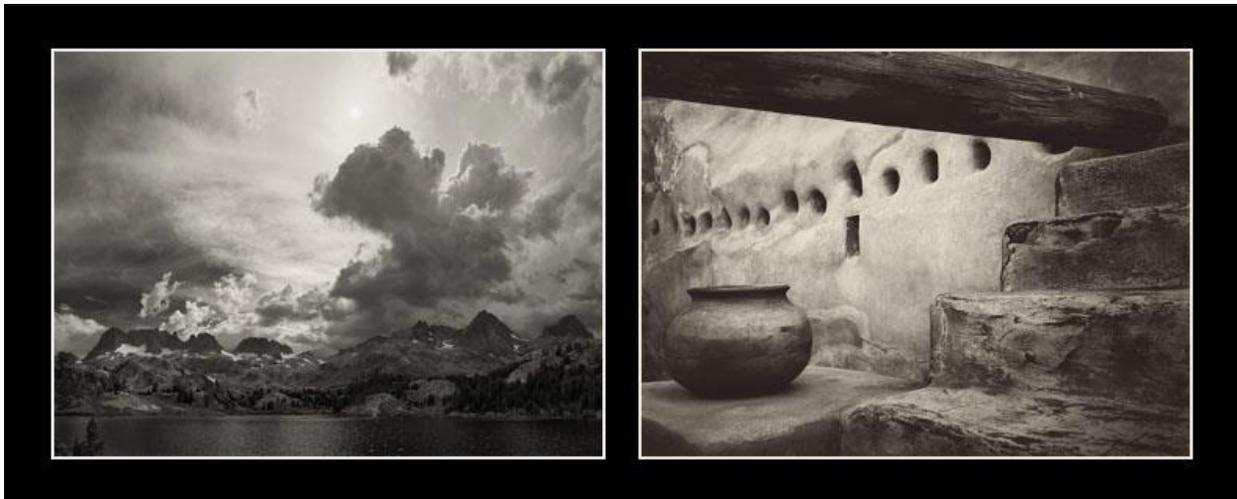


Carbon, Variable-Tone Black and White Inkset Epson 3800/3880 printers

www.PaulRoark.com

4/22/2015 – early, incomplete draft

This PDF discusses an arrangement for carbon pigment, “Eboni-6”¹ type inkset that adds a high quality blue toner to expand the image tone range of those inksets.² The goal here is to make the most lightfast, as well as most efficient,³ cost effective,⁴ as well as flexible⁵ means of producing the best B&W 16x20” prints with print tones from carbon warm to cool. This inkset prints only on matte paper and is fully Epson driver compatible. On the other hand, for optimum control I most often use QuadToneRip.⁶ With the advent of Epson’s new P800 replacement for the 3880, I expect these older but very capable printers will be readily available on the used market.



¹ See <http://www.paulroark.com/BW-Info/Eboni-6.pdf>. The inkset tested uses generic dilution base c6b. See <http://www.paulroark.com/BW-Info/Ink-Mixing.pdf> for clear base formulas. The concentrated carbon MK was supplied by STS Inks, which acquired Image Specialists (“IS”), the supplier of the “Eboni” MK ink to MIS Associates. The new version of Eboni is now available from MIS as “Eboni” v. 1.1. See <http://www.inksupply.com/eb6.cfm>

² The basic inkset has been tested successfully in an Epson 1400 at <http://www.paulroark.com/BW-Info/Eboni-Variable-Tone.pdf> and in a 7800 at <http://www.paulroark.com/BW-Info/7800-Carbon-Variable-Tone-2015.pdf>. Unlike the 7800 version, the 3880 version has only a single MK, allowing it to be fully Epson driver compatible. Since full sheets of watercolor paper are 22x30” the 3880 version is aimed primarily at coated inkjet papers, which do not need a second MK for excellent dmax. On the other hand, half sheets of watercolor paper can easily be printed, complete with the deckle edge on the bottom of the paper.

³ The 3880 footprint is only 27x15 inches. With the advent of the new Epson P800 17” printer, there will probably be good deals on used 3880 printers.

⁴ If you load your own carts and mix your own inks, the cost can be as low as about 1% of the OEM ink costs.

⁵ In addition to being a variable-tone inkset, note that the design facilitates easy upgrading or competitive toners. If a better or more cost effective toner is possible, it can be used. If the preferred tonal range is warmer, a warm toner can be used. Only one ink needs to be replaced. All the rock solid carbons are good to go for the long run.

⁶ See <http://www.quadtonerip.com/html/QTRoverview.html>. Profiles can be downloaded from <http://www.paulroark.com/BW-Info/7800-CVT-Profiles.zip>.

The above images show the approximate print tones for natural (no OBA) paper, with Stonehenge watercolor paper on the right *using profiles that produce a 100% carbon print.*⁷ Producing the best 100% carbon prints is still the top priority, not only in and of itself, but also for the best cool prints, one must start with the most neutral carbon core.

The reason to have the highest percentage of carbon in the inkset is simply because it is by far the most lightfast printing substance available, with up to 10 times lower delta-e than even the selenium toned silver print.⁸ Carbon also lacks the artifacts that appear when too much color is used. With the use of the toner, truly neutral or cool prints come within the range on this inkset, and they will have the highest percentage of carbon and least amount of color pigments in them of any inkset for any given degree of coolness and smoothness.

Many papers that are brightened with OBA's (Optical Brightening Agents/dyes) may print cooler with 100% carbon and be preferred by some. I generally avoid such papers because the OBA dyes fade. On the other hand, one of my favorite images that has been on my living room wall is printed on an old favorite of mine – Premier Art Smooth Bright White.⁹ More often I use the 325 gsm non-OBA version of this paper. Another, non-OBA paper that has turned in an impressive looking image is the Premier Art Generations Alise paper.¹⁰ I have not tested the brightened version.

Ink Arrangement

Y = Toner (6.5% Canon Lucia EX Blue, 3.5% Epson K3 Cyan, 90% clear base.¹¹)
LM = 2% MK (Eb6-Y)
M = 9% MK (Eb6-LC)
LC = 6% MK (Eb6-LM)
C = 30% MK (Eb6-C)
LK = 30% MK (Eb6-C)
LLK = 9% MK (Eb6-LC)
K = 100% MK (Eb6-K)

Cartridges and Chips

There are now a variety of competitors selling cartridges that will work with this family of printers. I have used (nearly) empty genuine Epson cartridges by disabling the backflow valve that stops re-filling the empty carts¹² and by resetting the Epson chips.¹³

⁷ See <http://www.DavidKachel.com/> for the photographer/artist who introduced me to Stonehenge paper.

⁸ See Appendix 1, below.

⁹ See http://www.premierimagingproducts.com/pm_smoothbwfineart.php; Premier Art's OBA-free Smooth Fine Art 325 gsm is the inkjet paper I most often use for my best work that is not on Arches.

¹⁰ See http://www.premierimagingproducts.com/pg_alisefineart.php

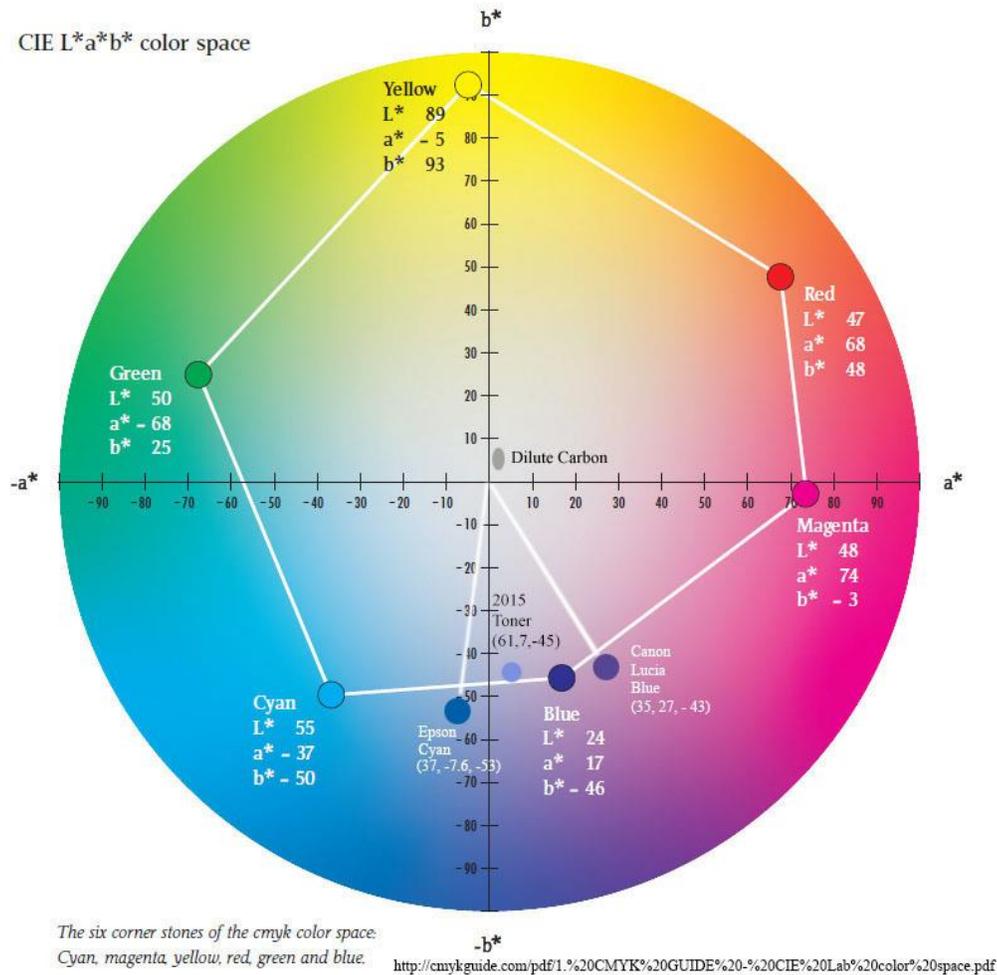
¹¹ Canon Lucia Blue (IPF-106B) and Epson 7800 K3 Cyan (same as 3800/3880 C) are used in the formula that I currently believe will produce the best results. To drain Lucia tanks, I just poke holes in the soft plastic with a clean awl – one high on the side for air to enter and one near the bottom on the side for the inks to pour out of into a 4 oz. bottle. I do this over a sink. For the Epson I used 7800 110 cyan cart with a modified MIS bottom fill adapter. See <http://www.paulroark.com/BW-Info/Modified-Bottom-Fill-Adapter.pdf>

¹² "JToolman" has pioneered the process of disabling the backflow valve. See his YouTube video at <https://www.youtube.com/watch?v=hTbnJgxMV8> . Basically, I used a needle that I'd dulled and some pliers to hold it. I made sure to have the pliers on the needle such that it would not go further than about 1/8" longer than the

Toner & Color Pigments¹⁴

The color pigments used in the toner mix are the best currently 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.¹⁵ I have placed the Canon Lucia Blue, Epson K3 UltraChrome Cyan, and mixed CVT 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 L, A and B measures. I also added a spot for the typical range of dilute Eboni carbon.

Epson Cyan and Canon Lucia Blue



obvious valve area. I found poking 2 holes through the backflow valve worked best. Be gentle with the external parts of the cart's coupling. You don't want them to leak.

¹³ This is one resetter that I know works:

http://www.ebay.com/itm/181401461962?_trksid=p2059210.m2749.l2649&ssPageName=STRK%3AMEBIDX%3AIT. One must break off a plastic guide, match the pins to chip contacts visually, and resetting twice may be needed.

¹⁴ This is the same toner as used in the 1400 version discussed here: <http://www.paulroark.com/BW-Info/Eboni-Variable-Tone.pdf>

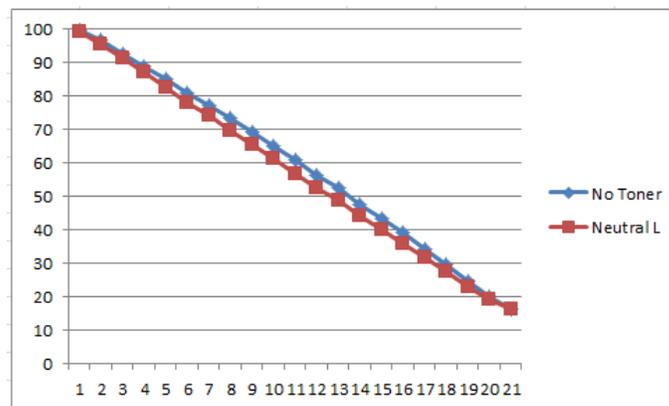
¹⁵ The original color wheel image is from <http://cmykguide.com/pdf/1.%20CMYK%20GUIDE%20-%20CIE%20Lab%20color%20space.pdf>.

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 narrow, 40 degree hue angle or distance on the color wheel between the Epson “Cyan” and Canon “Blue” relative to the usual cyan and magenta hue angle is the big difference. The use of color pigments with this small 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.¹⁶

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 somewhat with papers. Arches is the paper that usually 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 most 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 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. 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. Since the 3880 project is aimed at inkjet papers for the neutral range, I hope to test other blends and mixes that might be of interest. In particular I will see what C-B blend results in a flat Lab A for the popular inkjet papers.

With this carbon and the above color pigment mix, very little color is needed to tone a print to neutral. In addition to starting with the relatively neutral Eboni MK, 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.¹⁷



¹⁶ 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.

¹⁷ 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.

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.

Overall, even the best color pigments used here have a fade rate of about 2 to 3 times that of the Eboni carbon.¹⁸ 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 rate¹⁹ 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.²⁰ The difference is due to the combination of a more neutral starting carbon and a more efficient as well as much smaller use of color pigments.

So, while this toner plus carbon makes theoretical sense, a fade test is needed to be sure and verify the results. I have just taken a look at my fade test after 30 MLux-hours of exposure (8 weeks with my setup) and a report as well as scan of all the samples are posted on my web page.²¹ While it's too early to be sure, the results look like what I would expect from the theory. Of particular note is that the neutralized Eboni on Premier Art Smooth Fine Art 325 had barely measurable fade or color change.

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.²²

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 discussed here, much less color is used than in any OEM black and white approach.^{23 24} Ultimately, the print will warm as the colors fade. This is

¹⁸ I rely heavily on <http://aardenburg-imaging.com/> test reports. They are the best that are publicly available. Eboni, Canon Lucia EX and Epson UC K3 Cyan on H. Photo Rag have all been tested out to 140 MLux-hours of light exposure. 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.

¹⁹ 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."

²⁰ Compare Lab L changes of Eboni v. HP and Epson ABW grayscale tests on Hahnemuhle Photo Rag at 140 MLux-hrs reported at <http://www.aardenburg-imaging.com/>. See also Appendix 1, at the end of this PDF.

²¹ See <http://www.paulroark.com/BW-Info/Fade-Test-8-week.pdf> for the initial 8-week review. A scan of the test patches is at <http://www.paulroark.com/BW-Info/8Wk-fade-4-20-2015-100ppi-8bit.jpg>.

²² 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.

²³ 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

consistent with most 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. How much a real world, 2-pigment toner varies from this ideal is, in significant part, measured by the hue angle between the two pigments' colors. Here, the hue angle between the Canon Blue and Epson Cyan of only about 40 degrees is probably as good as it gets with available, high quality pigments. Consider that in a CYM inkset 360 degrees is spanned by the 3 colors. That is an average of 120 degrees between each of the color inks. The huge, typical cyan to magenta hue angle magnifies any differential fade, and, as noted above, the color pigments are working against each other as much as working against the yellowish carbon – very inefficient; more color is needed than would be the case with a narrower hue angle, again magnifying the effect of any differences in fade rate.

..... end 3880

Printing Characteristics and Profiles

My profiles will be posted at <http://www.paulroark.com/BW-Info/3880-CVT-Profiles.zip> .

The new profiles I've made use a strategy of utilizing some of the denser inks through the midtones more than the "standard" QTR profiling. While I have made some black only profiles, I do not like the degree of "grain" in such prints. I have found, however, that by using the second 30% concentration in the midtones like a "toner," I can achieve a delta-Lab B of about 3 that is very smooth. With more of the 30% and pulling the 100% into the midtones a bit, a delta-B of 2 can be reached with 100% carbon, but its smoothness is not as good, though still fine for many large prints. The goal of using the 30% MK in as a "toner" is to maximize the carbon content for the degree of neutrality achieved, with or without the use of the color toner.

As indicated above, there is a trade-off between relative neutrality and smoothness when only carbon is used. The "standard" QTR profiles are the warmest and smoothest. I have labeled the more neutral profiles with their approximate delta-B. Those with a delta-B of 2 are as "cool" as I wish to go with 100% carbon, and, again, they are smooth enough for most large prints. The delta-B of 3 ("dB3") profiles are visually quite smooth and the ones I'll probably use the most, though they are not, technically, as smooth as the standard, warmer QTR profiles.

compatible and stay in suspension in the less viscous thermal-printer inks. Thus it's Lab L fade is 2 – 3 times that of carbon.

²⁴ 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.

Epson Driver

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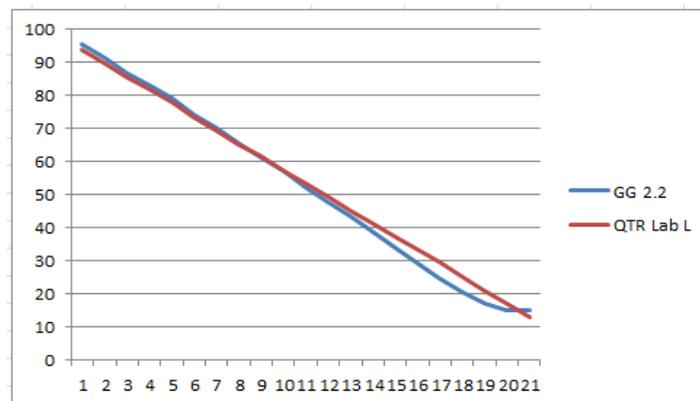
(This will be more like the 1400 <http://www.paulroark.com/BW-Info/Eboni-Variable-Tone.pdf>)

Printing with QuadToneRip

(This is 7800 section, which is similar in some respects, but the toner is in the LLK position, with a second MK in the Y position of the 7800 for use mainly with Arches, which will not be emphasized in the 3880 setup.)

QTR is the printer utility I use for most of my serious printing. Note that I use Windows 7 and the QTR Windows GUI. Mac users will have a different interface and workflow, but the profiles are entirely compatible.

At the outset, know that QTR, when printed from the Windows GUI, prints with a straight line Lab L characteristic curve. See the comparison of the Gray Gamma 2.2 and the QTR Lab L curves, below.

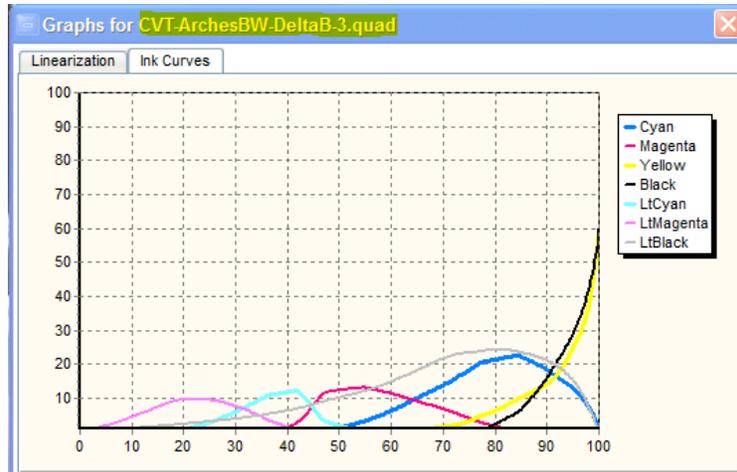


Because I edit in Gray Gamma 2.2, I need to adjust the print to compensate for the differences in how they print. To do this, I apply a Photoshop curve, after I have saved my master file, that offsets this printing difference just before I print the file. I save this printing file to the Desktop with “QTR” in its name. It can just be dragged and dropped into the QTR GUI. After printing, I delete the QTR-adjusted file. The Photoshop image adjustment curve I use is called “GG22-to-QTR.acv” and is in the Profiles Zip file.

The 100% carbon prints can vary in the degree of warmth or neutrality based on how the profile is written. If standard QTR profiling is used the print will be as warm as this inkset can print. That varies with the paper type from about 4 to 6. As noted earlier, more neutral 100% carbon profiles have been made and are market with the extent of their Lab B rise over the paper white.

For Arches watercolor paper, the delta-b=2 print does show some grain in the 25 – 50% range due to some MK being pulled into the midtones. Whether it would be acceptable is subjective, with print size, paper roughness and character of image being among the variables.

The delta-B=3 curve, which uses standard QTR profiling but with the second 30% K ink being pulled all the way into the highlights is much smoother. This is the one that satisfies me the most. Visually, without a loupe, I do not believe anyone can will see the additional grain. The curves for this profile are shown below.

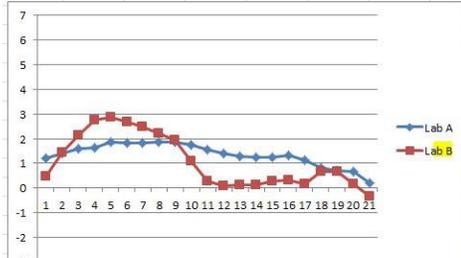
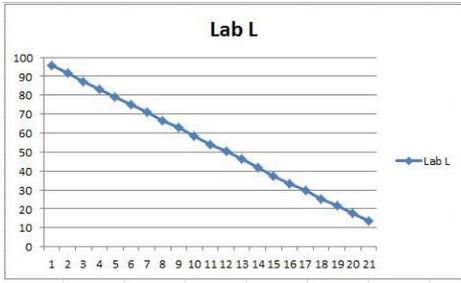


The neutralized version of the dB3 profile uses about 50% more color toner to achieve a neutral tone than does the neutralized dB2 profile. With the neutralized dB3 profile, the toner accounts for about 5% of the density of the print. The dB3 profile, blended with 35% of the neutralized profile dB3-N profile would make a print with the same tone as the 100% carbon dB2 profile but be considerably smoother, and less than 2% of its density would come from the color pigments.

While one would think that Arches watercolor paper and inkjet paper would be quite different, the Premier Art Smooth Fine Art 325 ("Pa325") that I favor was profiled from its warm 100% carbon Delta-B=3 profile to neutral by simply taking the Arches toner curve and pasting it into the Pa325 profile. The first test strip was a bit too cool. Lowering the ink limit brought that under control in the second test strip. That was all it took to make that neutral tone profile. So, while different papers may react differently to the toner, for many little or no change in the toner curve may be needed.

For cooler prints than the "neutral" (or "N") profiles print, just increase the ink limit of the toner. It is so light that the profile will probably be fine without linearizing.

When the 100% carbon and neutral profiles use the same carbon core, using the sliders in QTR, even with an extreme split tone, keeps the Lab L about as straight as the original profiles. All the slider is doing is changing the amount of toner and making very small offsetting changes in the linearization multiplier. See an example, below, made with the 1400 version of this approach. The main point is that the split tone sliders do not affect the Lab L curve the way they often do if two different partitions of differently toned gray inks are used.



File View Tools Help

Paper: Letter

Width: Length: Units: in mm

Orientation: Portrait Landscape

Media: Source: Sheet Feed Type: Matte Paper

Printer: <Quad1400-MIS>

Copies: 1

Placement: Centered Left Top Bottom

Scale: To Fit 100%

C:\Users\Pau\Documents\Images\Tests\21-Step.tif

Curve Setup

Curve 1: EbVT-EpsHPb-Neutral Resolution: 2880 dpi

Curve 2: EbVT-EpsHP-warm Speed: Uni-directional

Curve 3: None Black Ink: []

Curve Blending

Split Tone Curve Blending

	Highlights	Midtones	Shadows
Curve 1	0	100	100
Curve 2	100	0	0
Curve 3	0	0	0

(That's it for now.)

Appendix 1

Carbon Pigment Lightfastness

Fade Test Data²⁵

Aside from the toner, which does not need to be used (and is being fade tested now), the inkset I am describing is 100% Eboni carbon, and 100% carbon pigment images have resulted in the best digital prints tested by Aardenburg Imaging and Archives. What is unique about Eboni is that it results in a more neutral print tone than the other carbon pigments.

Comparing the Midtone L* = 50 test patches among the popular alternative printing approaches, all at 140 Mlux-hours of light exposure and all on Hahnemuhle Photo Rag, these are the delta-e²⁶ values reported. Lower is better.

MIS Eboni carbon = 0.6
Cone Carbon Sepia = 0.5
Epson 3800 ABW = 3.6²⁷
HP Z3100 = 1.9
Cone Piezo Neutral K6 = 3.5²⁸

Another comparison former darkroom printers may relate to looks at a wet-process, fiber based, selenium toned silver print. Aardenburg Imaging has tested the silver prints to 100 Mlux-hours of exposure. So, below I list the delta-e values for the L* = 50 test patch for the best inkjet print versus the selenium toned silver print that is most similar to what most of us used to print in the darkroom.

MIS Eboni, PremierArt Fine Art Smooth 205 gsm paper, Print shield spray = 0.1
Ilford Galerie FB Silver print, Selenium toned 1:20, Durst Theta printer = 1.2²⁹

This, no doubt, exaggerates the extent to which the carbon print is more lightfast than the silver print. However, when one also looks at the fact of un-buffered silver print paper being destroyed by airborne acids, whereas the buffered inkjet paper is protected, maybe these comparisons are not too far off. Add the problems of the gelatin coating on silver print compared to an un-coated Arches watercolor paper, and it becomes even more apparent that the expected life of a high carbon content inkjet print probably is significantly longer than that of a silver print.

²⁵ <http://www.aardenburg-imaging.com/> is simply the best database of fade test information that is available to those of us who are serious about our medium.

²⁶ Delta-e measures the total movement in Lab L, A and B – i.e., density fade as well as color shift.

²⁷ Epson ABW does better with a more neutral print, however, I did not find a test of one on H. Photo Rag. In general, the Epson pigments can be close to the HP test values.

²⁸ See <http://www.paulroark.com/BW-Info/Eboni-v-Cone-N-HPR-140hrs.jpg> to get a better feeling for what these numbers mean.

²⁹ Part of the silver print's problem was that the paper contained some OBAs. If we look just at the Lab L values or the test patches, the changes were as follows: Eboni carbon = 0.1, silver print = 0.3.