A Methodology for Analyzing the Black & White Process

How are you "spending" your gray scale?

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OK, OK, I know what you are thinking: the world needs another article on densitometry and the Zone System about as much as it needs a hole in the head. Many books and articles have been written about this seemingly age-old method for calculating negative exposure and development. What possibly could be written that would be new or different?

Let's think for a minute about what's going on when we make a print. The human eye is attracted to contrasts. As photographers, we have a "gray scale budget" ranging from D-max black to paper base white. How we spend that budget determines whether we have good contrasts in the shadows, mid-tones, or highlights. So it is *local contrast* – the separation of each Zone from its neighboring Zones -- that is important to photography. Being able to measure and control the distribution of contrasts across our print's gray scale is therefore what matters most.

Plots of transmission density are great for setting the exposure index and development time for film, and plots of reflection density from a print of a step tablet are great for understanding the characteristics of photographic paper, but no one seems to have joined these two measurements together and plotted the effect *on the print* of the *entire* photographic process: film choice, film exposure, film development, paper choice, enlarger contrast setting, enlarging time, and print development.

And even more important, every book or article I have ever seen plots only the transmission or reflection density curve itself. As I noted above, *density* alone does not make a photograph. It is the separation of densities – the *slope* of the density curve – that makes a photograph. So why not plot the slope of the curve as well? With a little help from the computer, this is straight forward. What is produced is a very useful plot of how the entire photographic process will distribute density separation (local contrast) between shadows, mid-tones, and highlights.

This article presents a methodology that will be used to understand how to print with a variable contrast light source such as the Zone VI LED head. A subsequent article, titled *How to Print with a Variable Contrast Light Source*, contains my methods for using such a light source.

For those of you who would rather have a root canal than program a spreadsheet, all of the spreadsheets referenced below are available in the Bibliography section on my web site: www.paulwainwrightphotography.com , together with other useful information too lengthy to include here.

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Let's Make a Negative

The starting point for our journey is the negative – a properly exposed and properly developed negative. All practitioners of the Zone System have at one time or another tested (or attempted to test) their film speed and development time. Since this is so common, I will only briefly describe my procedure here.

I am a 4x5 photographer (roll film users see my web site). When making a test negative, I sandwich a sheet of film under a 21-step step tablet (see Figure 1), take my loaded film holder outdoors where I have my camera focused at infinity and aimed at a white card in bright sun. A cloudless day is best because there is nice constant light. I meter the card and place it on Zone X, and expose the film. The step tablet attenuates the light a known amount at each step, so what results is a negative that has densities from Zone X to Zone 0 in roughly half-step increments. Assuming that Zone X exposure was given, the exact zone of each step is calculated as follows:

Figure 1

Exposure Zone = 10 - (Tablet Density/0.3)

The tablet density is usually supplied with the step tablet, or can be measured with a densitometer. Note that it is possible to calculate fractions of a zone, and the plots contained in this article will plot them that way.

Once the film is developed, it should produce a negative with a range of densities (see Figure 2). These densities can be plotted in the usual fashion to produce a density curve (see the individual points in Figure 3). I like to arrange my exposure index so that Zone I is on the straight line portion of the curve, and Zone VIII is between 1.3 and 1.4 density units. In Figure 3 I have also plotted a straight line approximation for the density points.

Figure 2

While it may take several trials to get the exposure index and normal development time nailed down, it is important to do so because this sets the stage for what is to come later. My web site contains more details about how to do this with or without a densitometer.

What we have created at this point is a properly exposed and developed negative that was produced in actual field conditions using *your* camera, light meter, shutter, film, etc. In my workshops, I call this negative my "benchmark" negative, because this is what I want a properly exposed and normally developed negative – from a film density perspective – to look like. Similar negatives should be made for your "plus" and "minus" development times.

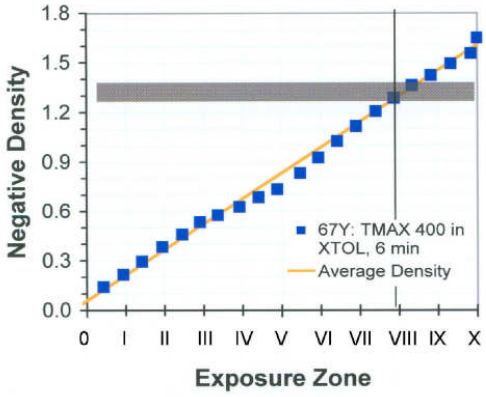

Figure 3

Reflection Density Plots

In every book or article I've ever seen, reflection density

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plots are made from step tablets. But think about this – what are you plotting? You are plotting a mathematically interesting quantity that is very difficult to relate to the art of making photographs. The last time I checked, people make photographs from negatives, not step tablets. So why not make our reflection density prints from actual negatives? This is not rocket science!

Let's use our benchmark negative to make our reflection density prints. What would we then have? Since we know the effective zone placement of each step of our test negative, if we contact print it, measure the reflection densities, and make a plot, now we can plot the print's density as a function of *original exposure zone* – the things we would have measured in the field with our spot meter if we had been making a real negative. It seems amazingly logical, but I've never seen anyone do this!

Let's Make a Print

I am using the Zone VI cold light head on my enlarger. Readers who use contrast filters, or who have enlargers that have VC heads that are calibrated in paper grades, can follow these procedures by using the various grade settings. Alternatively, sometimes people use split filtration printing in which they give the print 2 separate exposures, one with maximum yellow filtration (or the lowest grade setting), and one with maximum magenta filtration (or the highest grade setting). The relative time of each of these exposures determines the contrast of the print.

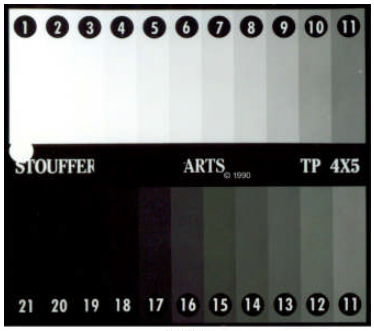

Figure 4

Let's start with making a contact print at what we'll call a grade 2 setting (white light or a grade 2 filter). For my Zone VI light source, I use a setting of E-E (equal amounts of soft and hard light). Figure 4 shows the contact print of our test negative. While the reproduction here may not show it, I have chosen a print exposure time that produces shades of gray from about the Zone II step through the Zone VIII step. Figure 5 is a plot of the reflection densities measured from this print.

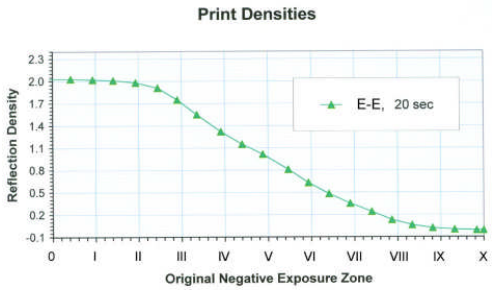

Figure 5

Pay close attention to the x-axis. Think about what this is telling you! This plot tells you that if you metered something in the field and placed it, for example, at Zone IV, and if you followed all the same procedures that we used to make our test negative and contact print, then that object will print at a density of 1.3. An object metered at Zone VII will print at .35, and so forth. This plot directly relates to the *original light meter readings* in the field, and it is telling us just how they will be rendered in the print. Pretty neat!

But What About Print Value Separation?

It is the separation of values – or "local contrast" – that makes a photograph. Let's apply this idea to our print, and plot the slope of the density curve. My web site contains the spreadsheet that does this.

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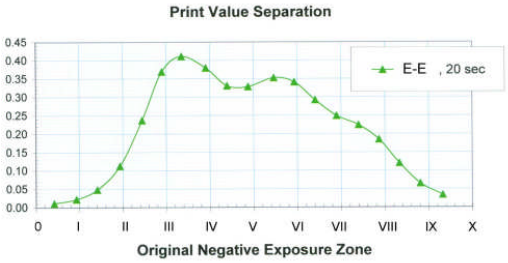

Figure 6

Figure 6 shows the slope of the reflection density curve from Figure 5. Wow look at those bumps! What does this tell us?

First, remember that this is a plot of the separation of print densities as a function of the exposure zones that you measured in the field with your light meter. This tells us how the print *contrasts* will be distributed between shadows, mid-tones, and highlights for our entire photographic process: film choice, film exposure, film development, paper choice, enlarger contrast setting, enlarging time, and print development.

Looking at figure 6, the print's local contrast (separation) begins to rise sharply around Zone II, peaks a little above Zone 3, falls off slightly through the mid-tones, has a hint of a rise around Zone VI, and then falls steadily above Zone VI. What this means is that shadow detail will begin to become visible for areas of your photograph that fall around Zone II, will be quite pronounced around Zone III, will be fairly even through Zones IV, V, and VI, and will fall off above Zone VI.

The pronounced falloff above Zone VI is fairly typical of many of the papers I have tested, but should not be cause for alarm. The human eye is quite sensitive to small changes in print brightness in highlight areas, and is much less sensitive to details in the shadows. An actual photograph printed on this paper from a real negative containing this distribution of densities would yield a satisfactory print with these enlarger settings. Nevertheless, plots like this can be used to make comparisons between enlarger contrast settings, paper type, etc.

Conclusions

I have laid the foundation for a method that evaluates the effect on print quality of the entire end-to-end photographic process. With this method it is possible to see the effect of film choice, film exposure, film development, paper choice, enlarger contrast, enlarging time, and paper development. I have also introduced the idea of plotting print value separation as a way to see what the effects of your process will be on local contrast in the print.

In the next article in this series, I will use these methods to compare the original and new LED light sources for the Zone VI variable contrast cold light head enlarger, and will then use this comparison to describe my methods for printing with a VC light source.

Paul Wainwright holds a PhD in physics from Yale, and has been making black & white images for more than 40 years. In 2001 he retired from a long career in research at Bell Labs to pursue large format fine-art image making full time. His interests include details of landscapes and architecture, and applying his research background to make the more technical aspects of photography simple to understand. Paul lives and works in Atkinson, New Hampshire, and teaches advanced workshops at the New Hampshire Institute of Art. He can be reached at info@paulwainwrightphotography.com .

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Figure Captions

Figure 1. In the dark, a sheet of film is loaded into the film holder along with a step tablet.

Figure 2. The resulting negative will have a series of densities ranging from Zone 0 to Zone X.

Figure 3. For the negative shown in Figure 2, the transmission density is measured and plotted as individual points. A straight line is also drawn to fit the points as well as possible, and represents the average density for this negative.

Figure 4. A contact print of the test negative.

Figure 5. Reflection density curve for the contact print in Figure 4.

Figure 6: Slope of the reflection density curve in Figure 5. This shows the print value separation that would result from all of the steps that are involved in making a photograph.

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