The Photoshop High-bit Advantage: Fact or Fiction

By Jim Rich

What's the fuss about?

Some months ago, a challenge was made on the Applied Color Theory list by Dan Margulis to various subscribers who believe that you always need to work with sixteen-bit images in Photoshop to protect digital images from becoming degraded. In that discussion, Dan believes that is not necessary to always work with high-bit depth images and that working with eight-bit images will provide just as good results. Basically, the challenge consisted of Dan saying to certain high-bit depth advocates either put up or shut up, show me the difference between eight-bit and sixteen-bit images. His argument was so good, I took the time to create a test to either validate or nullify his tests.

High-Bit Images

The definition of a high-bit image technically relates to how 10, 12, 14 and16 bits-per-pixel images are handled in Photoshop. Often a scanner or digital camera will create only eight-bit images and import them into Photoshop. Those types of images are typically used in the eight-bit Photoshop mode. Scanners or digital cameras that can import images with higher bit depths into Photoshop, such as 10, 12, 14 bits-per-pixel and of course, 16 bits-per-pixel can only be used in the 16 bits-per-pixel mode in Photoshop. In the case where an image's bit depth is between 10 bits and 14 bits, this is not true 16 bits. However, an image above eight bits that is imported and used in a Photoshop session is considered to be in the 16-bit mode.

The Eight-bit Verses Sixteen-bit Argument and Photoshop

In theory, high-bit depth advocates make a good case. The assumption is that there are more bits (and therefore more image details) in each pixel of a sixteen-bit image. Sixteen-bit images are supposed to offer more flexibility during image editing. So when you apply image processing to a sixteen-bit image in Photoshop, you will have less quantization errors and therefore less potential banding and less overall image degradation.

Quantization is where mathematical errors take place because fractions are not used between whole numbers in a digital file. The whole number values that become fractions during image processing are re-calculated and then become whole numbers again.

In practice when you ask the high-bit advocates to show you hard evidence, that is, to compare the results of eight-bit prints to sixteen-bit prints with the same number of edits, they often provide a rational argument by reviewing an images histogram. They also might point out that quantization is taking place. And in some cases, ego takes over and a rational discussion often stops. Then childish behavior kicks in and a dispute of, “my technique is better than yours because I say so” ensues.

Key Eight-bit Image Benefits

One of the primary end-user benefits of using eight-bit images over sixteen-bit images is that Photoshop offers more tools and therefore has more capabilities for adjusting and manipulating images. The sixteen-bit mode offers a very limited set of Photoshop tools. Eight-bit files are also smaller and take up less disk space. Because more Photoshop options are available in the eight-bit mode, this makes the workflow more efficient.

Test Methodology

In December 2002 at a color management conference, I setup and ran a test comparing eight-bit and sixteen-bit RGB images. For this test I printed eight-bit and sixteen-bit images via Photoshop (with profiles) to my Epson 5500 printer. Photoshop was set up to for an RGB workflow. Nothing was done purposely to bias the test. Transparent and reflection images were scanned by various brands of scanners as eight-bit and high-bit images and then were converted into the Adobe 1998 working space.

The images used were at risk to posterize due to the combination of their image content and the extraordinary image processing that was applied. A majority of the images in the test had over 30 edits applied. A number of images were converted from RGB to LAB modes two or three times. Some of the tone edits involved over a 25% change in both RGB and LAB modes.

At the conference, I placed 28 Epson prints on a table and let a group of imaging experts (pre-press types and photographers) inspect and review

them. The test was not for color accuracy between prints. Participants were given a form with yes and no response categories.

Test Results

The initial feedback from the group of experts who did not choose to fill out the form but who took a few minutes to compare the images was that they could not precisely see any differences between the eight-bit or sixteen-bit-images. They all went on to say that any response they would have would be a guess. This result was verified again with the approximately 20 test forms that were filled out. The overall outcome showed all participants were guessing (40% to 60% of the time they were wrong) at which images were eight-bit or sixteen-bits.

Histograms Can Guide You But…

In theory, an image might have a bad looking histogram (with lots of gaps), making one believe that the image will posterize. In this test, all of the eight-bit histograms looked bad. However, the number of visible gaps in these histograms was not the defining factor, it was how the final prints looked in the final print. Any other problems, such as banding or image degradation related to too many image-processing edits, were indistinguishable. This indicates that the behind the scenes math applied in Photoshop is so sophisticated that quantization errors are very hard to see on final prints even after an extraordinary image-editing session.

Are More Than Eight-bits Necessary?

The test I have described and its results cover a majority of eight-bit images used in most RGB workflow situations. But, there are some exceptions. Some situations (though very few) require using sixteen-bit images in Photoshop.

One reason to work with sixteen-bit images in Photoshop is if your original image (film) has a harsh break or banding due to the way the image was originally photographed. Once the problematic image is scanned into the computer system, using sixteen-bits, the file will be processed with little degradation. If the same image processing is applied to an eight-bit image with this problem, the file will degrade and fall apart. Banding like this only shows up in a small percent (2 % or less) of images. The most practical

solution is to scan only those types of images as sixteen-bit. Then work in the sixteen-bit Photoshop mode as long as possible. The rest of the images (98%) can be worked in an eight-bit workflow.

Quality Image Capture Technology is Critical

What I have commented on so far is related to working in Photoshop. This bit-depth issue is sometimes confused with the technical details of a good scanner or digital camera that can deliver high quality images. It is well known that to obtain high quality images, a scanner or digital camera usually requires higher bit-depth options. Meaning that you often need more than eight-bits per pixel to be captured during the scan or capture phase. This input scanning or digital camera strategy allows the resulting file to achieve good shadow detail and maintain color saturation. It is very typical for a input device to capture over eight-bits per pixel and is a positive attribute to an imaging system. This can include high-bit scans sampled down to the best eight bits or high-bit scans that are imported directly into Photoshop.

The Sixteen-Bit Myth

Six or seven years ago poor implementation of scanning and digital camera technology caused lots of banding and posterization problems. One of the technical reasons for banding was poorly written scanner drivers. The problem typically was created by inadequate or incorrect math when the driver was developed and written. This problem influenced some experts to recommend working in sixteen-bits. At that time, it was probably the correct thing to do.

Times have changed. In the last few years, scanners and digital camera technology has matured. Photoshop image-process has been refined. This test, and many others, verifies that imaging technology has become more accurate. It also points out that high-bit workflows are seldom necessary for editing images in Photoshop.

Scanning and Image Capture Tips.

If you are skeptical because you are convinced that 16-bit images are the only way to work in Photoshop, consider these options for working in the eight-bit Photoshop mode.

• Use the scanner or digital camera to capture the best sixteen-bit data. Make a copy and work on that in the 8-bit mode. Use the 16-bit original as a backup.

• Work in the sixteen-bit image during the initial stages of your Photoshop working session. Apply tone adjustments, such as: highlight, midtone, and shadow and gray balance adjustments before converting to eight-bits. Technically this is where a lot of quantization takes place.

• Get a good scan. From an end-users perspective, the reality is, if you have a scanner that introduces banding with either eight-bit or sixteen-bit-images, fix the problem either by acquiring a better scanner driver or by getting a new scanner.

What about CMYK?

While this test focused on an RGB workflow, the information from this test is pertinent to CMYK workflows. I have 35 years of color imaging experience and have been creating color separations with Photoshop since 1989. In the last five years, I have not seen any problems related to the eight-bit and sixteen-bit issues such as posterization when applying a reasonable number of color edits to CMYK images. However, until I do a test like the one I have described, my advice is to work in RGB with eight-bit images as long as possible. Apply major tone edits with Levels or Curves before converting to CMYK. Then fine-tune the CMYK file if necessary.

The Bottom Line

Let me make this clear. The position I have taken on the eight-bit verses sixteen-bit argument is based on facts. It was the advocates of sixteen-bit images who did not back up their argument with hard evidence that peaked my interest to do this test. If I see that evidence I am willing to reconsider my position.

Since I have spoken about this test, I have met some high-bit end-users who will not believe a word of the results. My final comments to them is that the hard evidence indicates in most cases that you cannot see a difference between eight and sixteen-bit image prints. If you do see a difference, it is only a guess.