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Some thoughts on filters they make color photography possible

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This is an "addendum" to a workshop on color filters that is a part of the Materials and Processes of Photography course taught in the School of Photo Arts and Sciences at RIT

All (just about) full-color photographic processes start their "life" as black and white systems. It is the appropriate use of filters in conjunction with these systems that makes color photography possible. This is the case for film as well as digital systems. Our eyes however, are a different story. :)

Given that filters play such an important part in color reproduction it is appropriate that the subject of filters in general be discussed and treated in a course on basic photo/imaging principles such as M&P.

In this workshop you will perform some "reverse engineering" exercises to demonstrate filter principles and their effect on tonal reproduction of colored subjects. The purpose is to gain a fuller understanding of filter principles and to be able to apply personal analytical skills to determine "cause" from "effect".

In a way, you will be doing forensic, investigative, work and will be determining from visual clues what the photographer must have done in order for a given photograph to appear like it does.

There are three general types of filters:

1. Color correction
2. Contrast filters
3. Special purpose

Color correction filters were treated in the color temperature workshop and special purpose filters (such as polarizing filters) will be treated in other workshops.

In this workshop we will be dealing with Contrast Filters. A fundamental principle to keep in mind is that light is electromagnetic energy that we can sense or see. One characteristic of this "energy" is that is a wave and the measure of this wave, or wavelength, is related to its perceived color. The wavelength is expressed in nanometers or nm for short.

Light consists of electromagnetic waves whose wavelengths extend from 400 to 700 nm. The shorter wavelengths, near 400nm, appear blue to us. The ones near 700 appear red and the in-between ones, green.

The sensation of "white" in our mind is produced when the light arriving into our eyes is made up of a mixture of all colors (or wavelengths) of energy.

Speaking in very general terms, and as hinted to above, we have decided to divide the visible spectrum into three major areas or color ranges. These are Red, Green and Blue.

Judicious mixing of these three colors can produce in our eyes the sensation of all colors. In general, if equal amounts of each are superimposed white is perceived.

If we alter the amount of any of these in the mix of red, green and blue light the color perceived will change. It will depart from white or neutral. There are various ways to alter the relative amounts of each component.

NOTE: we are talking here about mixing "light" and NOT paints. There a whole different discussion needs take place!

We can take out selected wavelengths from a white original by making white light pass through filters that selectively absorb the desired wavelengths. What we will see at the other end, then, is the color of the "white light" minus that which the filter took out.

Or, we can deduce the color of a filter and we assign a name to it based on the color(s) that the filter transmits or allows to pass. This is by "convention".

A red filter is called red because it lets red wavelengths pass. By inference, then, red blocks the remaining colors.

NOTE of INTEREST: There is one situation where the naming convention fails in general photographic practice. This is in the naming of a UV or ultraviolet filter over a camera lens to prevent UV rays from causing photograph to appear too blue when photographing in situations with an overabundance of UV radiation present such as ski slopes, etc. In this case the UV filter blocks, and does not transmit, UV energy.

All filters block or absorb some part of the light that is incident on them. Filters that have a detectable color just absorb some wavelengths more than others and, conversely, allow to pass or transmit some wavelengths more than others.

In general, contrast filters are used with black and white panchromatic materials. They are used because under certain conditions subjects of dissimilar color would reproduce as very similar shades of gray. This is so because black and white film does not allow us to distinguish the color that produced a particular tonal value. It only displays the density that results from a given exposure.

NOTE: Contrast filters, in this case possibly called "tricolor" filters, are also used over each "pixel" in a digital sensor in order to enable the sensor to make a composite, full color, reproduction of a scene by the "additive color" method much like it was the case with the Autochrome method and the Polachrome method.

To continue, then, it might be useful to recap the function of the six major contrast filters when it comes to controlling the effect ultimately perceived in a photographic print when subjects of various colors are photographed through filters.

NOTE: in the following statements the terms "lighten" and "darken" refers to the appearance of a subject area in the final print - not the negative

Red. This filter transmits about 1/3 of the visible spectrum, the red area extending from 600 to 700 nm approximately and blocks the other two thirds (the green and blue). When used with panchromatic film (meaning film with sensitivity to red, green and blue) a red filter will lighten red parts of a scene and darkens green and blue areas.

Green. This filter transmits also about 1/3 of the visible spectrum. From about 500 to 600 nm. It blocks the other 2/3. In this case the red and the blue portions of the spectrum. It is particularly effective for lightening the tone of green foliage while it can be used for darkening a blue sky.

Blue. Again, this filter also transmits about 1/3 of the visible spectrum. From about 400 to 500 nm. It blocks the other 2/3 which in this case is comprised of the green and red. It lightens blue subjects and darkens yellow, green and red ones. Photographing through this filter using modern black and white films will give the resulting image a "look" of early, only blue sensitive, photographic emulsions.

Cyan. Unlike the R,G and B filters this filter controls, affects or modulates only ONE color. Meaning that it removes red light from the incident beam but allows blue and green to pass freely. Therefore, it blocks wavelengths from 600 to 700 nm but lets all others through. When used it causes red areas of a subject to appear very dark while having little effect on anything else. This filter therefore is the "complement" of the red one. It does the opposite.

Magenta. This filter is the complement of the Green filter and controls the amount of the green that passes. It "modulates" the green (500 to 600 nm) band while having little effect on red and blue areas of a scene. A deep magenta filter will cause green areas of a scene to reproduce as dark on panchromatic film.

Yellow. It has its major effect on the blue, 400-500nm, region of the spectrum and allows greens and reds to pass freely. It is often used to slightly darken blue or cyanish skies to better separate the clouds from the skies in a final black and white print. This is so because panchromatic film has typically a high blue sensitivity and will record blue in a tone very similar to white unless the photographer takes steps to separate the two at the image capture stage.

NOTE of INTEREST: If an original color scene is first captured on color film or on a color digital camera then "post-processing" can be done on the film or digital data to achieve the tonal separation effects that, had a black and white record only been made, would have to be made at the taking stage.

Let's take a look at some practical applications:

1. Given that a photograph will be made on black and white panchromatic film assume that your task is to photograph a white sheet of paper with a grid pattern of faint blue lines on it. What filter would you use to emphasize the blue lines? And which filter should be used to essentially eliminate them?

Answer: A filter that absorbs blue would be the one to use to darken the blue lines. Either a deep yellow or a deep red. For maximum effect a red one. To make the blue lines "disappear" in the final print one would use a filter that transmit blue freely and this would be, of course a blue filter.

2. Given a historical document that came in contact with a green cover page and some of the green dye transferred to the white page. You want to make a copy of the document so that the green smudge is as unobtrusive in the copy as possible. Which filter would you use?

Answer: Choose a green filter whose color looks most like the color of the green dye that leached onto the white document. This will result in a copy where the green will be virtually invisible and the text of the document plainly readable.

3. A photograph of red flowers against green leaves is made and in the black and white record the flowers have a tone that is very similar to that of the leaves. How would you increase the tonal separation between them?

Answer: Since generally one prefers flowers to have a lighter tone than the background foliage in this case we want to darken the green but leave the red pretty much untouched. A magenta filter will reduce the amount of green going through to the film an this will make the green look darker.

If you had use a cyan filter this would have darkened the red flower and lightened the green leaves in comparison.

You can also "reverse engineer" this process. That is, if you know what the colors of a subject are you could determine what filter was used over a camera's lens when the picture was made on panchromatic film. Or if you know what the filter was that was placed on a camera when a photograph was made what the likely color(s) of parts of a scene were remembering that a filter passes light of its own color and blocks the rest. Therefore areas of a scene that appear very light in tone when a red filter, for example, was used over a lens can be most likely assigned the color red in the original scene. CSI would do it this way for sure!

Finally, once I was asked this: Could you share some thoughts and basic instructions on filters? I am primarily interested in their relationship to my black and white photography.

Very basic indeed:

1. Any filter that you photograph through will lighten those areas of the subject that are the same or similar in color to the filter you are using.

eg: a red filter will lighten subject areas colored red

2. Any filter that you photograph through will darken those areas of the subject that are complementary in color to the filter you are using.

eg: a red filter will darken any subject areas colored cyan or blue/green such as the sky.

3. Anytime you place a filter over the camera lens and photograph through it this will call for an increase in "apparent" exposure (meaning the film still expects a certain level of exposure but when removing some of the incoming light you must adjust for this so the film gets what it needs to produce a good negative).

This adjustment is summarized by the "filter factor" associated with any given filter. This tells the photographer essentially how much the effective speed of the film is diminished. For example, a filter requiring a filter factor of 5 means that if the original aperture was f/16 and the original time was 1 second, then if one would keep the aperture at f/16 the exposure time should go to 5 seconds.

One could arrive at this also by metering at the set speed of the film, for example, 100 and dividing this speed by 5 to end up with an "effective" speed of 20. If the metered settings suggest f/16 at 5 seconds then, making a measurement at a speed of 20 will indicate an exposure time of 5 seconds at f/16.

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PS: For sure there is a little more to filters than discussed above. The Basic Materials and Processes of Photography book is a very good source of additional information! Especially the section devoted to filters. I highly recommend it.