed, neutral shadows as density 0.20 (above film base plus fog) in each negative.
3. Control contrast to allow bright, neutral highlights to reach a density of 1.4 to 1.6 (above film base plus fog) in each negative.

DAVID — THOUGHT OF YOU WHEN I SAW THIS. HOPE ALL IS GOING WELL!

[illegible]

Filters

Several filters will work. One combination includes KODAK WRATTEN Gelatin Filters Nos. 29 (red), 61 (green), and 47B (blue).

Each separation filter transmits a specific primary color. A meter reading through each filter from an 18-percent gray card will not indicate exposure accurately, however, because meter light cells do not respond to color as film does. A meter can only provide a starting point for determining a filter factor; you must test the film and meter for color response and reconcile their differences.

Contrast

Negative contrast must be exact. You cannot adjust matrices and dyes to compensate for negative variability without a color shift occurring in the print. However, you can determine the required contrast and invent a method for consistently producing it. Either adjust the scene lighting or alter the development relative to the scene. The relationship between scene and negative contrast is called Contrast Index (CI).

Exposure

Development time, filter factor, and film ISO all affect correct exposure. These entities can be collectively expressed as a single concept—Exposure Index (EI)—that the photographer uses instead of ISO. The technique to in-camera separation negatives is determining "color-related EIs" for each separation negative exposure. These, and contrast relationships, are revealed in a film test.

Testing Materials to Determine EI and CI

You can devise a simple materials test that allows you to find contrast indexes and color-related exposure indexes for one type of film processed to two different development times. Once you know this information, you have a building block for an entire system that helps make consistently good separations with a minimum of effort or error.

Start by using the necessary separation-negative exposure and contrast as a goal and build a chain of inferences from these requirements. Test results rarely match these inferred needs, but the information can help you to determine EI and CI.

Here are the basics: A separation negative should have minimum density of 0.20 and maximum density of 1.5 if both shadows and highlights are neutral-colored in the scene. Since most scenes aren't so conveniently colored, it's best to say that a separation negative should have a contrast index that yields a density range of 1.3 if both shadow and highlight are neutral. Adjust the exposure so that any scene neutral is equal in density on each separation negative.

Contrast index relates scene contrast to negative contrast thus: *CI = negative density range/log scene exposure range.* To determine the log exposure range for any scene, find the scene brightness range in *f*-stops and multiply by 0.30. Find the scene brightness range by taking a meter reading directly from a dark, detailed shadow and comparing this to a reading from a bright, textured highlight. For example, if a negative of density range 1.3 is produced from a scene of 7 stops brightness range, that negative has a CI of 0.62 (1.3/7 x 0.3).

Including an 18-percent gray card in the scene is a useful tool for exposure. This may not be practical for live scenes, but it is essential for the test scene. An exposure that produces good shadow densities usually records a gray-card density between 0.70 and 0.90. If you include a gray card in the test scene and bracket a set of exposures, you should be able to find an exposure that produces a density of 0.70 to 0.90 and assign that result an exposure index.

To make the test, set up a scene, measure its contrast, carefully meter it through the separation filters, then make a bracketed series of exposures onto two separate rolls of 35 mm KODAK T-MAX 100 or P3200 Professional Film. Develop each roll separately to widely different times and use a densitometer to determine the EIs and film density range, or contrast. Using simple division, convert the film contrast to CI; then plot CI and EI values onto graphs. The graphed results can help you calculate CI/EI requirements for any scene.

How to Perform a Materials Test

Set up or find a test scene with a contrast range of 6 to 8 *f*-stops. The scene should have areas of detailed shadows and diffuse highlights. The difference between the two areas is scene contrast, often called brightness range. You will need to record scene brightness range in *f*-stops, accurate to within ½ stop.

Next, place a gray card prominently in the scene. Set the light meter to the film ISO, then read the reflected light readings from the gray card with no filter, and through each of the separation filters. Record these readings, then set up a table of bracketed exposures. Be generous. Use a 36-exposure roll and bracket around each of your four readings (no filter, red, green, and blue filters). Making four tests with the 36-exposure roll, you can bracket over a 9-stop range. Write down the brackets before you begin to make exposures, using the meter readings as a starting point. Extrapolate all 9 stops, and as you write each exposure, assign an EI value. What you write should look something like this:

Film:
KODAK T-MAX 100 Professional

Contrast:
Shadow (no filter) ISO 100, *f*/2.8 at 1/30 sec
Highlight (no filter) ISO 100, *f*/22 at 1/30 sec
Brightness range = 6 stops

Exposure:
Gray Card

Make actual exposures on the plan below to take into account that increasing development increases EI.

First roll (T-MAX 100 Professional Film):

1. No filter—EI 12, 25, 50, 100, 200, 400
2. Red filter—EI 6, 12, 25, 50, 100, 200
3. Green filter—EI 12, 25, 50, 100, 200, 400
4. Blue filter—EI 12, 25, 50, 100, 200, 400

Develop this roll for 4 minutes (see below).

On the second roll, use the following exposure schedule (T-MAX 100 Professional Film):

1. No filter—EI 25, 50, 100, 200, 400, 800
2. Red filter—EI 12, 25, 50, 100, 200, 400
3. Green filter—EI 25, 50, 100, 200, 400, 800
4. Blue filter—EI 25, 50, 100, 200, 400, 800

Develop this roll for 8 minutes.

Use either KODAK T-MAX Developer diluted 1:4 at 75°F (24°C) or KODAK HC-110 Developer diluted 30 mL concentrate in 1000 mL water at 72°F (22°C). (For either developer, develop T-MAX 100 Professional Film 4 minutes for the first roll and 8 minutes for the second. For T-MAX P3200 Professional Film, development time is 6 minutes for the first roll, 12 minutes for the second. A repeatable, consistent developing technique is necessary; inversion-type tanks are not recommended. Place the reels in a rack and lift-and-plunge vigorously for agitation, or use a water-jacketed drum processor.)

EI	No Filter		Red Filter		Green Filter		Blue Filter	
	f-stop	seconds	*f*-stop	seconds	*f*-stop	seconds	*f*-stop	seconds
6	*f*/2	1/15	f/2	1	*f*/1.4	1	*f*/1.4	4
12	*f*/2.8	1/15	*f*/2.8	1	*f*/2	1	*f*/2	4
25	*f*/4	1/15	*f*/4	1	*f*/2.8	1	*f*/2.8	4
50	*f*/5.6	1/15	*f*/5.6	1	*f*/4	1	*f*/4	4
100	*f*/8	1/15	*f*/8	1	*f*/5.6	1	*f*/5.6	4
200	*f*/11	1/15	*f*/11	1	*f*/8	1	*f*/8	4
400	*f*/16	1/15	*f*/16	1	*f*/11	1	*f*/11	4
800	*f*/22	1/15	*f*/22	1	*f*/16	1	*f*/16	4
1600	*f*/32	1/15	*f*/32	1	*f*/22	1	*f*/22	4
3200	*f*/45	1/15	*f*/45	1	*f*/32	1	*f*/32	4

Interpreting the Materials Test

It is useful at this point to restate your goal, which is to make separation negatives to a density range of 1.3 with a shadow density of 0.20. A gray card density of 0.80 ± 0.10 on the negative indicates correct exposure. Your tools for analysis include a densitometer, a pocket calculator, and two pieces of graph paper.

Begin with the roll of film developed for 4 minutes and examine the strip of exposures by white light. Find base density plus fog, then the frame with a gray-card density closest to 0.80 above film base plus fog. On that frame measure shadow and highlight densities from the same areas you metered when you set up the test. Determine density range by subtracting shadow from highlight density, and determine CI by dividing density range by scene brightness range (in *f*-stops) x 0.30. Write down the CI.

Now select the frames exposed through the red filter. Again find the frame with gray-card density closest to 0.80 above base plus fog. Refer to your notes and see what EI produced this frame. Write this down.

Use the same procedure to determine EI for green and blue. Then using the roll developed for 8 minutes, repeat your steps. You should find that the 4-minute development produces a CI less than 0.50, while the 8-minute development has the CI up to about 0.80. Red EI will be far below 100 at 4 minutes, while green and blue are higher, and all EIs will be considerably higher at 8-minute development.

Plot test results against the development times (see Figures 1 and 2) to allow the extrapolation of more information.

Relationship Between Development Time and Contrast Index

Film	KODAK T-MAX P3200 Professional	KODAK T-MAX 100 Professional
Developer	KODAK HC-110 Developer, 30 mL concentrate to 1000 mL H_2O, 72°F (22°C)	
Light	Diffused daylight	

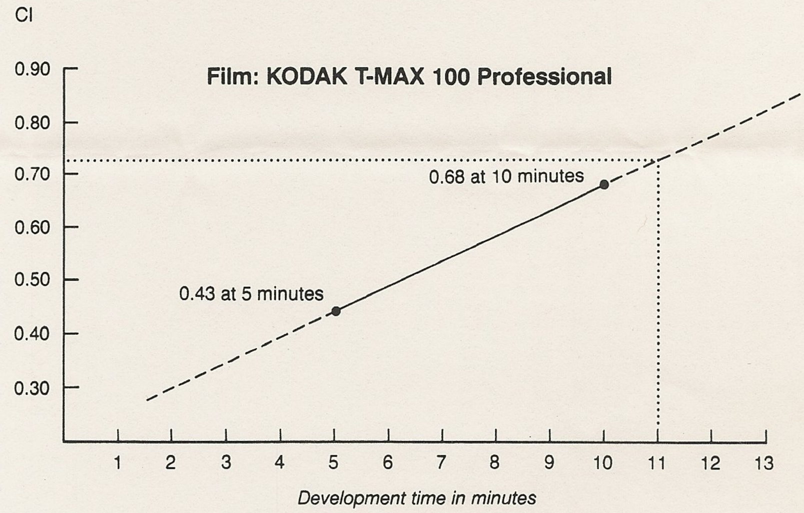

Figure 1A

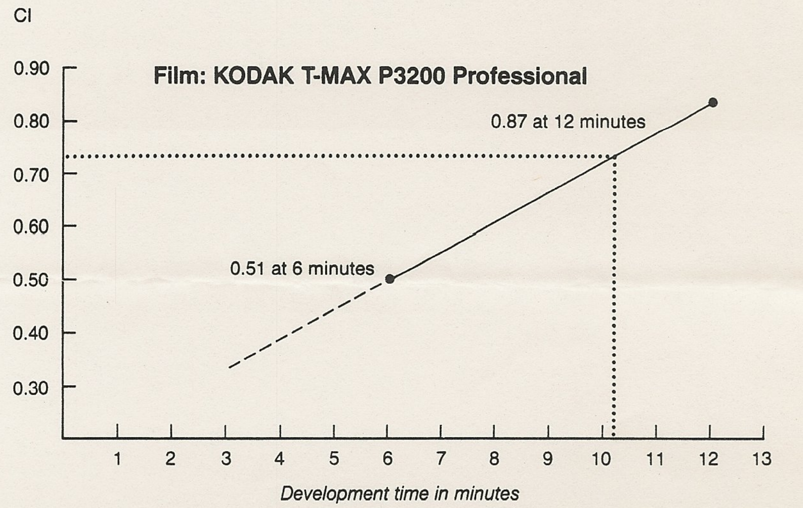

Figure 1B

As development time increases, contrast index increases. Since the relationship established by two test developments is relatively constant, you can use the graphs (Figure 1) to find the development time needed to produce any CI. This is indicated by the dotted line (which solves the problem of what development time is necessary to produce a negative of CI = 0.72). You can use any scene/negative combination to calculate a CI based on the formula:

$$CI = \frac{\Delta D}{\log \Delta E}$$

Where

ΔD = negative density range
ΔE = exposure range of scene
$\log \Delta E$ = 0.30 x exposure range of scene in *f*-stops

Figure 1B graph shows CI versus development time for T-MAX P3200 Professional Film. The graph shows how the values of contrast index and development time relate. The dots are entered at the CIs produced by specific development times and a line is drawn between them. A dashed line extends the relationship to lower development times. A dotted line demonstrates how to use the graph to find the necessary development time for any required CI. If the scene is 6 stops of brightness and the negative must be density range 1.3, then the required CI is 0.72. The required development time will be 10¼ minutes.

The graphs in Figure 2 can be similarly used to find the correct color-related EI for any development time. Use the graphs from Figures 1 and 2 together: First, find the scene brightness range, and then find the CI needed to produce a good separation. From the CI, find development time. Then, from development time, find color-related EIs.

As development time increases, film sensitivity increases. The lower EIs obtained for red reveal a light meter error in sensitivity to red.

Relationship Between Development Time and Exposure Index

Film	KODAK T-MAX P3200 Professional	KODAK T-MAX 100 Professional
Developer	KODAK HC-110 Developer, 30 mL concentrate to 1000 mL H_2O, 72°F (22°C)	
Filters	No. 29 (red), No. 61 (green), No. 47B (blue)	
Light	Diffused daylight	

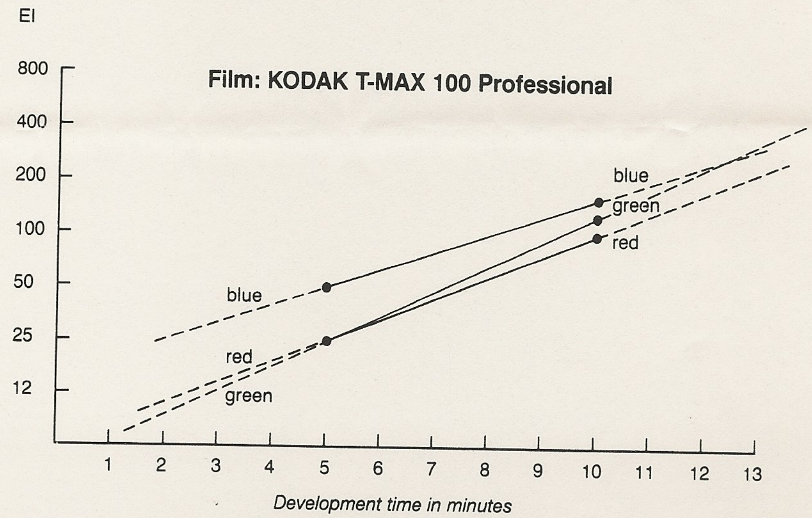

Figure 2A

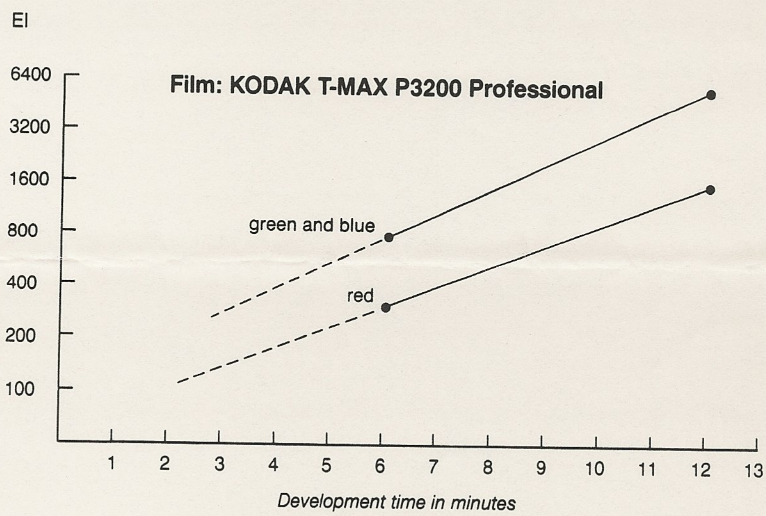

Figure 2B

Development Calculations (Required Density)

Scene Brightness Range (*f*-stop)	CI (neg. range ÷ log exposure range)	Field Chart for KODAK T-MAX P3200 Professional Film				Field Chart for KODAK T-MAX 100 Professional Film			
		Development Time (min) from Figure 1	Approximate EI for Development Time			Development Time (min) from Figure 1	Approximate EI for Development Time		
			Red	Green	Blue		Red	Green	Blue
5	0.87	12	1600	5000	5000	13 ¾	250	320	400
6	0.72	10 ¼	800	3200	3200	11	125	160	200
7	0.62	8 ¼	500	1600	1600	8 ¾	64	1600	125
8	0.54	6 ¾	320	1000	1000	7 ¼	50	80	80
9	0.48	5 ¾	250	640	640	5 ¾	32	50	64
10	0.43	5	200	500	500	5	25	25	50

Figure 3

Instead of carrying both graphs into the field, digest your findings into a chart (highlighted portion of Figure 3). Any scene with greater brightness range than 10 stops or with a lesser brightness range than 5 stops will require special developing techniques, so the chart (Figure 3) is limited by 5 and 10 stops.

Keep your field chart in your camera bag next to a 4 x 5-inch gray card. When working with a scene, put your camera on a tripod, look carefully to ascertain dark detailed shadows and bright detailed highlights, then unmount the camera and use its meter to measure those areas. Calculate CI, then put the gray card into the scene, set the camera meter for the correct color-related EI, place separation filters one at a time over the lens and meter from the gray card. Jot down the exposure, return the camera to tripod, and fire away. (For good image registration later, each exposure must be made at the same *f*-stop.) Record the required developing time, then move on. You may opt to introduce blank frames at the end of each scene and divide rolls in the darkroom so that you can record different scenes on the same roll.

A repeatable, consistent developing technique is necessary for good results. Avoid the temptation to use my findings—development procedure is greatly individualized and so are the results. The CI that you obtained from 4 minutes will most likely not be what anyone else produces. Also the separation negative density range of 1.3 is somewhat arbitrary. Dye printers usually do a separate test to determine the absolute negative density range limits inherent in enlarger light sources and personal work habits.

How can you tell the separations apart? Dye printers have a standard code: No corners cut = red, one corner cut = green, two corners cut = blue. Because of the perforated edge on 35 mm film, there's lots of space to cut the corners.

A Final Word

Using the approach above will work only if camera flare is constant between the test and the actual scene. Since there's no easy way for an amateur photographer to assess camera flare, the most suitable approach is to choose actual scenes in which light intensity and direction are approximately the same as used for test exposures.

Charles Luce is a Professor in the Visual Arts Department at County College of Morris, New Jersey. He is also an Instructor at Parsons/The New School, New York, New York.