Looking at New Methods in an Old Way

Abstract

It has been said, “There is nothing new under the sun.” We know that this is no longer true. Since this quote we have gone to space, invented the computer, the internet, email and too many other things to count. Things that were once a fantasy are now a reality.

In the last few years of photography we have made better cameras, lenses, new ways of capture and we see this changing so fast that it is almost beyond comprehension.

This thesis will show the correlation between an old established photographic method, the Zone System, and a new tool that is a large part of our newer method of evaluating exposure and capture, the histogram.

The thesis will first review the Zone System, secondly it will discuss histograms as we use them in our digital workflow and then show the use of the correlation of the two.

The Zone System

We have heard that history repeats itself. In some ways this is true. We hear about global warming. Can this be a repeat of history? Yes, otherwise we would still be living in the ice age.

We learn from history. History helps us understand the past, evaluate the present and predict the future. One aspect of photographic history that can help us better understand the present is the Zone System.

In the late 1930s Fred Archer, while an instructor at the Art Center College in Los Angeles, wrote a series of articles for *U.S. Camera* magazine outlining the Zone System. After reading the articles, Ansel Adams approached Archer, and they worked to refine the process. The Zone System as we know it was introduced in 1941.

In the Zone System brightness levels have been assigned numbers “0” through”10”, using Roman numerals rather than Arabic numbers. There are eleven brightness levels where 0 represents black, V represents middle gray (18% reflectivity) and X represents white. These eleven brightness levels are called zones. *[Illustration 1 Eleven Zones] 14*

Between one zone and another there is a difference of a factor of two. Zone IV is twice as light as Zone III. Therefore one zone change is equal to one f-stop of light.

The Zone System gives photographers a systematic method of precisely defining the relationship between the way a photographer visualizes the subject and the final result. It was originally used for black and white sheet film. It can also be used for roll film although all of the exposures on the roll would be manipulated as opposed to sheet film where individual exposures can be altered.

In the Zone System the first step in image management is visualization. As a photographic artist we need to look at the scene and analyze various elements within the scene.

Management of the scene is controlled by a number of elements such as camera placement, lens selection, contrast levels of the method of capture and control of image values. The Zone System helps with the control of the image values. Zones are directly related to exposure while visualization relates to the final print. Controlling image values is basically viewing a scene with its tonal ranges and noting what needs to be done to produce the desired final image. This is visualization.

Most scenes have a variety of elements of different luminance. Therefore, the exposure of the scene is actually a combination of many different captured light values. The base exposure is the same as far as the camera is concerned (f stop and shutter speed) but the illuminance varies as the luminance of each subject element varies.

In the Zone System a reflected light meter is most often used. Most of the early light meters measured overall average luminance. This made it very difficult to measure scenes of high contrast as a light meter tries to make everything 18% reflectivity. Realizing that not all scenes are 18% reflectivity the photographer can meter specific parts of the scene. A spot meter is very useful here to determine the luminance for each of the parts of the scene. One of the best ways to overcome the general overall averaging metering is to meter the part of the scene that is most important and then adjust the exposure to let that part of the scene fall into the zone that you desire as the final result. For example if you meter a dark shadowed part of the scene the meter will try to put it in Zone V or make it 18% reflectivity. Therefore the photographer might want to place it in Zone III, average dark but still showing adequate texture and shadow detail. Then the rest of the scene will fall into equivalent zones.

The final image produced is directly related to the exposure and where the photographer placed the key elements during exposure. Tones and textures vary as the zone varies. As stated

previously, Zone III is average dark showing full texture, Zone V is middle tone (18% reflectivity) and Zone VII is light tones with full texture. *[Illustration 2 Eleven Zones described] 14*

As previously stated, the reason the Zone System is particularly good for sheet film is that each sheet can be developed individually to get the desired results. Therefore, if you take one or more duplicate exposures of the scene, you can develop one sheet and if it is not exactly what you desire, you can develop the next one using a different development time.

When you expose a sheet of film the part that is most affected is the part that receives the most light, which are the dark areas of the negative. When a negative is developed the part that received the most exposure, the highlights, will be most affected by the chemical reaction between the film and the development chemicals. The black or very dark areas of the scene are going to be clear or very light on the negative. Development will have little consequence on the clear or light areas.

For a combination of film type and developer there is a normal development time that will render a good print from a properly exposed negative. Each zone as exposed will be reproduced as that zone on the paper, within the limitations of the ranges of the paper. Some papers do not have pure black or pure white.

If the photographer wants a full range of tonal values on the final print but has a low contrast scene, the negative will need to be given more development time. This has an effect on the highlight portion of the negative by giving the highlights on the negative more density and therefore lighter values in the print. This gives a low contrast scene more apparent contrast. This process is known as expansion. Where "N" represents a normal development time, the expanded development is referred to as "N+". Ansel Adams used this to raise a Zone VII to a

Zone VIII in the final print. This is referred to as “N+1” since it changed the highlights one zone.

If the scene has too much contrast and a full range image is desired, just the opposite would occur. Decreasing development, contraction or “N-”, would render the highlights less dark on the negative and therefore less contrast on the print. If a Zone IX were rendered as a Zone VIII then this would be “N-1”. There are times when even more change is desired. On these occasions a “N+2” or “N-2” adjustment might be used.

It can be seen that this is not as practical for roll film because all exposures on the roll would be effected the same with a N+1 or N-1 development.

Because of color shifts, color film does not do a well as black and white film in variations in development time.

Histogram

A histogram is a graphical display of tabulated information. The word histogram is derived from Greek: histos, anything set upright and gramma, drawing, record or writing.

In mathematical terms, a histogram is simply a mapping, $m_{i,}$ which counts the number of observations that fall into various disjointed categories. These categories are known as bins. The graph of a histogram is just one way to represent a histogram. Thus if we let n be the total number of observations and k be the number of bins, the histogram m_i is represented as

$$n = \sum_{i=1}^{k} m_i.$$

A histogram does not apply only to photography. You can map elements as related to events, time, temperature or just about anything to get a picture of what has occurred. If we want to see how things have been and help predict the future, we can create a histogram.

American Society of Photographers, for example, can create a histogram of the number of members as related to time. This lets them know where they have been, where they are now and what they can expect in the future. If they do not like the expected data, they can change the prediction by changing variables.

In digital photography possibly the most useful tool we have available to us is the histogram. We need to know what a histogram tells us and how to use this information.

A histogram, as we know it in digital photography, is a graph of the brightness levels captured by the camera. Some histograms will also break down the image as far as colors, Red, Green and Blue (RGB), but here we are only going to discuss the brightness levels as they apply to an 8-bit method of capture.

Most digital cameras today have some form of histogram built into them. Most of these digital cameras can be programmed to display the image immediately following the exposure with the option of a histogram also being displayed. This can be very useful for the photographer in determining if the camera has in fact captured the scene with the desired exposure.

In an image recorded in the 8-bit mode there are 256 brightness levels. In the 256 brightness levels "0" represents black and "255" represents white. Since this is a linear scale "128" would represent mid tone or 18% reflectivity. This means that if you were exposing for a subject with medium values, it would fall about the mid point of the camera's dynamic range. If a subject is exposed too close to either extreme, you chance falling out of the capability of the

image sensor to capture all elements of the image. If you expose too close to 0, there will be no image at all, or it will be very dark and noisy. If you expose too close to 255, there will nothing except over saturated blown out highlights with no information.

If you have an exposure card that has black, white and 18% gray you will have three spikes in the histogram, one for each brightness level. *[Illustration 3 Black, White and Gray Exposure card showing Histogram] 15, [Illustration 4 Black and White Exposure card showing Histogram] 15* A mid tone image will most often have a smooth curved histogram with a "mountain" in the middle of the graph. A light meter will tell us what exposure will render a standard 18% gray card as a mid tone. *[Illustration 5 Mid Tone Image showing Histogram] 16, [Illustration 6 Full Tone Image showing Histogram} 16*

A digital image sensor in a camera, capturing in the 8-bit mode, is similar in sensitivity to that of color transparency film, a range of approximately five f-stops. Therefore it is not always possible to capture all tonal ranges with your digital image sensor.

To help us understand this better look at another form of energy, sound. Our audible range is about 20Hz – 20,000Hz. One of the best recognized forms of creating sound in the form of music is the piano which has a range of A(0) 27.5Hz to C(8) 4183Hz. This is divided between eighty-eight keys or eighty-eight bins if we look at this in the form of a histogram. The volume of sound is measured in decibels.

The piano is unable to produce a range from 20Hz to 20,000Hz but it can still produce beautiful music. Our forms of capture, even though limited, can still capture beautiful images.

A "musical" histogram would have the tonal ranges as the horizontal or "x" axis and the volume represented in the vertical or "y" axis. *[Illustration 7 a Musical Histogram of a part of "Unforgettable" by Natalie and Nat Cole] 17*

A photographic histogram will be a display of the brightness levels, 0 – 255, along the x-axis and the amount, or volume, of each brightness level captured by the image sensor displayed on the y-axis.

Any information that does not hit the x-axis at the ends of a histogram, which we call the table, is not recorded. If the histogram does not "hit the table" on the left, then there are dark areas in the scene that will not have detail. If the histogram does not "hit the table" on the right side, then there are light areas that are not captured or will have no detail. We call this blown out highlights. *[Illustration 8 a High Key where the background has Blown Highlights] 18, [Illustration 9 Early Morning scene that has Blown Highlights in the background] 18*

Histograms and the Zone System

Both the Zone System and histograms are ways of analyzing light and exposure. By using the numbers or zones assigned to each value of light, we can more accurately evaluate the brightness levels and change the image to our desired outcome. In digital there are distinct divisions of brightness. Film, on the other hand, being analog has a smooth transition from black to white even though it is divided into eleven zones.

Before we start to photograph with any digital camera we need to evaluate effective ISO of the image sensor, as not all image sensors are the same sensitivity. Some image sensors will consistently under expose while others will over expose. There are a few image sensors that will capture the subject at the ISO as metered.

This is also true of film. We need to find our working ISO for each film type that we intend to use. To do this with film and the Zone System we need to do a series of test shots of an 18% gray card at the ISO recommended by the manufacturer. Bracket the exposures at half stop

intervals. Next, the film needs to be developed at a normal development as per the specific chemistry that is being used. Use a densitometer to determine the exposure that is closest to the given density of a negative for a particular film. After evaluation, a film rated at an ISO of 100, for example, might need to be exposed at ISO 80 or ISO 160 depending on the outcome of the test.

With digital this is a little less complicated because of the histogram. Meter the light and expose an 18% gray card. Look at the histogram to see if the spike is exactly in the center. If the spike is not in the center of the histogram, all of the other exposures will be off the same amount. Adjust your ISO until the spike is in the center when exposing an 18% gray card. This will give you the effective ISO for that specific image sensor.

The first step in obtaining a good image is to analyze the scene. In the Zone System we want to observe the scene and determine the most important part. Look at the shadows to see if they contain information that needs to be captured or if they will not lend any significant importance to the image. Also, look at the highlights to analyze their importance to the final image.

In digital photography we need to do the same. Without analyzing the zones in the scene we do not know how our histogram should appear. If there is a dark area with limited highlights, your histogram will be heavy on the left with perhaps just a small amount on the right. Knowing that you need to place dark areas in Zone III to retain texture will let you know where these areas should appear in the histogram. Knowing that you need retain a value of Zone VII to keep full detail in the highlights will help you visualize the histogram on the right side. Analyze the scene and visualize the histogram the same way you do in the Zone System.

As with the Zone System you need to meter the most important parts of the image. A good spot meter will help evaluate the brightness levels of the scene. With digital technology and zoom lenses we can do a "spot" or "facial" histogram. *[Illustration 10 Control Image showing histogram of full image] 19, [Illustration 11 Image showing a "spot" or "facial" histogram] 19* You can zoom in on the most important part of the scene and see if it falls in the desired zone of the histogram.

Before you do this, establish the histogram zones and range of your camera. To do this photograph a gray card making sure the spike is in the middle. Do exposures at full stop intervals, plus and minus, and see where the spikes fall on your camera's histogram. This will establish histogram zones of your camera. *[Illustration 12 Zone VII on camera back] 20, [Illustration 13 Zone VI on camera back] 20, [Illustration 14 Zone V on camera back] 21, [Illustration 15 Zone IV on camera back] 21, [Illustration 16 Zone III on camera back] 22*

Since there are 256 brightness levels of a histogram, the camera's histogram from darkest, on the left, and lightest, on the right, divided by the five stop range of a digital image sensor, each full stop as represented on the camera will contain approximately 50 discrete brightness levels (256 / 5 = 51.2). You need to remember four or five points from the left (dark) and four or five points from the right (light) are too close to adequately capture any detail.

Once you know your camera's working zones and the division of units you can analyze the scene, as captured, with greater accuracy. *[Illustration 17 Five Zones as captured by the camera's five stop range] 22*

Development of film in the Zone System is very similar to "digital development" in Adobe Photoshop. Digital photography has brought us back to sheet film in that we can "develop" our images one at a time and "not the whole roll." As with film, development where

"N" is normal development, "N+" represents expansion development and "N-" represents contraction development, we have ways within digital production to do similar manipulation.

In Photoshop we use levels and curves to expand or contract our digital files. Knowing that 256 brightness levels of the histogram divided by eleven zones, as defined in the Zone System, renders 23.27 divisions per zone (256 / 11 = 23.27) will help us look at digital manipulation not just visually, but also scientifically. This is not to be confused with the camera's histogram, which has a five-stop range and fifty (51.2) brightness levels.

Unlike the Zone System where we affect the highlights or the darkest part of the negative, using levels we can alter the lightest areas (255), darkest areas (0) and even change the mid tones (128). Actually, Ansel Adams did find out that by subtly using selenium toner he could add almost a full stop of tonal range to the final print, producing richer dark tones that still hold shadow detail. By using curves in Photoshop we can make adjustments to any of the 256 divisions of brightness by clicking on a specific number and changing the curve. This change will be similar to changing the characteristic curve of film, in that the steeper the curve, the more contrast the image will have and the flatter the curve, the less contrast.

In levels or curves a change of adjustment in the amount of 23 units (23.27 rounded off to the closest whole number) will result in a one zone change. Remember that one zone is the equivalent of one stop. This gives us a numerical value equal to one stop of brightness. To get a N+1 or a N-1 change, we need to make an adjustment of 23 units. To get the equivalent of an N+2 or a N-2, two stops change, we need to make an adjustment of 46 units. *[Illustration 18 showing changes of zones with N+ development] 23, [Illustration 19 showing changes of zones with N- development] 24, [Illustration 20 showing Normal Development] 25, [Illustration 21*

showing N+1 digital development] 25, [Illustration 22 showing Normal Development] 26, [Illustration 23 showing N-1 digital development] 26

With film when we use a N+ development we over develop the negative while a N- development we under develop the negative. Deviation from normal development has an effect on the negative. Too much manipulation, N+ or N-, will cause a change in the grain of the film. In digital development the same is true. Too much manipulation can cause excessive noise or produce artifacts in our digital files.

Just looking at the image on a computer screen does not tell us how much control or change we have made. Today's mentality for some seems to be just "shoot it and fix it in Photoshop". This makes about the same amount of sense as "just shoot it and let the lab do the rest". By using a more scientific approach, we have more precise control of our images.

Conclusion

We see that we can learn from old proven systems to help us scientifically control our newer methods of capture. In both film and digital we need to know the facts and how they affect the outcome.

We learned in the Zone System to evaluate the scene, visualize the outcome and meter for the best desired results. We have learned how the proper development of a negative will produce the final image desired. The same methods apply to our digital capture. We need to know that the digital settings on our camera are like choosing the proper film for the job.

We visualize the scene and place the most important part in the proper digital zone of the histogram.

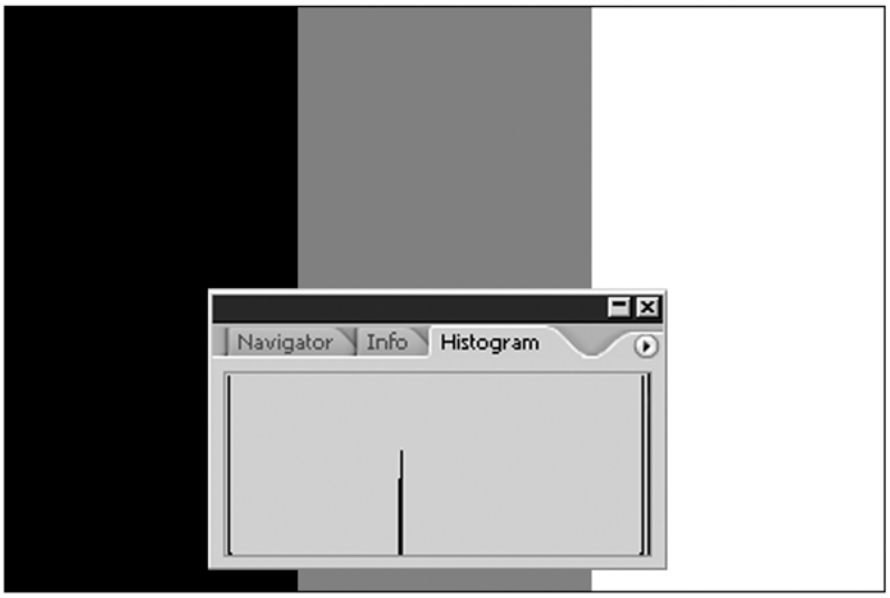
We have a scientific approach to digital development so we know how to adjust the zones to get the desired results.

Understanding methods created in the past, the Zone System, helps us comprehend and use the tools that we have now in today's photography.

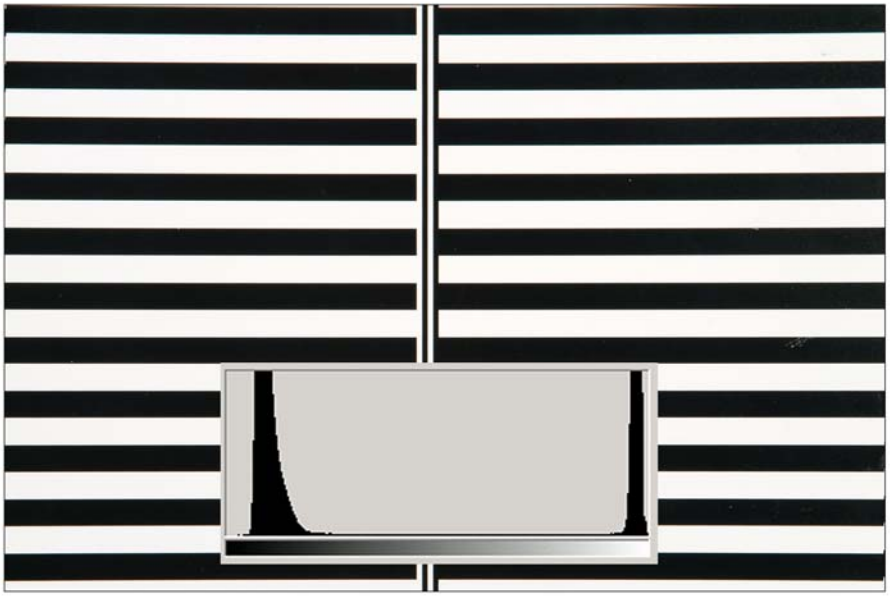
1. [Illustration of Eleven Zones]

X	Pure white: Light sources and specular highlights
IX	Slight tone without texture: glaring snow
VIII	Lightest tone with some texture: textured snow
VII	Very light skin: lightest tone showing full texture
VI	Average Caucasian skin, light stone
V	Middle gray 18% reflectivity, clear north sky
IV	Average dark foliage, landscape shadows
III	Dark shadow areas showing full texture
II	Gray - Black, darkest area sith some texture
I	Near black with slight tonality, no texture
0	Pure Black

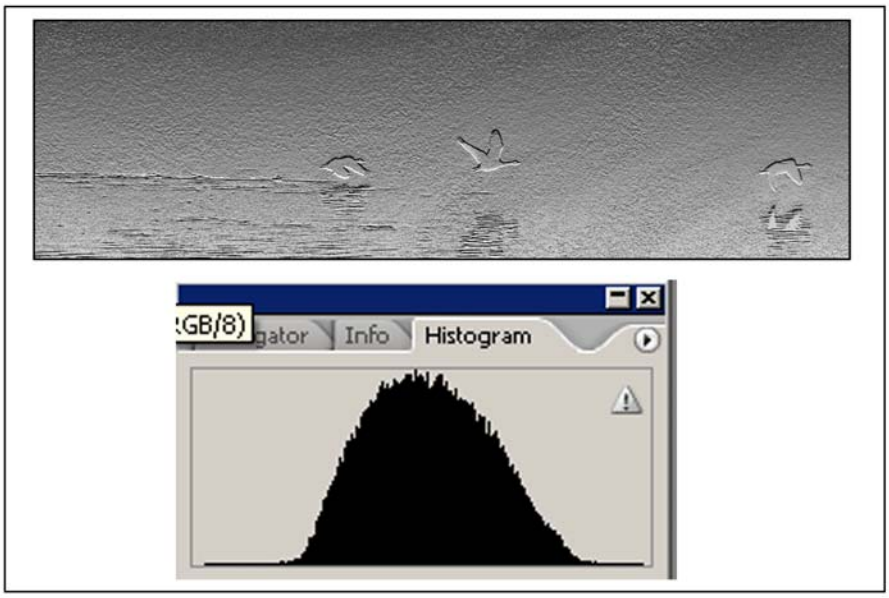
2. [Illustration of Eleven Zones described]



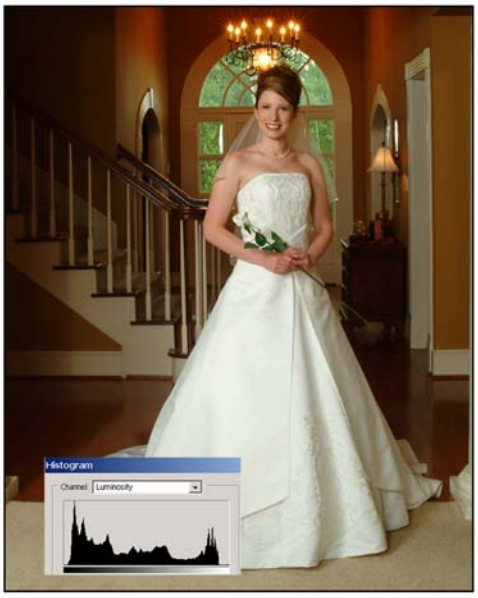
3. [Illustration of Black, White and Gray Exposure card showing Histogram]



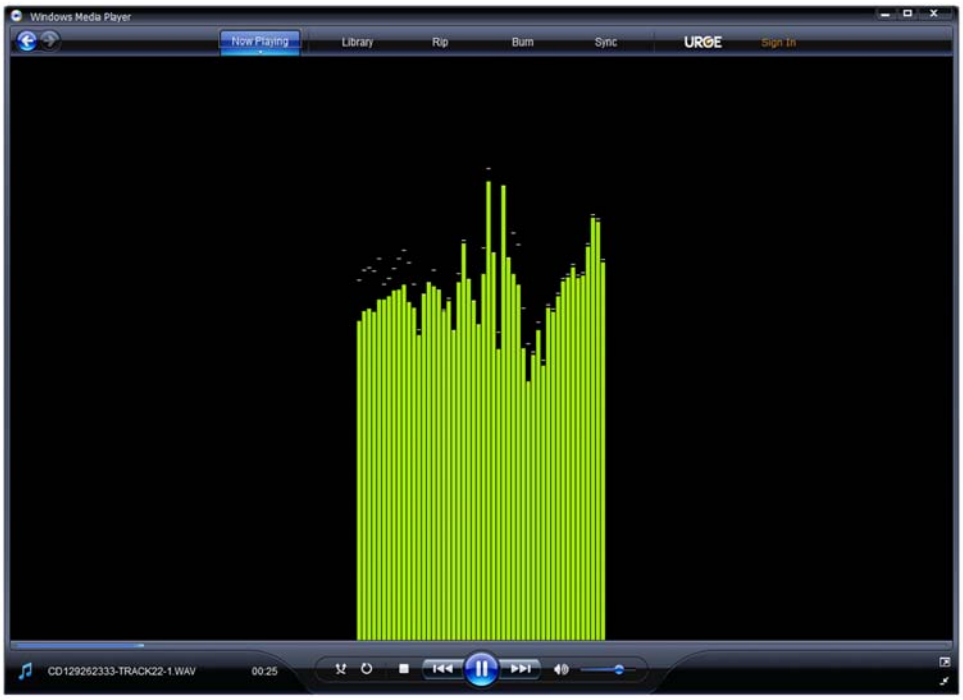
4. [Illustration of a Black and White Exposure Card showing Histogram]



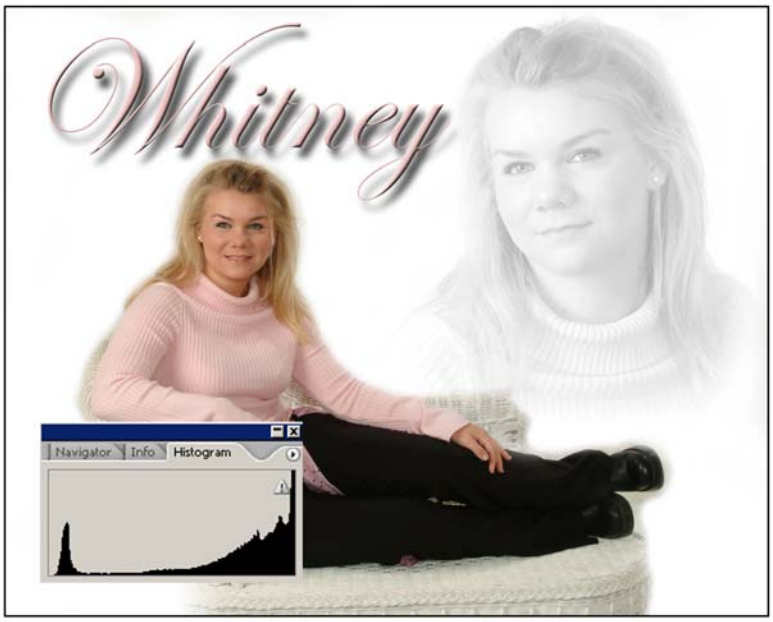
5. [Illustration of a Mid Tone Image with Histogram]



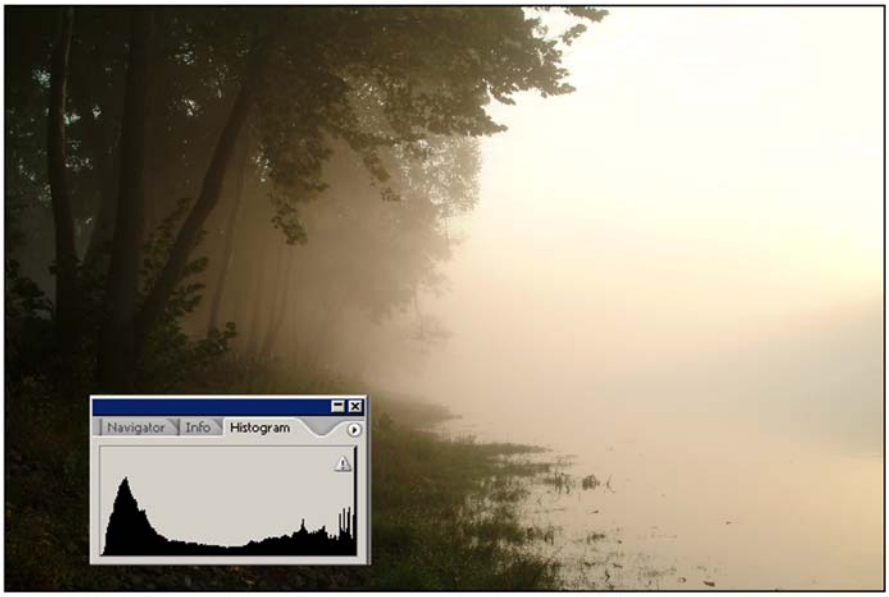
6. [Illustration of a Full Tone Image showing Histogram]



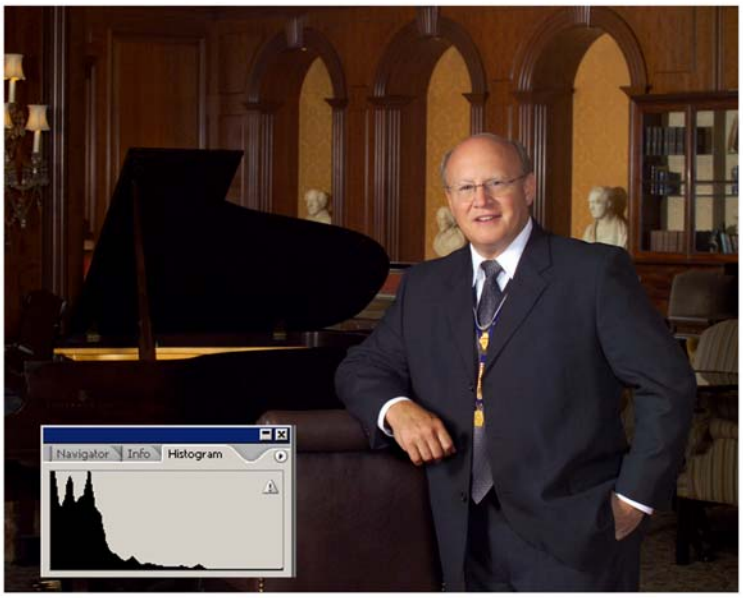
7. [Illustration of a Musical Histogram of a part of “Unforgettable” by Natalie and Nat Cole



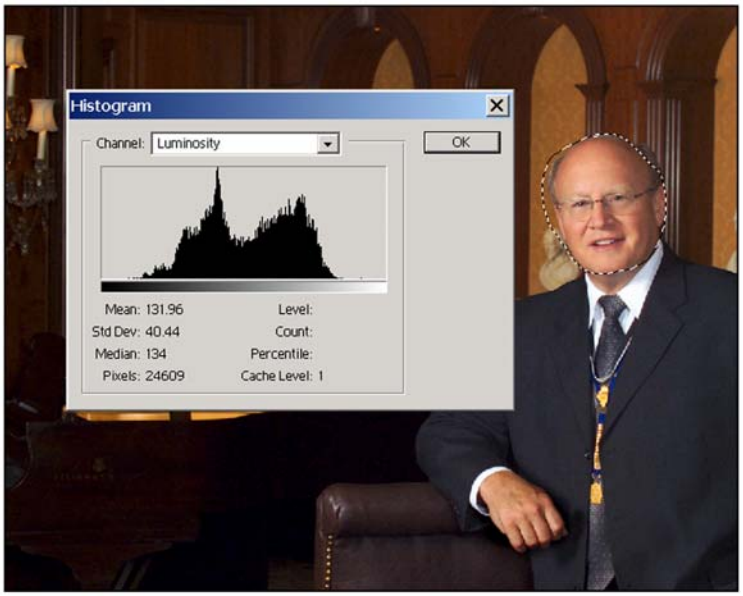
8. [Illustration of a High Key where the background has “Blown Highlights”]



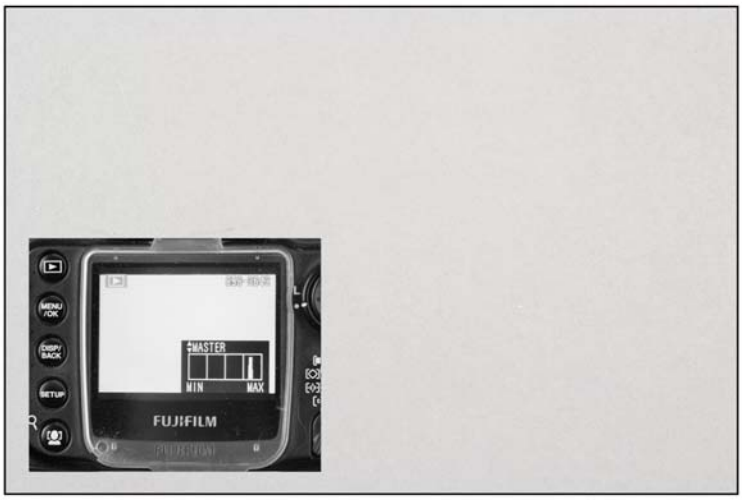
9. [Illustration of an early morning scenic that has “Blown Highlights” in the background]



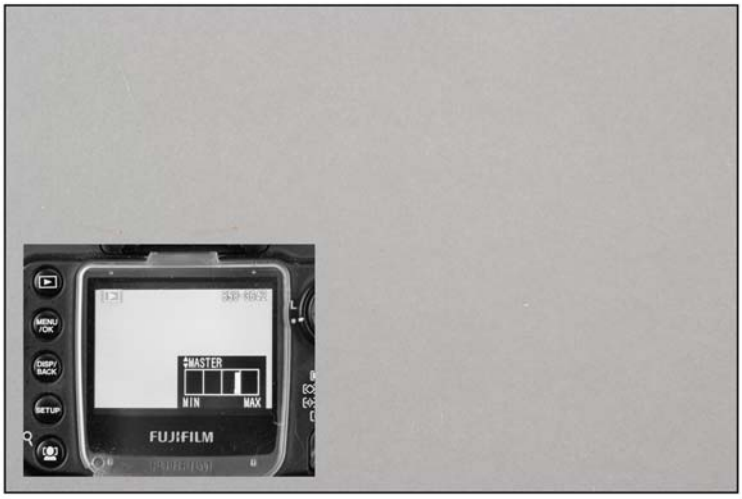
10. [Illustration of a Control Image showing Histogram of full Image]



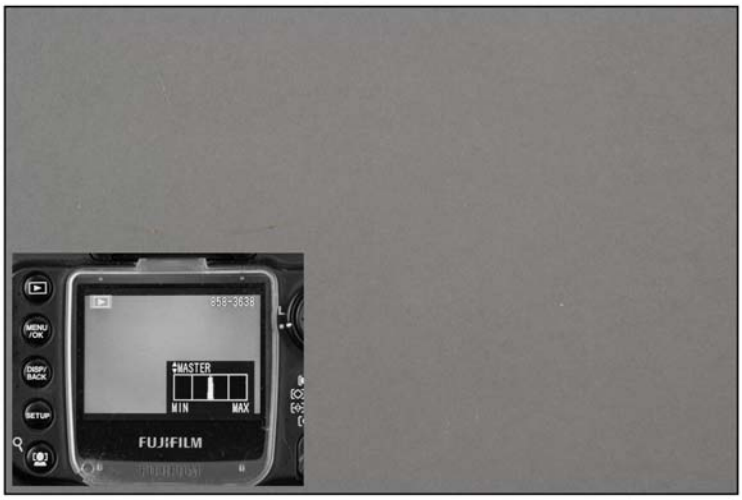
11. [Illustration of an Image showing a “Spot” of “Facial” Histogram]



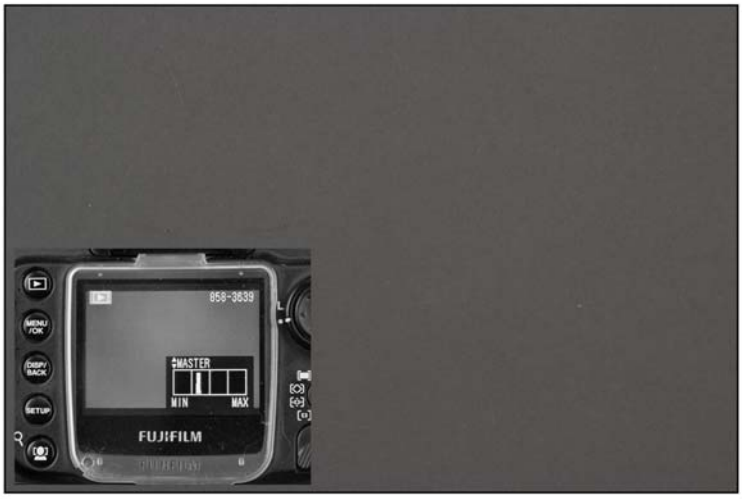
12. [Illustration showing Zone VII on the back of the camera]



13. [Illuatration showing Zone VI on the back of the camera]



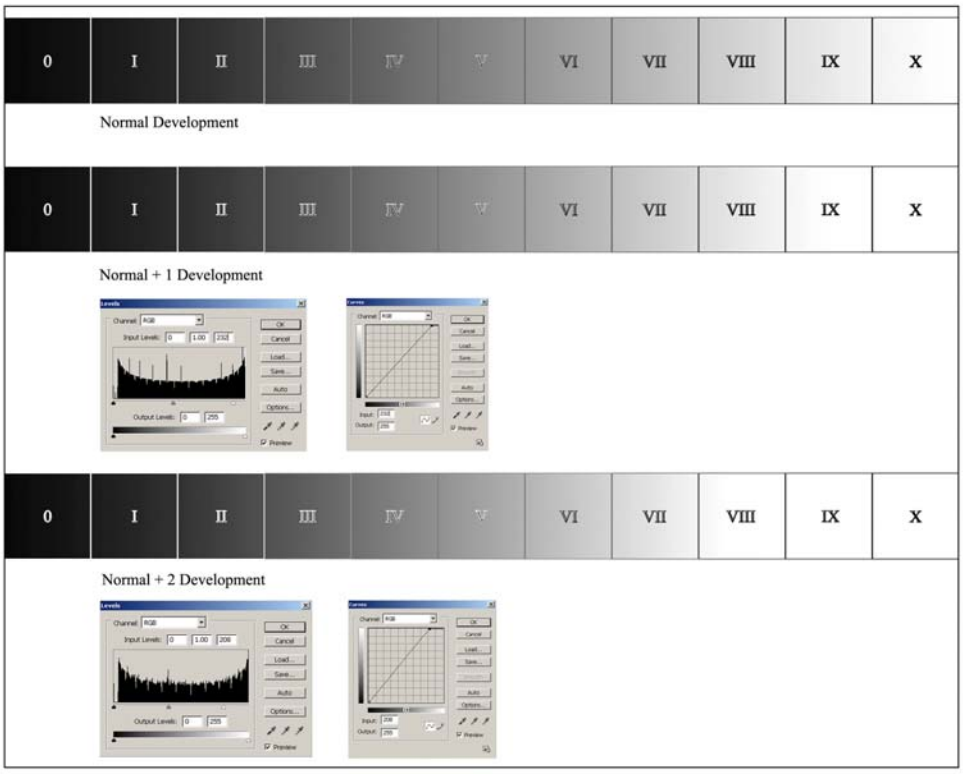
14. [Illustration showing Zone V on the back of the camrea]



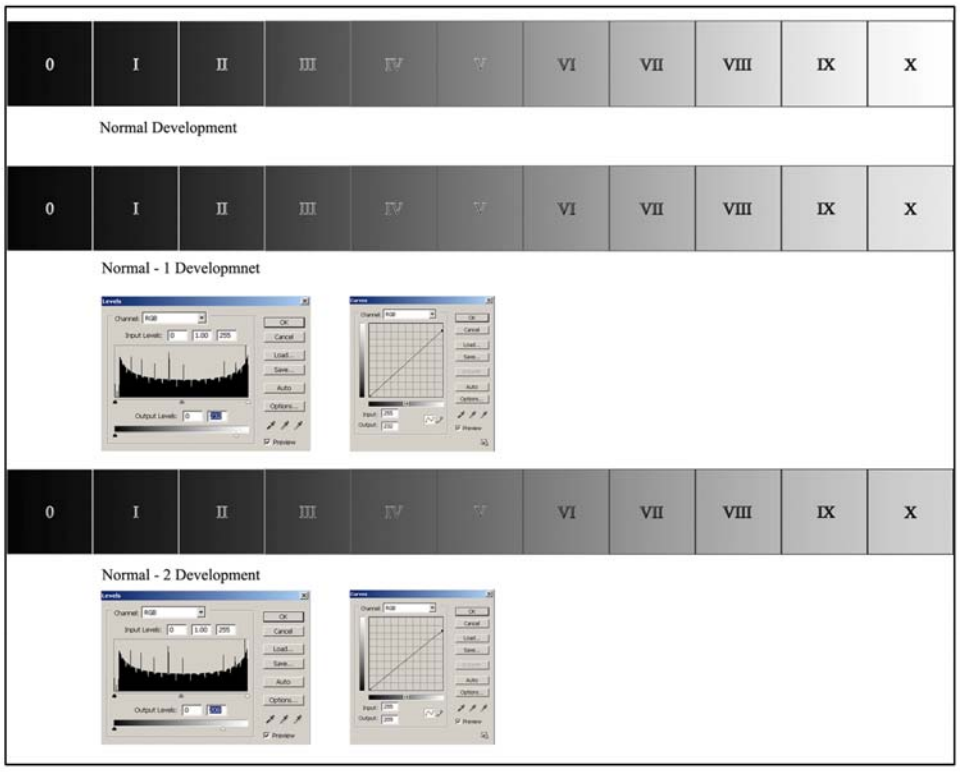
15. [Illustration showing Zone IV on the back of the camera]

16. [Illustration showing Zone III on the back of the camera]

17. [Illustration showing the Five Zones as captured by the camera's five stop range]

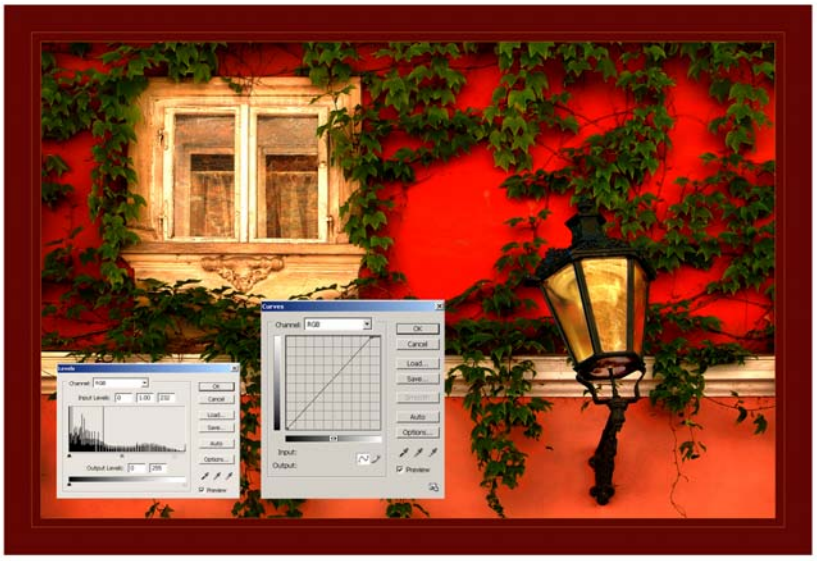


18. [Illustration showing changes of the Zones with N+ development]



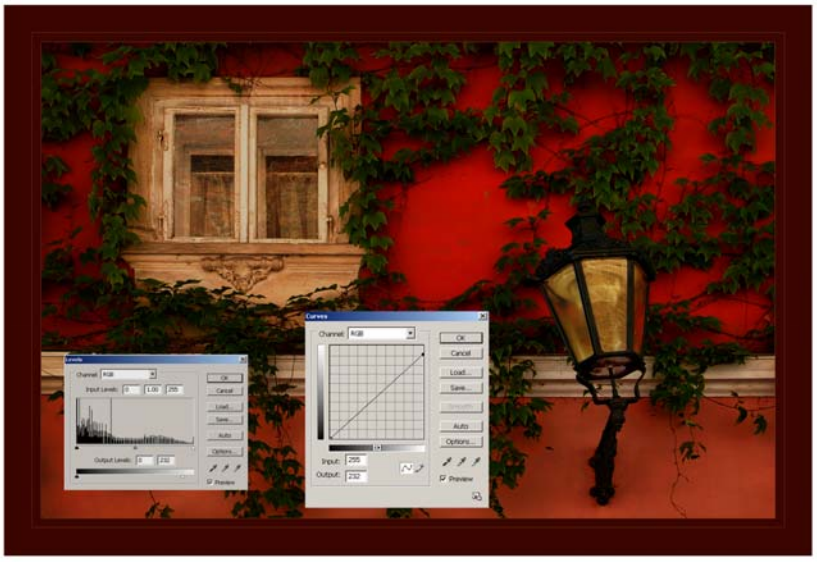
19. [Illustration showing changes of the Zones with a N- development]

20. [Illustration showing Normal Development]



21. [Illustration showing N+1 digital development]

22. [Illustration showing Normal Development]



23. [Illustration showing N-1 digital development]

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