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These images show the contrast using two different electronic flashes with the same film and processing. Kodak Ektachrome 100 Professional.



In-date and out-of-date Kodachrome (KPR) that has been properly refrigerated/frozen over its life.



Same subject, same processing using different batches of the same emulsion. Kodak Ektachrome 64T EPY

Color Interpretation: A Function of Process & Film—Part II

Michael R. Peres

Editor's note: In the November issue of PLM, RIT Associate Professor Michael Peres discussed transparency film color as a function of several variables. Following is Part II of that analysis.

ACHIEVING FAITHFUL color reproduction is a challenge, due to the many variables that can impact the final results. Aside from the emulsion characteristics discussed in Part I of this series, the following factors can also affect fidelity:

- Different batches/lot (emulsion number) of the same film type
- Contrast and/or direction of the light source
- Effect of the photofinishing on color and density
- Exposure and resultant saturation
- Professional and general picture-taking films
- Age and storage conditions of the emulsion
- Latent image keeping
- Spectral "Blindness"

With all of these factors affecting the quality of the color reproduction process, it is easy to predict some difficulty in getting consistent color results over time. Each of these factors can, by itself, influence the deviation of the color result in varying degrees.

Often after the first generation original is created, post-production color balancing may take place. Adding 5cc green or removing the orange cast from a slide made of the incorrect color temperature is a simple activity with slide duplicating films. In fact, with electronic photography and digital imaging using programs such as Adobe Photo Shop, critical color is as easy as a "mouse" click away.

For the discriminating user of silver halide films though, post production activities should be the last resort and not a planned-on activity. There are several factors that can affect the fidelity of the final result.

Color emulsions are manufactured in

very large quantities. Each time a new batch is created, it may show slightly different characteristics. To avoid variations, it is best to use the same emulsion where comparisons are to be made. Determine the batch and lot number by looking at the side of a box of professional film.

Photofinishing and its influences can greatly affect density and contrast. If a process is to be monitored over the course of time, all exposed films should be processed in the same run to avoid variances in chemical activity and its effects on color constancy.

The contrast and/or direction of the light source will effect the relative brightness between the highlight and the shadow produced at the subject. Contrasty (specular) light has a greater range of brightnesses, while softer (diffuse) light sources will have less range between the highlight and shadow. Transparency films in general work optimally with an 80:1 brightness ratio between the usable highlight and shadow. This assumes a material with an approximate gamma of 1.8 -2.0.

The contrast of the light will also affect the value or brightness of color. Contrasty light will produce a different-appearing color rendition than soft light because the white areas will be brighter and the shadows will be darker. Mid-tones in each lighting situation are likewise to be affected, yielding a different-appearing contrast in each case.

In a prior illustration, the concept of contrast and its affect on color was demonstrated, but equally important to color quality is density as a product of exposure. Transparency films require very tight exposure control. The different densities produced as a result of different exposures also effect the color saturation. Overexposed film consequently results in washed out or muted colors as contrasted to slightly underexposed film, which results in greater saturated color.

For this reason alone and the inability

to predict with exact certainty the color saturation possible in any given circumstance, it is wise to bracket exposures in 1/3-stop increments over and under the predicted exposure.

One other comment about exposure and its potential role in color saturation. All contemporary films come in magazines that are DX coded. Because many of the current cameras read the DX coding, setting the ISO on the camera is almost a thing of the past. If you work with a DX-coded camera, make certain to read the packaged data sheet that comes with the professional films and override the DX coding when necessary.

Color transparency films are integral tri-pack films. Each of the sensitized emulsions, red, green and blue, have a slightly different response as a function of the sensitization. As the emulsion ages, certain predictable changes occur and each emulsion will lose sensitivity. The film will undergo a color shift. An expiration date is an indication of usability limits. Testing of the film can confirm at what point the material no longer delivers an acceptable image and should be discarded.

Transparency films may be acquired either as professional or amateur picture-taking films. Professional films are packaged close to aim for speed and color balance and are intended to be refrigerated to maintain that aim. Professionals also process their films soon after exposure. General picture taking films are released with slightly different aims to take into account the aging common in room temperature keeping over time before and after exposure, and before processing.

Once the latent image has been captured, what happens next can influence the final result. The latent image is vulnerable to changes over time. These changes can be manifested as less effective exposure, an increased density of a color slide, or changes in color saturation.

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ADHESIVE TYPE	SILICONE
ELONGATION, %	100%
ADHESION TO PANEL, OZS./IN.	40 OZS./IN.
180° HOLD, 1000 GRAMS (PSTC-7)	14 DAYS+
TEMPERATURE PERFORMANCE RANGE	-75 TO 500 F
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Color Interpretation

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tion. The image change or loss of latent image is contingent on storage conditions, the age of the film, and exposure to fumes from some chemicals.

The latent image is very stable for the most part. While general picture takers may obtain adequate results with processing years after the original exposure, professionals require more than merely adequate results. Some medical photographers never leave exposed films in-camera for more than one week—regardless of the number of exposures made.

For optimum results, the film should be processed as soon as possible after exposure. Refrigeration will minimize latent image changes.

Some subjects, beautiful as they are visually, just don't reproduce well on transparency film. Color slide film has three emulsion layers which ideally would have 100% sensitivity across the three primary spectra, 400-500nm, 500-6000nm, and 600-700nm. In reality this does not happen, as there are peak sensitivities and trough sensitivities. Consequently, some subject's colors may lie in regions that are not ideal for recording. These colors are then not recorded accurately. This results in slides which could include low saturation or false colors. Many examples of this occur, and so other emulsions should be considered if this is the case.

Predictable Film Relationships

- Generally the higher the sensitivity, the more pronounced the grain pattern: the lower the ISO, the less pronounced the grain pattern. Tabular grain products may be an exception to this.
- The higher the sensitivity, the lower the resolution; while the lower the sensitivity, the higher the resolution.
- The higher the sensitivity, the lower the color saturation; the lower the sensitivity, the higher the color saturation.
- Higher contrast films may yield pictures that appear sharper, but in reality, they may contain less resolution.
- Color slide films have more contrast than color negative films; however, there is no relationship between contrast and film speed in these films. Lower speed films may not necessarily be higher in contrast than higher speed films.
- Color negative films can have more latitude than color slide films, but there is no relationship between latitude and

sensitivity.

- Films with extended sensitivity may yield less accurate color reproduction.

Color Interpretation

The images in this article were produced under the tightest possible photographic controls. All emulsions were kept frozen prior to use and were re-frozen after exposure prior to processing. All films were processed simultaneously to ensure that each emulsion by itself demonstrates color interpretation and is not representing a color shift from the processing. In each series, the light source, camera, lens, and procedures were consistent in an attempt to allow the film itself to be the only difference that is presented as a final result.

On a Personal Note

In producing this project, it was my hope to provide other working professionals a better basis from which to select emulsions for their needs. By no means is any of this work meant to misrepresent any emulsion.

This project started out as a small curiosity on my part several years ago and blossomed quickly into over 100 rolls of exposed film and processing. I am greatly indebted and appreciative to the Scientific Imaging area of the Eastman Kodak Company, and to Dr. Richard Zakia, Professor Emeritus R•I•T, for his technical help with my research.

References

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