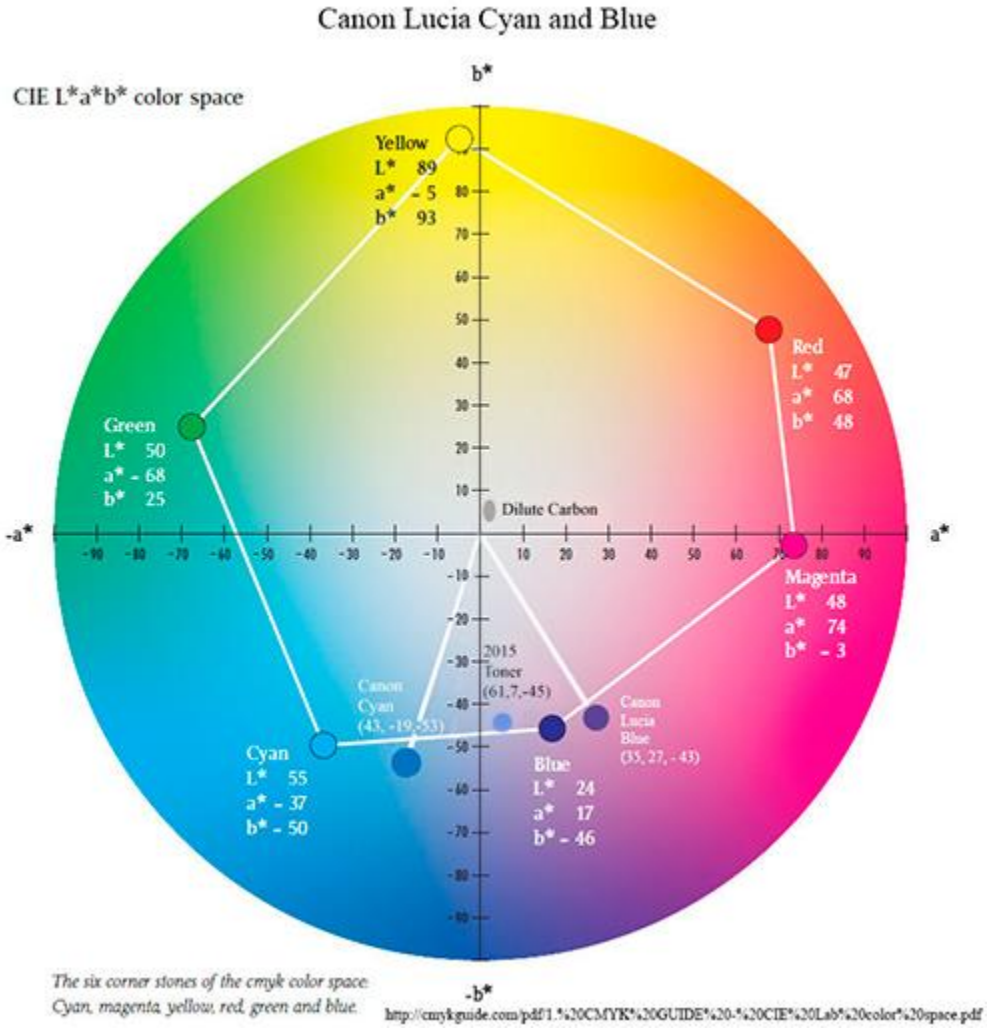
Color Toner Approach for Carbon based Variable Tone
Black and White inksets

www.PaulRoark.com 2016

Toner & Color Pigments

The color pigments used in the toner mix in my current variable tone ink mixes are the best available for this purpose according to my analysis of the Aardenburg-Imaging fade tests, in addition to their actual colors and the goal of keeping the hue angle difference to a minimum. See the Lab Color Wheel below.[1] I have placed the Canon Lucia Blue and Cyan, and mixed light blue toner colors on a color wheel that already included the usual colors. The colors of the blue, cyan, and toner inks were taken from draw-downs on non-OBA inkjet paper. In short, they are the actual colors placed on the color wheel according to their Lab A and B measures. I also added a spot for the typical range of dilute Eboni carbon.



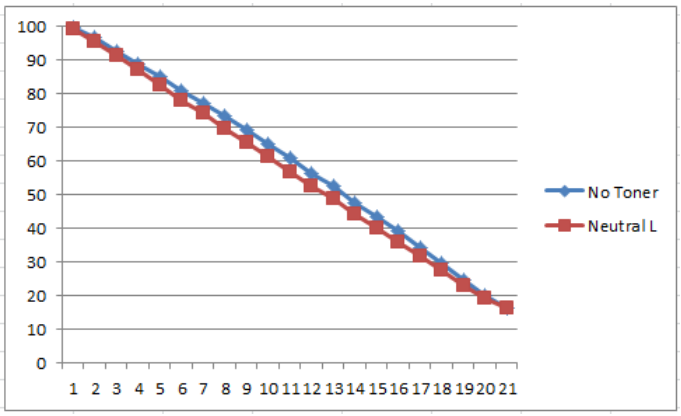
[1] The original color wheel image is from http://cmykguide.com/pdf/1.%20CMYK%20GUIDE%20-%20CIE%20Lab%20color%20space.pdf.

The important thing to notice is the extent to which the pigments I recommend are, in effect, different shades of blue, straddling what lab "blue" is defined as on the chart. The relatively narrow, 50 degree (approximately) hue angle or distance on the color wheel between the Canon "Cyan" and Canon "Blue" relative to the usual cyan and magenta hue angle is a major distinction from how carbon is cooled in most inksets. The use of color pigments with this smaller hue angle differential makes for very efficient use of color and minimal risk of differential fade of the color pigments affecting the print tone over the very long potential life of the print.[2]

The dilute carbon range typically encountered with this inkset is also depicted on the color wheel, above. One of the variables that is only able to be controlled via the mixing is the Lab A. This varies only minimally with papers. Arches watercolor paper is the paper that often has the lowest Lab A. The toner blend is set such that when Arches is printed with a "neutral" profile, the print Lab A and B are flat, horizontal lines between the paper and the deep shadows. The 100% K is cooler, but is seen basically as only darker. With many inkjet papers, when the Lab B is flat the Lab A will rise about 1 unit above the line between the paper's value and the deep shadows, giving the print just a slight "selenium" look, which, not coincidentally, is what I and many darkroom workers preferred in the silver print era. I have found no paper that prints with an excessive Lab A (magenta) hue. Note again that with this toner approach, it is easy to move the blend to one that results in the tone you prefer for the paper you use simply by adding a small amount of Canon blue (higher Lab A/magenta) or cyan (lower Lab A, more green looking) to move the toner hue slightly in one direction or the other.

With this carbon and the above color pigment mix, very little color is needed to tone a print to neutral. It is again the narrow hue angle that aids the efficiency of the toning. The color pigments are not fighting/offsetting each other the way they do in a typical cyan and magenta setup; they are more directly focused on offsetting the yellow hue of the natural carbon.

The Lab L graph, below, compares a neutral test strip with a 100% carbon version, where the carbon inks were printed with the identical QTR profile.[3]



As can be seen in the above graphs, the additional density added by the toner is never as much as the 5% difference between the steps of the 21-step test strip. If the color pigments totally disappeared, aside from a side-by-side comparison, viewers would not notice a density difference.

[2] For more control, but at the cost of considerably increased profiling difficulty, the two color pigment dilutions could have been put into different ink positions. This would allow Lab A control.

[3] The paper was Premier Art Smooth Fine Art 325. The linearized neutral test strip was printed, and then the toner in that profile was turned off and the test strip printed with the same linearized profile, but without the toner.

Overall, even the best color pigments used here have a fade rate of about 2 to 3 times that of carbon.[4] However, since the color inks' total contribution to the density of the print is so low, a neutral print, mathematically, will only have a Lab L/density mid-tone fade rate[5] of approximately 10% more than the 100% carbon print. That compares to over 100% or greater Lab L/density fade rate disadvantage of the OEM B&W approaches.[6] The difference is mostly due to using the maximum amount of carbon relative to color.

I have fade tested this approach for the equivalent of 50 Wilhelm years of display, and the theory and actual results are consistent. See, for example, http://www.paulroark.com/BW-Info/8-week-neutral-v2-v-silver-sel-50-hr.jpg, http://www.paulroark.com/BW-Info/16-Week-Arches-Neutral-sprayed-Fade-test.pdf, http://www.paulroark.com/BW-Info/Fade-Test-8-week.pdf, and http://www.paulroark.com/BW-Info/Fade-Test-Claria-Roark-v-AaIA-7-2015.pdf. I will continue to do fade testing of different papers that are of interest, but the pattern of my testing as well as that of http://www.aardenburg-imaging.com/ with respect to the components and OEM inks is consistent, and a major reason I have chosen this approach – maximum carbon and the best color pigments with the lowest hue angle between them works.

The most noticeable problems with third party toners and blended carbon-plus-color inks in the past have related to ink separation and green shifting images as the magenta used for toning faded much faster than the cyan.[7]

With respect to the separation, I have tested the toner mix above with my centrifuge, and its performance in that test was as close to perfect as any ink – including OEM LK inks – that I have ever tested.

With respect to the potential green shift, the very small amount of color needed, the high quality of the pigments, and the narrow hue angle between the 2 color pigments suggests this will never be a significant issue. In the first look at the fade tests there is just barely measurable color shift, which is typical of both of the color pigments used to make the toner. So, some shift is expected. However, it was negligible. Note that serious green shift has not a problem with OEM pigments and the OEM B&W approaches. Epson ABW appears to suffer most from its yellow fade. They use all the colors in their B&W printing. In the carbon variable tone approach of my recent mixes, much less color is used than in any OEM black and white approach.[8] [9] Ultimately, the print will warm as the colors fade. This is consistent with most

---

[4] I rely heavily on http://aardenburg-imaging.com/ test reports. They are the best that are publicly available. Although test patches of the pure color inks have not been tested, there are test patches that are close to the pure colors. These probably provide good estimates of the relative performance of the pure inks as well as the carbon.

[5] Technically, I measure the increase in Lab L. In more common language, however, the density of the print is decreasing. That is, the print is "fading."

[6] Lab L changes of Eboni carbon v. HP and Epson ABW grayscale tests on Hahnemuhle Photo Rag at 140 Mlux-hrs is reported at http://www.aardenburg-imaging.com/ . Comparing the Midtone L* = 50 test patches among the popular alternative printing approaches, these are the delta-e values reported. Lower is better.

MIS Eboni carbon = 0.6
Cone Carbon Sepia = 0.5
Epson 3800 ABW = 3.6
HP Z3100 = 1.9
Cone Piezo Neutral K6 = 3.5

[7] See http://www.paulroark.com/BW-Info/Eboni-v-Cone-N-HPR-140hrs.jpg for a comparison of carbon v. a popular neutral third party B&W ink.

[8] HP Vivera PK and grays are a carbon-color blends that show great color stability is fade testing, but HP still has to use much more color relative to the carbon due to the very small carbon particles it must use to be glossy paper compatible and stay in suspension in the less viscous thermal-printer inks. Thus its Lab L fade is 2 – 3 times that of carbon.

photographic materials, but this will be at a much slower rate and lesser extent than the historic materials. Note also that the paper and carbon pigment bleach in the opposite direction of the warming that will occur. The only medium that will be more stable is a 100% carbon print.

The ideal carbon offset toner arguably might be composed of only a single blue pigment. This would be so that the fade path would be straight to the warm carbon as opposed to veering off into a green or some other color due to differential fade of the pigments. However, based on my tests, that does and is not likely to ever exist. Even the silver print tends to have some drift to a lower Lab A with time. However, with both the silver print and the neutralized carbon print, the stability is so good that the paper base is probably the weak link. That is why I consider Arches watercolor paper to be my signature medium.

[9] For the print tone to go to a negative Lab A – that is, become green – the Lucia Blue would have to disappear totally while more than half of the Epson cyan is still intact, and that is just not going to happen. The Lucia EX Blue patch in the Aardenburg-Imaging test on H. Photo Rag at 140 Mlux-Hours of exposure has a very impressive total delta-e of 1.9.