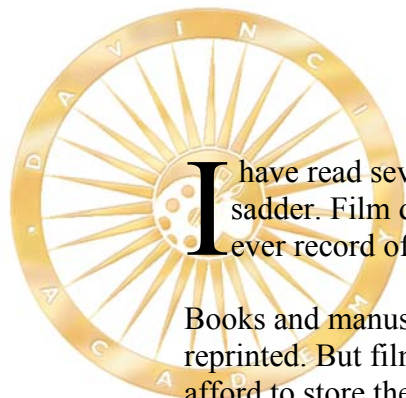


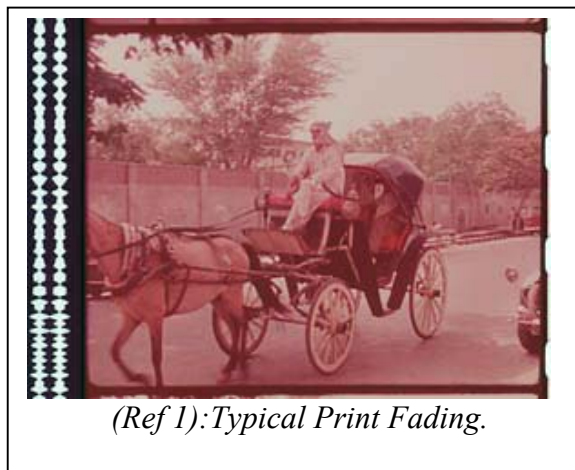
## Color Restoration for Film



I have read several sensationalist articles about the death of film, but the truth is far sadder. Film does not die, it fades away. As it fades, the human race loses the best-ever record of our achievements, history, and culture.

Books and manuscripts that can last for centuries are mass-produced and frequently reprinted. But film archive facilities can barely afford to store their treasures, never mind remaster them. The longer we leave film, the harder it is to restore.

Film consists of dye layers that combine to create color images. As film ages, the dyes fade at different rates, resulting in an image with a strong colorcast. Faded negative is characterized by its blue shadows and yellow highlights, while faded print has a distinctive red cast. To make matters worse there are often no available references to establish what the true colors once were.



*(Ref 1): Typical Print Fading.*

In typical cases of print fading, such as in this example, most of the blue and a lot of the green information has been lost. (Ref. 1)

Color restoration therefore must:

- **B**alance out unequal fading of the dye layers
- **E**nhance weaker blues and greens
- **A**pply a uniform correction to restore the original color fidelity
- **T**rim any scene-to-scene differences

Restoration of a film with commercial value would usually begin with a dirt, scratch, and damage correction process using a solution such as da Vinci's semi-automatic revival restoration system. While this may correct many problems encountered with aged film, it will not improve the colorimetry.

The first step in restoring color is to assess the film on a telecine or scanner. A scanner can offer the higher resolutions that archivists often seek, but they are very slow and perhaps unnecessary, since a great deal of the original resolution is usually lost during the aging process anyway.

The process is the same for both telecine and scanner, but given the typical shortage of funding, archive facilities can take advantage of a telecine and salvage ten times as much of their film material, all with HD resolution.

By walking through a color restoration process with our sample frame, it's easy to



*Telecine Base Memory (TAF)*



*(Ref.2) Telecine Adjusted*

demonstrate how quickly true color can be restored to film.

Colorcasts are not a uniform color, but are instead dependant on the original density and color of the image, which lead to a “crossover” that is not easily fixed with traditional means. The first step is to balance the print using the RGB controls of the telecine. The goal at this stage is not to create an image that looks “normal,” but to balance the blacks and whites as far as possible and, more importantly, to capture all remaining dye information.

This initial stage is tricky because the red channel is significantly more sensitive than the green or blue. You’ll see that the result is biased towards cyan, particularly in the whites, to allow for the greater information loss in these areas. The image is also quite flat in contrast to avoid clipping in the shadows or highlights. (Ref 2)

Once the film has been optimized in the telecine, the da Vinci 2K continues the process. Because the red bias has been offset in the telecine setup, the da Vinci behaves much more predictably.

The objective now is to balance the picture using the usual clues. In our sample frame, the black of the cab and the white of the garments are a good starting point for neutrals. The skin and the



*(Ref 3) da Vinci Primary grading with Custom Curves*

road are useful references to check against.

The four-channel lift and gain controls improve the contrast and neutrality in the blacks and whites of the image, but there is still the color crossover to deal with. It is now more visible and shows up as a warm cast in the road.

Custom Curves provide a perfect solution. Standard primary tools have fixed overlaps with each other, but the point and rate of change is user defined in Custom Curves. Setting upper and lower mask points on the curves ensures that the shadows and highlights are correctly isolated. Color channels can now be manipulated around those points.

In this example, green layer sensitivity is increased for the mid tones and blue layer sensitivity is increased for the highlights. The blue adjustment is bordering on creative rather than restorative, but is justified because the fading has left little true blue information, and without that, the image risks looking dull and gray. (Ref 3)

The sample image is now probably as faithful to the print image as is possible, given the fading. However, it still lacks the color depth that it likely had when it was first seen fifty years ago. Secondary enhancements can restore some of that former glory.



*(ref 4) Secondary Enhancements.*

Remember that the objective here is to generate a uniform grade that will work for most, if not all, of the scenes.

Start by isolating and reducing the red saturation. The red cast of the source material has been balanced out, but has left the reds disproportionately vibrant. Custom Curves is sometimes sufficient to adjust this, but a secondary adjustment based on hue and saturation is often easier.

The next task in our sample restoration is enhancing the green foliage. This should be followed by isolation of the sky and the addition of some blue using Colorist Toolbox. Isolation is performed as a defocused luminance matte and the correction is a blue offset. A soft-edged Power Window can be used to mask the road and other highlights. That would not work on every project, but after reviewing a selection of scenes, it seemed beneficial in our sample image. (ref 4)

The base transformation is now complete, and could be recorded back to film as a permanent restoration, or to tape for distribution. Some corrections go beyond pure archival restoration, though, and if the material is destined for re-release, there is more work to be done.



*Original Film Frame*



*(ref 5) Final Grade*

If the material had already been through a restoration process, grain and dirt would probably not be an issue. Otherwise a real-time noise reducer could be used. Unfortunately, these devices apply temporal filtering that can generate unacceptable artifacts.

Another approach is to use the 2K Defocus and Colorist Toolbox options. The final image shown here is mixed over itself with Gaussian blur in Defocus and then sharpened in Toolbox. The result has a “glossy” look that is applied to each frame and therefore has no unpleasant artifacts. (ref 5)

Remember that the goal is to create a single grade that improves the entire film. The advantages of spending time on this one light setting are that it should reflect the original colorimetry more accurately and reduce the cost of a restorative transfer by eliminating scene-to-scene grading.

Naturally, for more important projects, with bigger budgets, event-based grading is still possible. But as the following stills show, a single light grade such as the one explained here can be used on other scenes from the same roll of film without any further tweaks. (ref 6)

It's a simple and cost-effective way to renew color and reclaim some of our lost film archives.



*(ref 6) Same One Light Grade Applied to Other Scenes*

Happy Coloring!

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