

How to Print with a Variable Contrast Light Source

Getting the most out of the new Zone VI LED head

by Paul Wainwright

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Introduction

In the first article in this series, *A Methodology for Analyzing the Black & White Process*, I described a way to understand how your gray scale is distributed in your prints. The procedure shows the effect of your *entire* photographic process: film choice, film exposure, film developer, paper choice, printing controls, and print developer. Furthermore, it shows how the *local contrast* – the gray scale separation of each zone from its neighbors – will be distributed in the print. The effect of any changes in your photographic process can be readily seen in your prints in a quantitative way.

One of the most important elements of the photographic process is the enlarger light source. I have long been a user of the Zone VI variable contrast cold light head. Like all cold light heads, this light source has a grid of fluorescent tubes behind a diffuser, which results in a better rendering – in many people’s opinion – of the tonality of the negative. However, a *variable contrast* cold light head has two sets of fluorescent tubes. A green/yellow tube, called “soft” on the control box, produces very low contrast prints. The other, blue/magenta colored, produces very high contrast prints, and is labeled “hard” on the control box. To control the actual contrast of a print, one can control the relative intensity of these tubes. For each light source, the control box has a scale labeled A through H, with “off” and “Min” on the low end, and “Max” on the high end. This scale seems arbitrary at best, and has been greatly improved upon in the new head.

Alternatively, one can control contrast by controlling the relative amounts of time each tube is “on.” This is sometimes referred to as *split printing*. The beauty of this type of light source is that one can go back and forth between one method of exposure or another without recalculating enlarging times. For example, an exposure of 25 seconds with the soft and hard controls both set to E is completely equivalent to one 25 second exposure with just the “soft” set at E, followed by one 25 second exposure with just the “hard” set at E. This adds a lot of flexibility to the printing process because it facilitates burning and dodging at different contrasts. Furthermore, to fine tune the contrast of a print, it is feasible to add or subtract small amounts of either the soft or hard exposure by increasing or decreasing just one of the split printing times. Such changes will impact the highlights or shadows, respectively, without significantly changing the other. No other type of light source can do this, until now.

This article “sheds light” on how to print with a variable contrast head by taking a quantitative look at the Zone VI “legacy” VC cold light head (no longer available), and the new Zone VI LED-based head. I wish to thank Richard Newman for making the test prints with the new head, and for putting up with all my questions. More details (including the spreadsheets) about my detailed comparison between these two heads can be found in the Bibliography section of my web site: www.paulwainwrightphotography.com.

Basic Differences

Unlike the original VC cold light head, the new head uses an array of light emitting diodes to produce the enlarging light. There is one set of diodes that emits a yellow/green light, and one that emits a blue/magenta light. As before, these are labeled “soft” and “hard” on the control box. However, the similarity ends there. Unlike the somewhat arbitrary A through H scale of the old control box, the new one is labeled 0 through 99, and is a *linear* control of the light intensity of the diodes. For me, this makes it much easier to understand how I am controlling the highlights and shadows of my print.

Another important difference: there is no warm-up issue with the LED head. With the legacy head, a stabilizing circuit is needed to insure that the light output of the tubes is correct. A green LED on the front of the head indicates that both tubes are producing the desired intensity. However, this is frequently a problem with the “soft” tube. Until my darkroom warms up to about 75 degrees – difficult in winter here in New Hampshire – I usually need to run the “soft” tube for 20 or 30 seconds just before making a print in order to get the LED to stay on. For this reason, I never run the “soft” tube above the “E” setting on the control box. Furthermore, that green LED on the front of the head is bright enough to make hand puppets on the wall of the darkroom, and it fogs paper. I have all but covered mine with black tape. The new head avoids this entirely.

In the densitometry studies plotted below, you will notice that the legacy head produced slightly blacker blacks than the new LED head. In my opinion this is not a function of the light source, but rather is probably due to some other variable what was impossible to control from opposite sides of the country. Maybe it was the water.

Another apparent difference is the overall brightness of the two light sources. Working with the legacy head, I set my 150 mm enlarging lens between f/11 and f/16. With the new LED head, Richard used f/5.6 on an 80 mm lens. Both sources were set to about half intensity (E-E in my case, 50-50 in Richard’s), and both enlargers were set and focused to produce an 11x14 print. Our printing times were in the same ballpark, which seems to indicate that the new head is about 2 or so stops less bright than the old. However, it would be best to repeat this test in the same darkroom with the same lens before drawing final conclusions.

Quantitative Testing

Since the control boxes are designed differently, we need to make the test prints somewhat differently in order to make an accurate comparison. Since the new head controls the illumination linearly, it is easy to dial in known percentages of soft and hard light. With the legacy head’s control box this is not possible. Instead, I made the legacy test prints using split printing: I maintained the same control box settings, and varied the percentage of soft and hard light by changing the times each was on.

Richard and I used exactly the same negative. We made contact prints to avoid any possible problems with fall-off, which the legacy head has. We also both used Ilford Multigrade IV paper developed in Zone VI paper developer, diluted 1+2, for 2 minutes at 68 degrees. I made the reflection densitometry measurements with the Heiland TRD-2 densitometer.

Using the test negative described in the first article, Richard and I agreed to start with equal amounts of “soft” and “hard” exposure, and to adjust our printing times so that the Zone V tonality of our gray scales matched. For me, I used 25 seconds of “soft,” followed by 25 seconds of “hard” (for all tests described below I used the “E” setting for each). For Richard, he used 22.6 seconds with the LED control set at 50-50 (equal “soft” and “hard”). The resulting density plots and separation curves are shown in Figure 1. The legacy curves are in red, the LED curves are in blue.

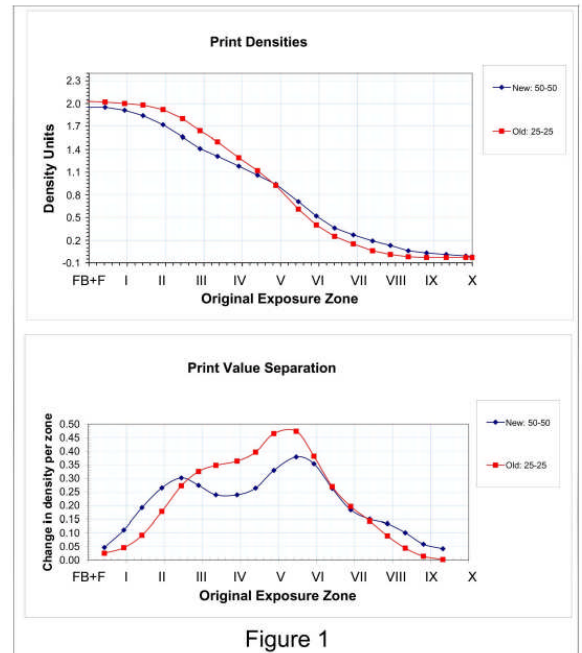
First conclusion: for equal percentages of “soft” and “hard” exposure – what might be called a “grade 2” equivalent setting – the new head produces a longer gray scale (less contrast) than the legacy head. This can be seen by looking at the Print Value Separation curves of Figure 1. The legacy head produces a maximum separation of almost .5 density units per zone, while the new head keeps the separation below .4 density units per zone, but has improved separation in both the highlights and shadows.

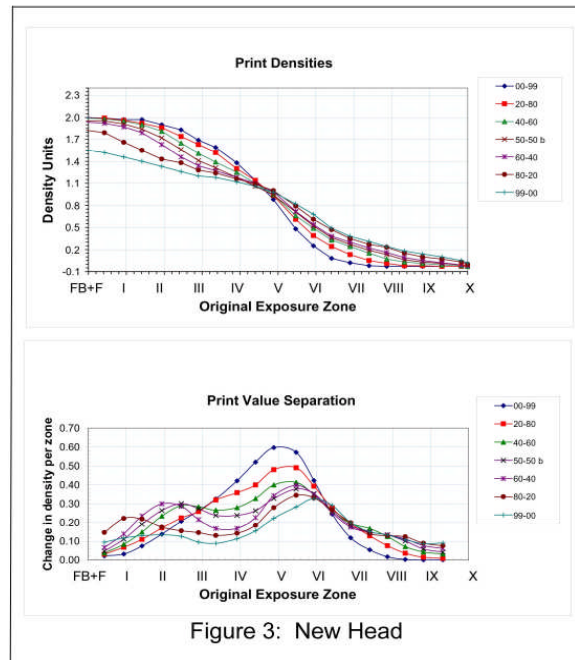
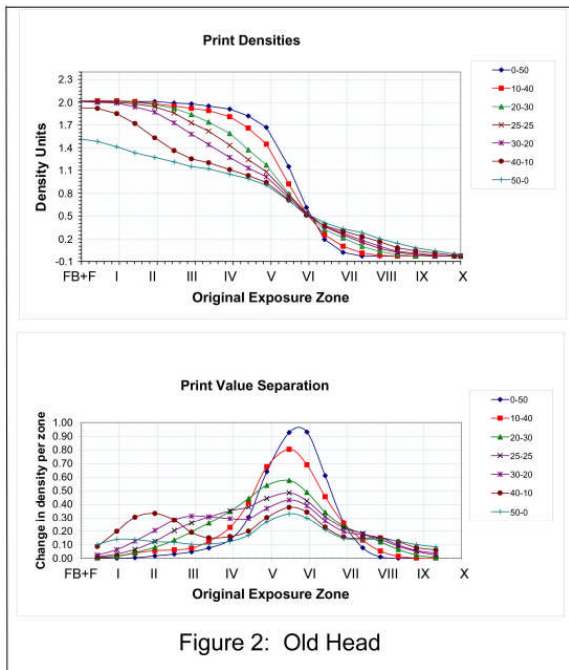
The dip in the curve for the new head around Zones III and IV is a property of the paper and not the enlarger. All VC papers, to some extent, show this mid-tone separation deficit, and one of the tricks to making great prints is learning how to avoid it or use it to meet your artistic needs.

Having established our initial printing times, Richard and I each made a set of 7 contact prints using the same overall exposure but varying the percentage of “soft” and “hard” light. Our prints were made with the following settings:

Legacy Head			LED Head
Soft = “E”	Hard = “E”		22.6 sec
50 sec	0 sec		99-00
40 sec	10 sec		80-20
30 sec	20 sec		60-40
25 sec	25 sec		50-50
20 sec	30 sec		40-60
10 sec	40 sec		20-80
0 sec	50 sec		00-99

These contact prints were measured with the densitometer and are presented in Figure 2 (for the legacy head) and Figure 3 (for the LED head). While these curves are awfully busy, we can draw our second conclusion: the legacy head “pivots” around Zone VI, while the LED head “pivots” around Zone V. What this means is that as you change the percentage of “soft” and “hard” light, your gray tones stay the same for Zone VI for the legacy head, and Zone V for the LED head. This is not a big difference, but it is something the photographer needs to get used to.



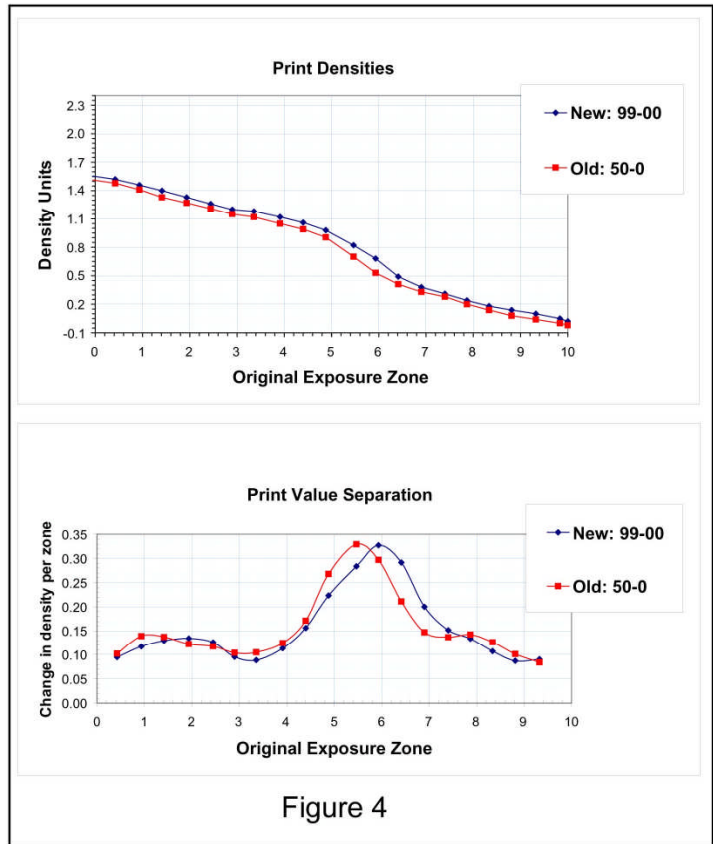


Another thing to note about these curves is that the two heads produce almost identical low-contrast characteristics, but that the high-contrast results are different. As Alan Ross pointed out in his review of the new head (see *View Camera Magazine*, November/December 2005), the new head produces less contrast than the legacy head. However, Richard Newman tells me that this can be overcome by filtration. Intermediate settings for the new head also seem to result in a longer gray scale (lower contrast) than the old head, and we will look at some specific comparisons next.

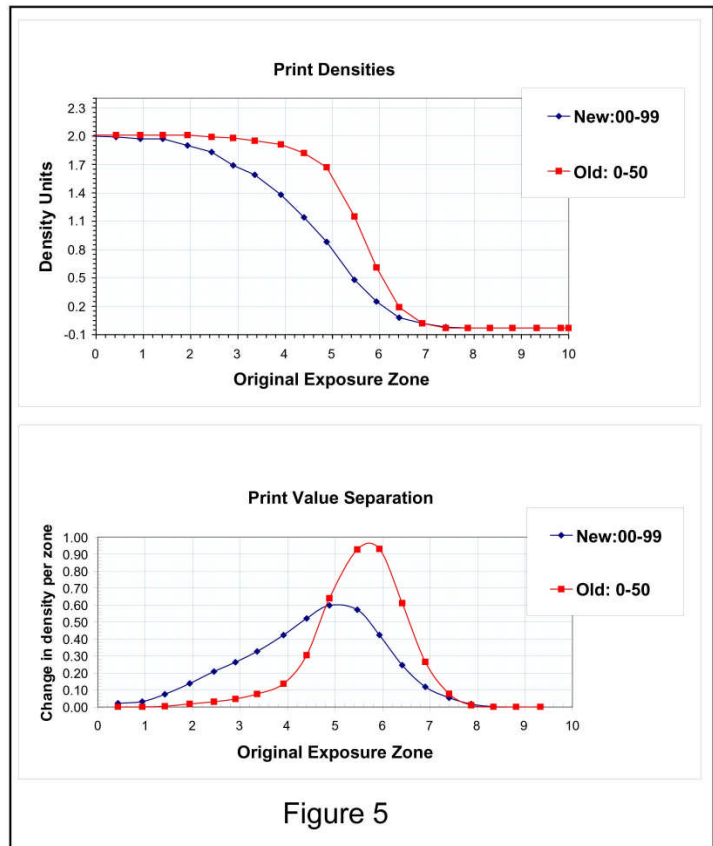
Detailed Comparisons

To understand these two VC light sources in more detail, let's take a look at some specific comparisons. As with Figure 1, all of the legacy head's data is in red, and all of the LED head's data is in blue.

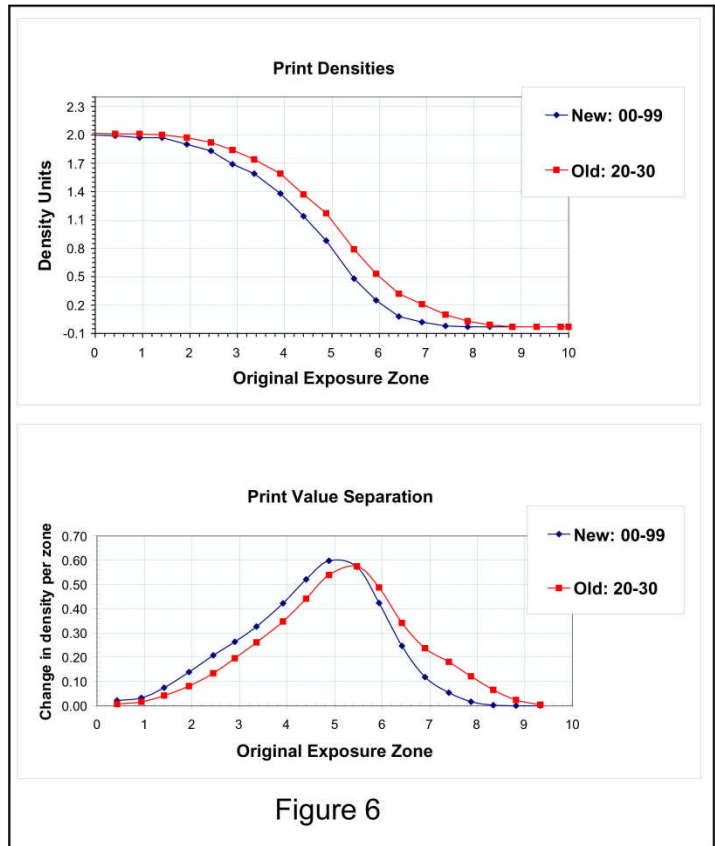
First, let's look at the lowest contrast setting for each head: 99-00 for the LED head, and "soft" only for the legacy head. Figure 4 shows the density curve and print value separations for these. Notice that the overall contrast range is essentially identical, and that the print value separation is also a close match (the slight differences are not significant).



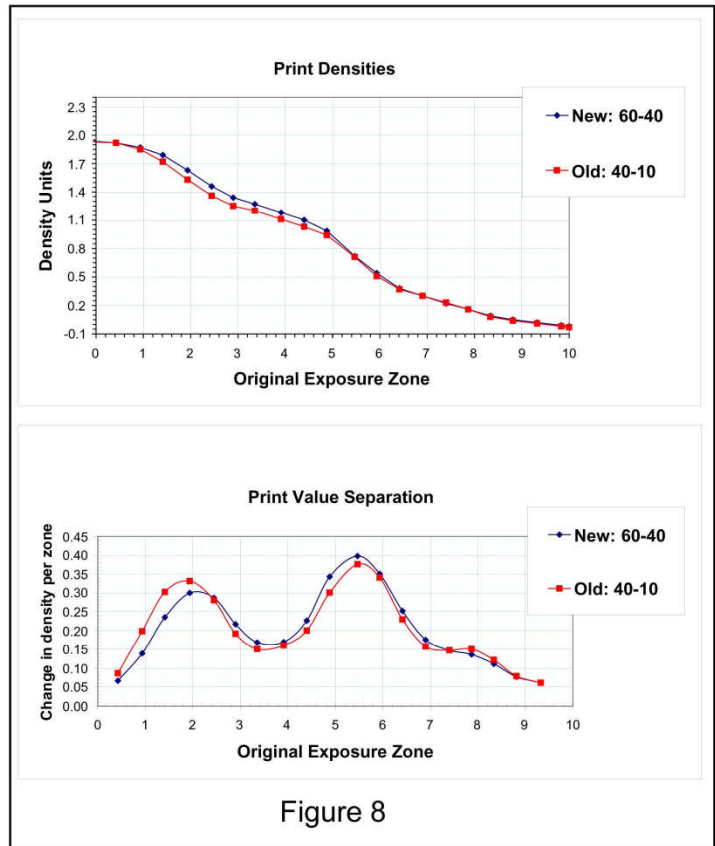
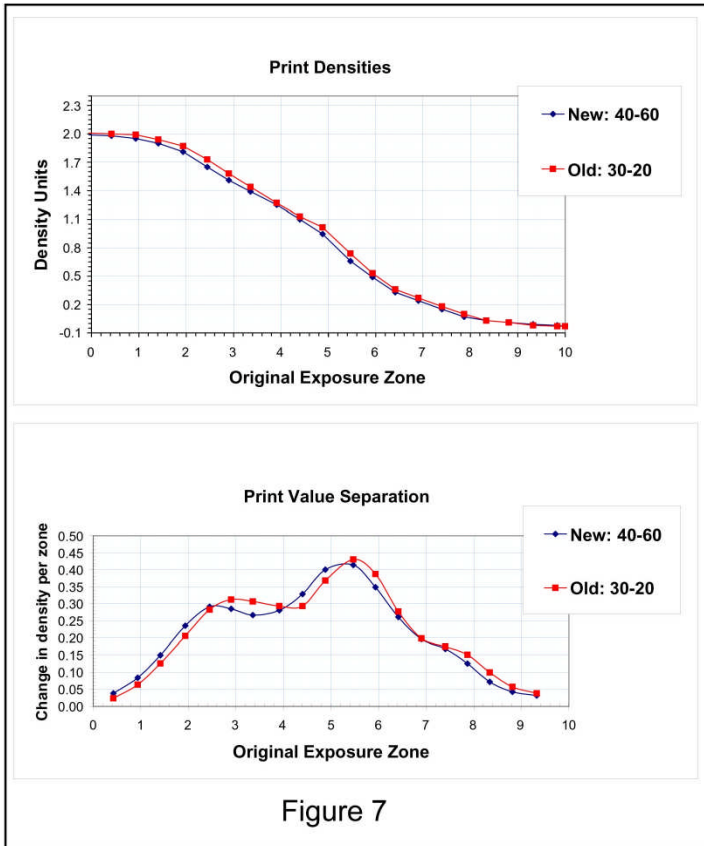
Next, let's look at the highest contrast of each enlarging head: 00-99 for the LED head, and "hard" only for the legacy head. As can be seen in Figure 5, there is considerable difference between them. The legacy head reaches a maximum contrast of almost 1.0 density units per zone, while the LED head peaks out at about half that, but shows an extended tonal range in the shadows (Zones III and IV).



So, we might ask what legacy setting most closely matches the highest contrast of the LED head? Figure 6 again plots the LED head's 00-99 (highest contrast) curves, compared with the legacy head's 20-30 setting (20 seconds "soft," plus 30 seconds "hard," both at the "E" setting). This is only slightly higher contrast than the "neutral" setting of equal "soft" and "hard" on the old head, and is a significant disadvantage of the new head in my opinion.



Let's look at two other comparisons. If we set the LED head at 40-60 (slightly on the contrasty side of neutral), that compares very closely with the old head at 30 seconds "soft," followed by 20 seconds "hard" – slightly on the less-contrasty side of neutral. Figure 7 shows this result – almost a perfect match. And if we set the LED head at 60-40, and compare this with the old head at 40 seconds "soft" and 10 seconds "hard," (see Figure 8), we again see a very close match.



Notice the significant dip in the curves of Figure 8. This is due to the two-emulsion design of most VC papers. It represents a significant decrease in the local contrast of the lower-mid tones in the print, and is usually best to avoid. The best way to do this is to tune your negative development times to produce negatives that are slightly less contrasty, so that a higher contrast setting is needed in the enlarger. This problem is due to the paper design and is not limited to VC light sources. I have seen very similar curves for the Saunders dichroic enlargers at the New Hampshire Institute of Art where I teach master printing workshops each summer.

The following table summarizes the “equivalent” settings for the two heads:

Equivalent Settings	
Old Head (time in seconds: soft and hard)	New Head
50-0	99-0
40-10	60-40
30-20	40-60
20-30	00-99
10-40	None
0-50	None

So, How Do You Print with One of These Things?

Based on my experience with the original Zone VI VC cold light head, here’s how I would approach this new device. First, I would pick a small number of control box settings as starting points for a family of contrast grades. For the legacy head, I typically start with one of the following, depending on the contrast range of my negative:

Soft	Hard	“personal” paper grade
E	Min	1
E	E	2
Min	E	3
Min	Max	4

My “normal” negative exposure and development times are tuned to produce full-scale prints with the E-E setting, so I think of this as my “grade 2.” The other settings produce less or more contrast, as needed. I think of these as my personal grades 1 through 4, although it does not matter whether these match the industry standards for such things. I know what they do, and I’m used to them.

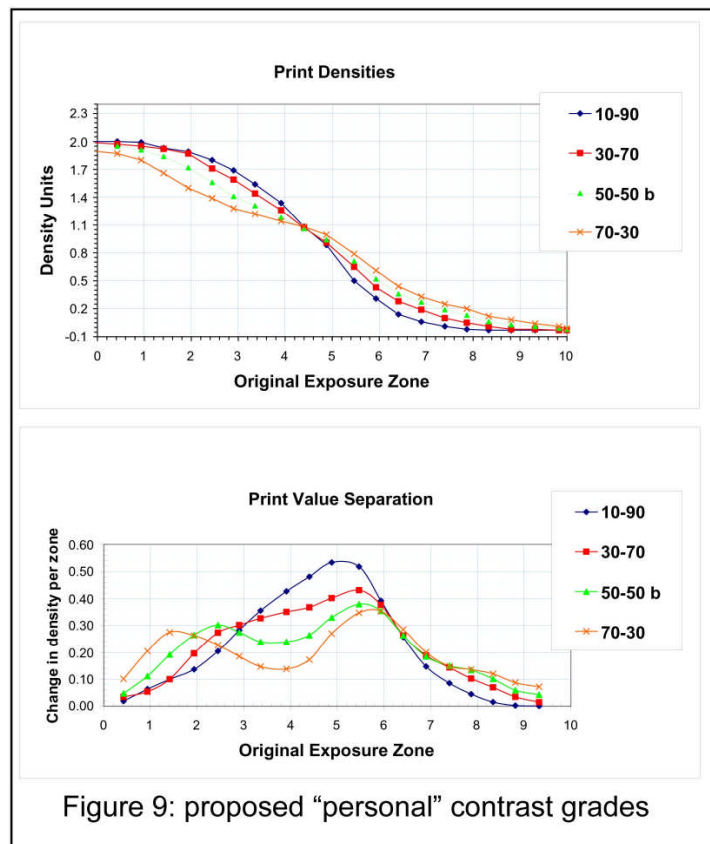
For the new head, I would pick the following starting points for “personal” paper grades, and tune my negative development testing to give a full-scale print at 50-50:

LED control setting	“personal” paper grade
70-30	1
50-50	2
30-70	3
10-90	4

Again, it does not matter whether these personal paper grades match the industry standards. They are *your* paper grades, and if you use them consistently you will learn what they do, and will be able to tweak them to fine-tune your prints. For me, I find it's too confusing unless I narrow down the alternatives, at least at first.

I try to avoid printing at the (personal) grade 1 setting. As I mentioned above, most VC papers show pronounced mid-tone separation deficits when printing at lower contrast settings. Ilford Multigrade is one of the better ones, but it is still unavoidable. It's best to have a slightly less contrasty negative, which requires slightly more contrast to print it. With the new LED head, I would be very comfortable printing at the 30-70 setting for a full-scale negative.

My proposed “personal” paper grades are plotted in Figure 9. As mentioned above, if the new LED head was my standard enlarging light source, I would tune my negative development to increase the negative contrast somewhat. Since the curves presented here are based on my negative development that has been tuned for the old head, new curves based on increased negative development would show more contrast than these. Nevertheless, notice that the maximum contrast ranges from 0.35 to 0.54 density units per zone. Also notice that I would have a wide range of densities (from about Zone I through at least Zone IX) for the “grade 1” setting, while the “grade 4” setting would produce a density range from about Zone II through Zone VII with my current negatives.



Let's Make a Print

I am a great fan of the “proper proof” from Fred Picker’s *Zone VI Workbook*. I know there are people who violently disagree with me, but it works for me. Based on my analysis of the proof, I can make a preliminary judgment about the negative’s contrast, and pick one of my pre-determined “grades” to make the first work print. This judgment is based on what has worked in the past for me, given what I see in the proof. It just comes through experience, but depends on the consistency of the proper proof. Having picked an initial contrast, I make a test strip in the usual way, pick an enlarging time, and make my first print. I look at it

under a dim (25 watt) viewing light (to help compensate for dry-down). Quite frequently I want to see a different enlarging time, and/or a different contrast. Still working within my family of personal paper grades, I make a number of prints, increasing or decreasing either the contrast and/or enlarging time. I make 8x10s at this point because it is cheaper to throw them out, which is exactly what happens to most of them!

I never make a final print in one darkroom session. There is a lot of thinking that needs to take place looking at dry prints – usually with a glass of wine in my hand! I'm thinking both about the technical how-to aspects of making the print, and also the emotional content of the print: does it convey what I feel about the subject? However, let's continue on with the description of making a print, with the understanding that days or weeks might pass between steps. With care (and good notes), the stability of the Zone VI head makes it possible to come back to print a negative again at another time and pretty much pick up where you left off.

Once some initial prints are made, I might go in any number of directions.

I might consider intermediate contrast settings. With the old head, this is most easily accomplished by going to split printing mode. This enables me to lighten/darken the highlights, or lighten/darken the shadows, by varying the enlarging time under "soft" or "hard" light, respectively. With the new head, this can be done much more easily by varying the control settings since they linearly control the intensity of each grid of LEDs.

One of the great strengths of a VC head is that you can control the highlights and shadows independently. You will notice that my "personal paper grade" settings for the new head did not use the maximum intensity of either light. This allows me some room to tweek either of them a bit higher if needed.

Another thing that I would certainly consider would be burning and/or dodging. Edge burning is frequently needed to keep the viewer's attention within the print. Also, edge burning is sometimes needed with the old Zone VI head to overcome some edge fall-off. However, another real strength of a VC head is being able to jump to split printing mode to dodge the "soft" and "hard" exposures separately. One of my most powerful tools as a printer is being able to dodge during the "soft" exposure. The effect is to lighten highlights in the dodged area *without significantly lightening the shadows*. The resulting effect is to increase the contrast in just that area, and further influence the viewer's attention. Burning and dodging with just the "soft" light is almost undetectable. You can do it 'til the cows come home, and all you will see is a change in contrast without those ugly burning or dodging "edges."

For example, Let's say I have a work print that was made at a 30-70 setting for 20 seconds, and it looks pretty close to what I want. The highlights are exactly right, but the shadows are a bit heavy. Also, there's an area of mid-tones that I want the viewer to notice more. Here's what I would do. First, I would keep the same enlarging time and back off on the "hard" setting, and try another print for 20 seconds at a setting of 30-65 or maybe 30-60. This would lighten primarily my shadows, have some effect on my mid-tones, and essentially no effect on my highlights. Then I would switch over to split printing. I would make another print with a 20 second exposure at 30-00, followed by a 20 second exposure at 00-60 (or whatever final "hard" setting I picked above). During the 30-00 ("soft") exposure, I would dodge the area where I want to increase the contrast. Depending on my desired effect, I

might make several prints with different amounts of “soft” dodging. I would be able to strongly increase the contrast of the dodged area without being “noticed.”

Further Testing

There are several additional tests I would like to perform with the new head. For sure I would repeat the brightness test that I mentioned above. But more important, I would want to do a fall-off test. With the old Zone VI head, this is a big problem, and I would be very interested in seeing the results for the LED head.

To perform this test, set the enlarger to make an 8x10 full-frame print with a 4x5 negative. Focus the enlarger, remove the negative, and stop down to a setting you would typically use to make a print. For me, I stop down 2 or (probably) 3 stops, so with my 150 mm f/5.6 lens I would stop down to f/16. Then set the contrast control to its maximum value: 00-99, and make a test strip (with no negative). Pick an exposure time that gives a light to middle gray, then expose an 8x10 sheet for that time, develop it, and look at the print. Ideally you should see an even tone of gray from edge to edge and corner to corner. If you don't, there's fall-off in the light intensity as you move away from the center, and you will need to compensate for it by edge burning. The effect is more pronounced at higher contrast settings, so it won't be noticed much at a more normal contrast setting, but it's there, and you need to be aware of it.

Conclusions

I have presented a quantitative analysis of the new Zone VI VC head, compared it with the same analysis of the old head, and have used my experience with the old head to describe an approach to printing with the new one. Along the way, I've tried to point out the advantages with a cold light or LED VC head, as well as any other useful thoughts that might help you make better prints. Good luck!

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.