Interpreting the Camera Histogram

By Chuck Gardner

On the simplest level a histogram (turned sideways below) is like a rain gauge:

Each site on the camera sensor has a finite ability to record light just as the rain gauge as a finite ability to hold water. The more light the sensor cell records, the further to the right on the histogram the indicator for that cell will appear. As light "fills" the sensor "bucket" the resulting signal produces a lighter and lighter tonal value. Light reaching the sensor from the most reflective areas of the scene will fill the sensor faster than dark ones. It does not matter what tone the object in the scene is; whatever is brightest in it is represented by the rightmost "blip" on the graph. The position of that brightest object on the horizontal scale of the histogram does not represent how it appears in the scene, but rather how it will be reproduced.

The state of "fullness" of the sensors is shown on the histogram as a bar graph. The horizontal axis is a grayscale of tones with 256 steps, from black (0) on the left, to white (255) on the right. Those steps represent tones on the screen or print, not

tones in the scene. The camera sensor doesn't see tone, just variations light intensity. For example you can make a gray card appear gray, black or white by changing its exposure.

It is important to note the histogram is not revealing the tone the object, only how much light is reflecting from it. The contrast of the scene per the histogram could be the result of a black and white cat in flat sunlight, or two white cats, one in shade and the other in shadow. That's why the photographer's eyes and brain play an important part in interpreting the histogram. Identifying the lightest and darkest objects in the scene then correlating them to the position of left and right edges of the curve on the horizontal scale can reveal whether they will be reproduced accurately as seen by eye; but only if the photographer knows what tone in the final print each point of the horizontal scale represent. That can be done with a simple test, as explained below.

The width of the data points on the bar graph shows the range of reflectance from the scene. If there is only one tone in the scene (e.g., a gray card) or a narrow range, the baseline will be quite narrow because the reflection will be uniform. But if there is a wide variation in reflectance across the scene the bar graph will be wide. Thus the width of the data points reveals the contrast of the scene.

The height of each bar on the histogram represents the number of sensor sites receiving the same level of light. Because the bars are so small and a scene usually contains a range of tones the bars form a curve depicting the dominant "key" of the scene. If the scene is predominantly light the curve will have a hump on the right side. If the scene is mostly dark the hump will be to the left. If the scene has a few very light and dark tones but it is mostly middle tones the curve will be "bell" shaped (i.e., standard distribution).

The most valuable information on the histogram is the position on the baseline of the graph of the brightest reflected value, represented by the bar furthest to the right. The horizontal axis of the graph represents the dynamic range of the camera, the range of light it can record between the time when the sensor "bucket" level rises above the noise until it is full and can record no more. It is helpful to visualize the horizontal axis as a grey scale tones from black-to-white, with gray in the middle. How the brightest object in a scene will be reproduced on the print can be deduced quite easily by comparing its tone in the scene to how the right side falls on the horizontal axis.

If there is something big and white in the scene figuring out what the histogram is saying is pretty much a no-brainer, as in the shot above of the rain gauge. Just align the right most bar of the graph with the right edge of the graph a perfect exposure is assured.

If there isn't a white textured highlight in the scene the simplest thing to do is to add one, a white terry towel, so setting exposure via the histogram remains a no-brainer. If it is not practical to add the towel and shoot a test it is simply a matter of identifying what is the brightest tone non-white tone and knowing where it should fall on the horizontal tone reproduction “gray” scale.

Calibrating the Camera Histogram – A Simple Test

It would be very instructive if the camera histogram was superimposed with a grayscale and calibrated in f/stops, and you can do just that yourself in less than five minutes:

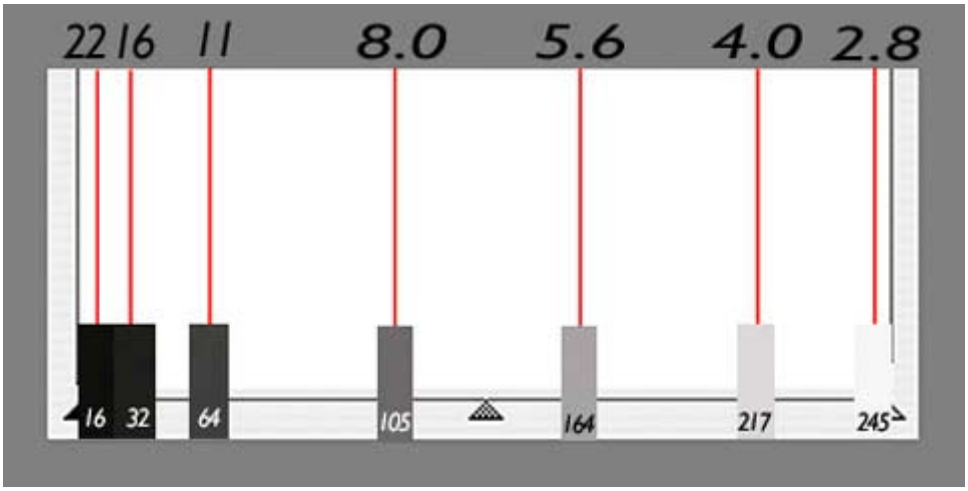
1 Take a gray card or white card, or anything neutral, put it in the sun and do a custom WB.

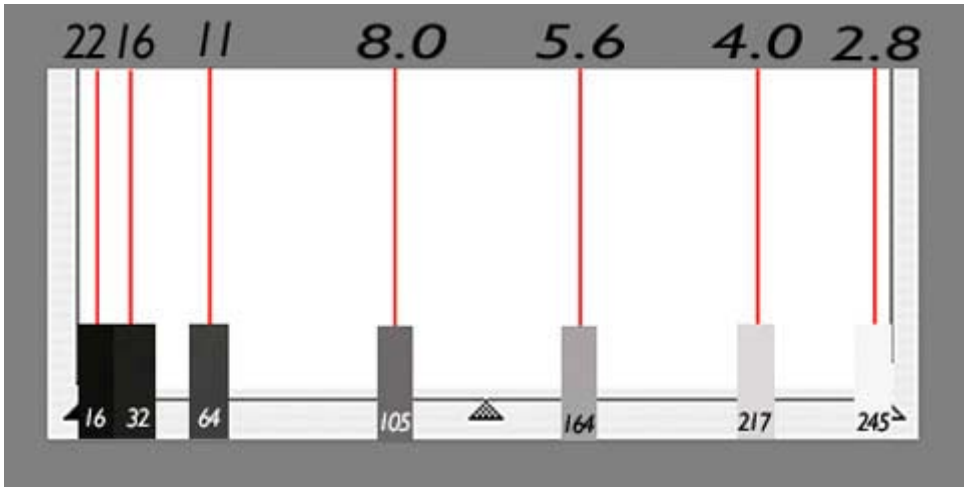
2 Use your lens with widest range of aperture. Put your camera in M mode in manual focus and open your lens to its widest full f/stop (e.g., f/1.4, f/2.0, f/2.8) Fill the entire viewfinder with the card and make it slightly out of focus. Find the shutter speed that will make the image blink indicating overexposure, but then select the next fastest speed until the blinking stops.

3 Shoot a series of shots of the full card, stopping the aperture down 1-f/stop with each frame until you run out of stops on the lens.

4 In playback mode view the histograms for the series. You will see a narrow spike indicating the amount of light reflected from the card march right-to-left across the histogram. Put a piece of plastic wrap or clear tape on the LCD and mark spots where the spikes occur with a marking pen.

Below is an illustration created in Photoshop from the test I did on my Canon 20D. The red lines represent where the spikes from the card appeared on the camera and Levels histogram. The tone patches are cut and pasted from the actual files with their average RGB value read with the eyedropper below:





So what does this tell me?

1. My camera can record about 6 stops of detail.

2. By noting where the 1-stop intervals are falling I now know with certainly what 1, 2, 3 etc, stops under exposure looks like on the histogram.

3. Because my target was a Kodak 18% Gray card, not a white one, fact I could reproduce it as anything from white to black tells me I can control how the brightest object in the scene will be reproduced in the file by controlling where on the histogram the right edge of the curve falls even if it isn't white. If the brightest thing in the photo is ANY neutral in tone I can even predict its RGB values and tone in the reproduction simply by noting where the right edge of the curve falls and compare that position to the lines from the test. I can laminate that test and carry it as a reference.

It's a very simple test to perform and it only takes a few minutes. Try it and learn more about your camera's range and what its histogram is telling you.

Hand Held Spot Meter Calibration

Using the histogram effectively depends on the ability of the photographer to interpret the scene and find the brightest in it. Actually that is quite simple. As in the card test above its simply a matter of increasing the exposure to the point where the brightest area blinks a warning, then backing down the exposure a 1/3 stop or so, if white, or to the tonal value position determined in test.

A hand held reflection spot meter with a narrow 1-degree field of view (e.g., Sekonic L-558, Minolta IV) can also be a valuable tool for determining the perfect digital exposure. By default the meter will display the exposure variables needed to render the measured area gray at the camera's ISO speed. Because the most critical area for exposure is the textured highlight and meter sensitivity may differ from that of the camera I suggest this very simple calibration point which shifts the meter default reading to a textured white reference point and compensates for any camera/meter calibration issues:

1) Meter a textured highlight like a white terry towel in sunlight. Have someone hold it next to their face.

2) Shoot a bracketed series of exposures, evaluate in Photoshop and pick the one which reproduces the face and towel the best and note the f/stop.

3) Now go back to the same place, meter the towel, and adjust the ISO2 speed of the meter until the meter reads the f/stop which produced the best looking file.

Once calibrated that way simply read any highlight you wish to retain texture (reproduced as print value 8), press ISO2 on the meter, read the exposure setting. No more mental gymnastics!

Chuck Gardner

Tutorials: http://super.nova.org/DPR/
Contact: cgardner@nova.org