Primary Colors
Part 3 of 3
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The YCM Color Model in Photographic Processes

Last month, I discussed the YCM color model as it applies to printing processes. In this article, I will discuss the application of the YCM color model to photographic processes.

Negative Photographic Film

When photographic film is exposed and developed, the resulting image is a *negative* of the original subject**:**

- In the case of black and white film, the grayscale is *inverted* such that lighter shades become darker and vice versa. White becomes black and black becomes white.

- In the case of color film, the grayscale is inverted *and* each color is replaced by its *complement.* Thus, RGB primaries are converted to the corresponding YCM primaries.

Some of us may remember the days of print photography. We took pictures with those bulky box cameras, had the films processed at the drugstore, and got a bunch of transparent *negatives* back. These images were indeed negative, a result of the chemical processes use to develop them.

Then we had prints made from the negatives. The prints, being negatives of negatives, were positive images. We sent the prints to the relatives, and stored the negatives in a shoebox.

Before color film came out, it was all black-and-white**:**

Black and white negative image

Black and white print

With the advent of color film, we could get color negatives and color prints**:**

Color negative image

Color print

Note how the colors appearing in the color print look in the negative image**:**

- The white clapboard siding is black.
- The dark shadow under the porch roof is almost white.
- The light gray roof is a darker shade of gray.
- The dark green grass is a light magenta.
- The bright blue sky is a dull yellow.

From this, we can generalize**:**

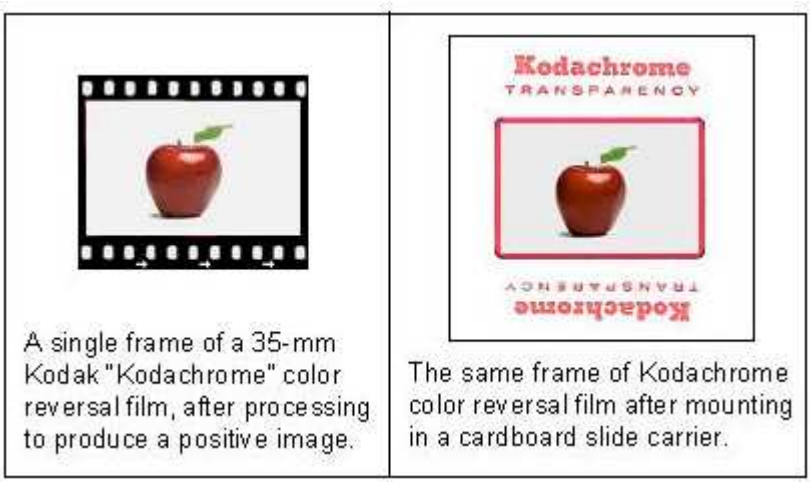
- A black-and-white negative simply inverts the grayscale. A black-and-white print (a negative of a negative) restores the original grayscale.
- A color negative inverts the grayscale *and* changes the colors from RGB to YCM. A color print (again, a negative of a negative) restores the original grayscale *and* restores each color back to its original color.

Now, in the interest of full disclosure, I must note that the above images were not scanned from individual original hard copies. They are digitally-manipulated versions of the same original image, a scanned 35-mm color slide.

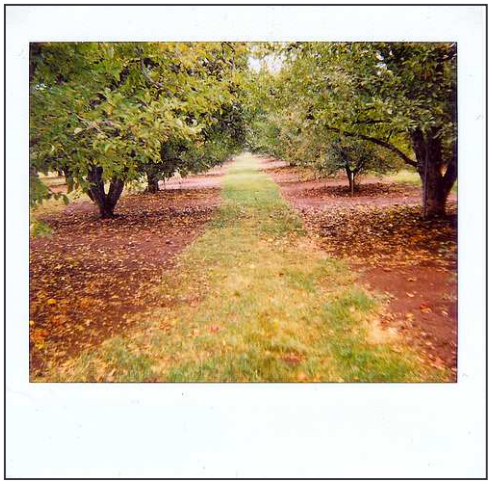
Reversal Photographic Film

"Reversal" film produces a positive image on the original film base, omitting a physical intermediate negative. But the process doesn't skip the "negative" stage altogether**:** the negative YCM image is chemically processed ("reversed") to become a positive RGB image on the original film base.

A common (if obsolete) example is the 35-mm slide format, widely popular among amateur photographers before the advent of digital photography. In this process, the latent image is first processed to develop a negative (YCM) image**;** the film is then exposed to light and further processed to reverse the negative image, resulting in a positive (RGB) image on the original film base.



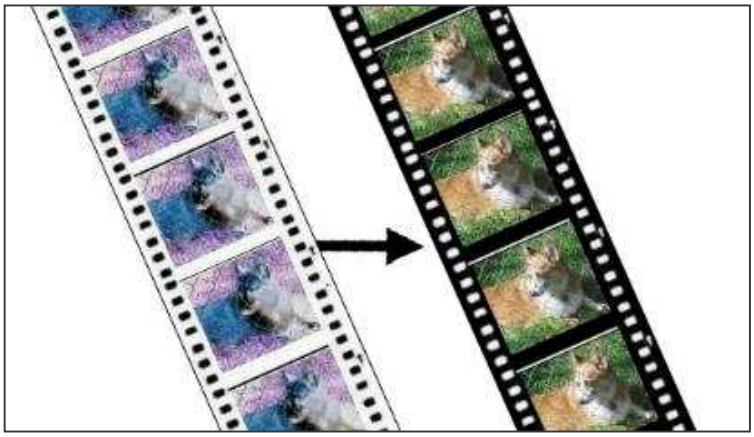
Another example is the "Land" camera manufactured by Polaroid Corporation. Polaroid cameras utilized an all-chemical process in which the entire development and YCM-to-RGB conversion process is accomplished inside the camera.



A detailed explanation of the Polaroid process may be found on Wikipedia at <http://en.wikipedia.org/wiki/Polaroid_Corporation>.

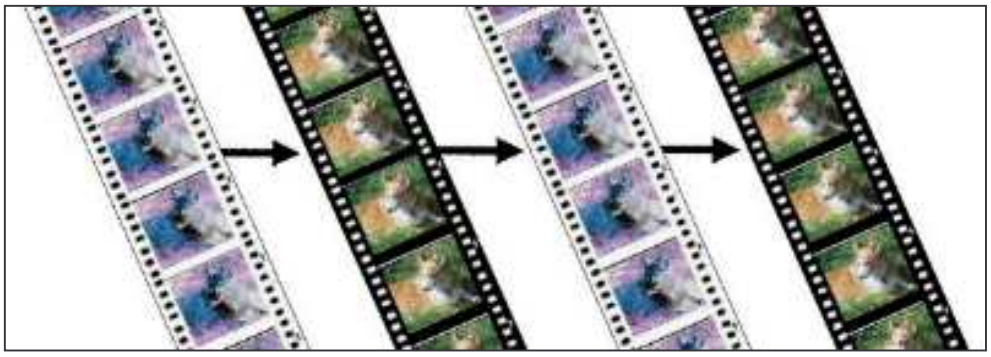
Motion-Picture Film

Color motion picture film is similar to the negative film described above. The processes are similar**:** the original exposed film is developed to produce a YCM negative. This negative is then printed onto another strip of negative film, producing a positive (negative of negative) "release print."



In theory, this process can be repeated as many times as necessary. Unfortunately, the process degrades the original negative. Simply running a negative through a projector subjects it to wear and tear, and may result in other damage. Even the most expensive equipment owned by Hollywood production companies cannot be trusted with repeated runs of the original negative of a million-dollar theatrical film.

An interim solution to this problem is a four-step process**:** a single intermediate positive print of the original negative is used to print two or more intermediate negatives. In turn, each intermediate negative is use to print two or more release prints.



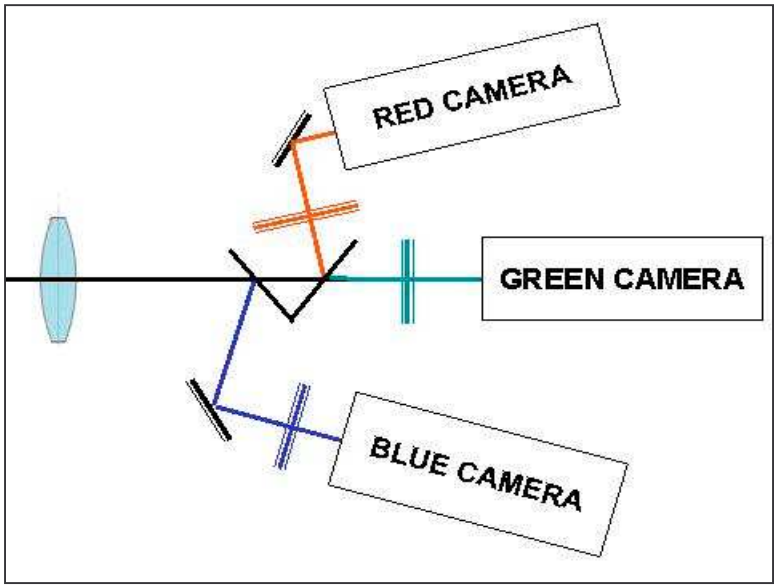
By judiciously repeating this process, it's possible to produce enough prints to release a theatrical film in a number of theaters simultaneously.

I've heard that some film production companies even employ a six-step process**:** negative-positive-negative-positive-negative-positive. I suppose this might be necessary for nationwide release of a popular movie, although I've never been able to confirm it.

A further problem facing film production companies is safe long-term storage of original negatives. Even if a movie doesn't do well at the box office, the original master negative is a valuable asset. The master negative of a popular movie can be worth more today than the entire original production cost.

But color film degrades over time, even under ideal climate-controlled storage conditions. As the warning on every box of Kodak color film reminds us, "photographic dyes, like all dyes, may, in time, change."

Over the years, various techniques have been devised to deal with this problem. Most of these techniques utilize some sort of special three-film camera in which three strips of *black-and-white* film, one for each of the three RGB primary colors, are exposed simultaneously. A hypothetical three-film camera would look something like this**:**



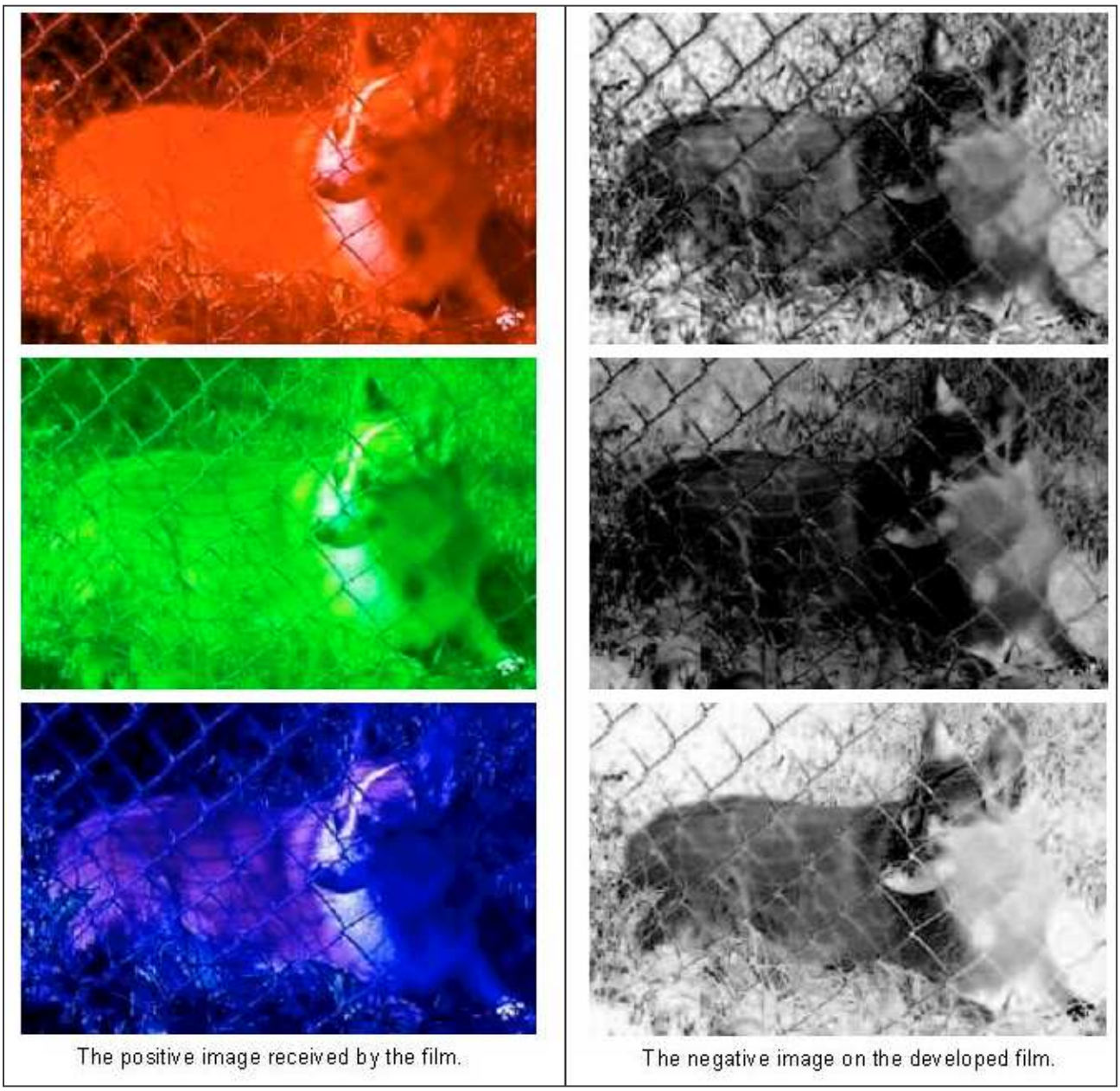
In this hypothetical three-film camera, the image is focused by the lens at the left, then strikes a series of *dichroic* mirrors—mirrors which selectively reflect one color and pass others. These mirrors selectively direct red and blue light into their respective cameras, allowing the green light to pass straight through to the green camera. All three cameras are mechanically interlocked so that their images are synchronized.

After development, the three strips of film are *black-and-white negatives* of the original image, each exposed by a different color. Thus, for example, the negative exposed in the red camera responds to the red light that exposed it. Being a negative, it represents, *as a black-and-white image*, the negative of red—i.e., *cyan*.

Because the images are captured in black-and-white, no color dyes are involved. Thus, these films retain color stability in long-term storage. These films are called YCMs for obvious reasons.

Motion picture production companies store YCMs in secure climate-controlled vaults. The YCMs of a popular movie are among the most valuable assets owned by a motion picture studio.

The following images illustrate the process:



The positive image received by the film.

The negative image on the developed film.

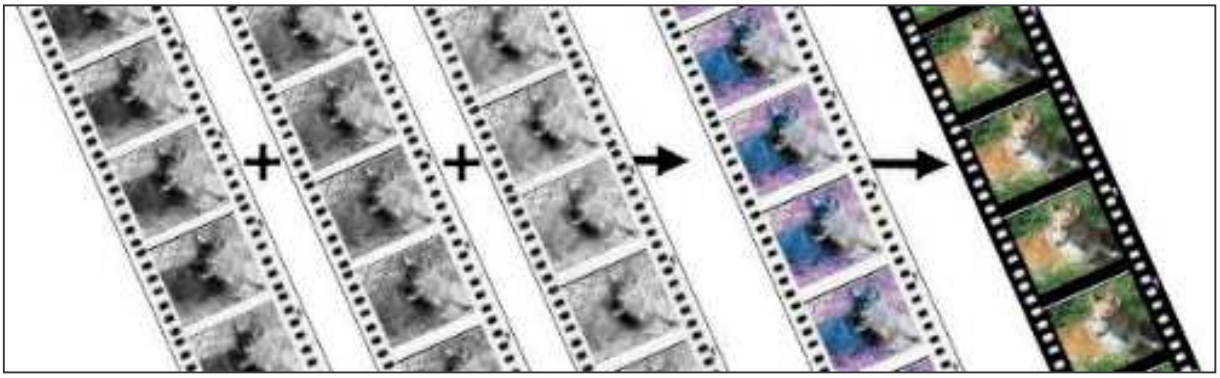
The color images in the left column represent the images focussed onto the black-and-white negative film. After the development, the negative images appear as shown in the right column. Note that the green image (the "brightest" primary color) produces the darkest negative, while the blue image produces the lightest negative.

Color release negatives are "struck" from the black-and-white YCMs by exposing color negative film stock to the three YCMs in a process that is essentially the reverse of the three-film camera. Each YCM is illuminated by its complement (red, green or blue), thus producing a negative composite image on color film stock**:**

Color positives are then made from the negatives**:**

Lucy (Pembroke Welsh Corgi, 2005)

Thus**:**



As the color release negatives age, a film production company can retrieve the original YCMs and make new release negatives. By using newer color film stocks, new release prints can be produced that exceed the technical quality of the original release prints.

Using technologies available today, original YCMs can be transferred directly to video, and stored as digital image files, without any further photographic processing. Color "release files" for television playout or DVD production can be produced by electronic processing of the YCM image files.

Several years ago, Turner Broadcasting purchased the old MGM studio in Hollywood. Ted Turner was widely criticized for "overpaying" for the company. But Turner wasn't buying MGM, the production company. He was buying the MGM film library—the YCMs stored in MGM's vaults. MGM movies have been feeding Turner's cable channels (TNT, TCM, and TBS Superstation) ever since.

This ends the three-part series of articles about primary colors.

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