Intro to Digital Photography: Color Notes

*** Slide 3 We have seen this image before, the frequency response of the cones of the human eye and how we see green colors the best. The amount of colors that we see is defined as the color space, and on average people can differentiate about 10 million colors. The color space for digital cameras, however, we select. All digital cameras have, at minimum, JPG color space which is 8-bit color; there are 256 shades of red, 256 shades of green, and 256 shades of blue when combined creates a color space of 16.7 million possible colors. While this color space has more colors than we can see, it doesn't have all the colors that we can perceive. There are other color spaces available that are even larger: most RAW images from DSLRs are 12, 14, or 16 bit color; medium format cameras with large sensors have 24 or 32 bit color spaces. (Twelve bit color is 4096 shades of red, green, and blue each for a total of 68,719,476,736 possible colors.)

*** Slide 4 We see objects because they reflect light, if they didn't, then they would be invisible. We see color due to the fact that the object absorbs all but one color and reflects it. The red apple is red because it reflects red light, absorbing all other colors; the green leaf is green because it reflects green light, absorbing all other colors.

*** Slide 5 This can be downloaded from Wikipedia, and it represents 1,000,000 colors. It is a 1,000 pixels on each side, and each pixel is a different color. This represents roughly 1/10 of the possible colors that we can see. There was an article last year in Discover Magazine that mentioned that some people have a twist in their genetic makeup that allows them to see more colors than the average person. For example, say I had three paint chips where one was 100% red, the next on 99% red, and the third 98% red; the average person might not tell the difference between the 100% & 99% or the 99% and 98%, but they can tell the difference between the 100% & 98% because there is enough difference. The people with this genetic twist, however, can see the very subtile difference between the three; they live in a world of colors the average person can't see and have no way to describe these colors.

*** Slide 6 There are only three colors to white light: red, green, and blue. By mixing red, green, and blue you get different colors. These three colors are additive colors, for they add to make different colors. When you add red and blue, you get magenta; blue and green make cyan; and green and red make yellow. These colors are known as RGB (Red,

Green, Blue).

*** Slide 7 Subtractive color is ink on paper. It is also known as a four-color process for you use four color inks to make up the different colors on paper. The four ink colors are cyan, magenta, yellow, and black. These are known as subtractive colors (they are called subtractive for they absorb most light, reflecting back only their color). When you mix equal portions of the three colors of yellow, cyan, and magenta, you don't get black but a purplish-gray color; this is why black is added. These colors are known as CMYK (Cyan, Magenta, Yellow, Black).

*** Slide 8 When the RGB and CMYK color spaces are compared against each other, there are differences between they two. RGB colors tend to be brighter while CMYK are duller; there are sharper transitions with RGB while CMYK transitions are smeared out a bit. RGB, which is transmitted light, is brighter than CMYK, which is reflected.

*** Slide 9 HSB, or Hue, Saturation, and Brightness, are the three values that define color. You may see HSB as HSV (Hue, Saturation, Value) or HSL (Hue, Saturation, Lightness / Luminosity)--all are the same thing. Hue is the color: red, blue, green, brown, yellow, orange, gold, silver, cyan, turquoise, teal, sea foam green; it is a designation of the base color in degrees from red, which is 0. Saturation is the amount of color you have, from fully saturated (100%) to no saturation (0%); as saturation decreases, the color shifts more toward white to at 0% saturation it is white--the hue hasn't changed value, it is still whatever it was, but there is none of it at 0% saturation. Brightness (also known as luminosity, lightness, or value) varies the brightness of the color, from 100% to 0%, which is black.

The sphere image attempts to represent this color model in three dimensions, using L*a*b color space (Lightness, a, b). In L*a*b color space, a has the red to green colors while b has the blue to yellow colors, and L is the lightness. The dead center of the sphere is neutral gray, balanced between light and dark, red and green, blue and yellow.

*** Slide 10 Munsell Color Space. Color theory has been around since the time of Newton, who used a prism to split a beam of white light into the spectrum. Wikipedia has a very interesting page on color theory if you want to know more. Color, since it has three values (hue, saturation, and brightness) can be envisioned in three dimensions. In the late 1800s / early 1900s Munsell developed his color theory which envisions color in 3 dimensions. He used hue (pure

color: red, blue, green, etc.), brightness from 0 (pure black) to 10 (pure white) and then chroma (tint or shading of the pure color depending upon its position along the brightness axis).

*** Slide 11 Color space was not defined until 1931 by the International Commission on Illumination. The color space on the image is a representation of the visual perception of the human eye, and this was mathematically defined. Color space is the basis for digital photography, for it tells the camera--and the image editing software--how many colors are available for use.

*** Slide 12 The Prophoto color space is the largest color space at 32 bits. Developed by Kodak, it has colors that are mathematically defined but are otherwise invisible to the eye for they reside outside of the human visual perception. Prophoto is used by high end professional cameras whose prices begin around $20,000. It is also the color space used by high end photo quality inkjet printers that have 10+ ink colors. The Prophoto color space is very good in reproducing saturated reds, oranges, and yellows on these high end printers. And Prophoto is the native color space for Adobe Lightroom and Photoshop CS5+; your image might not be made in the Prophoto color space, but the Prophoto color space has all the colors available in AdobeRGB and sRGB.

*** Slide 13 AdobeRGB the the next largest color space and, depending upon the camera, can be 12, 14, or 16 bit color. You may see this on you camera menu as AdobeRGB(1998). AdobeRGB is one of the two color spaces that the majority of digital cameras have, and typically is accessed only if your camera can shoot in RAW mode. AdobeRGB covers most of the colors available to four color print, and it is the native color space for older versions (pre CS5) of Photoshop.

*** Slide 14 sRGB, or Standard RBG, is the default color space for every digital camera--they can all shoot JPEG / JPG images which have sRGB as their native color space. sRGB is 8 bit color, with a possible 16.7 million colors available; when compared to the other color spaces, however, it is small, which is one of it's nicknames, small RGB (some people call it shitty RGB). Being the native color space for JPEG / JPG images, you know that it can be faithfully shown on monitors, the vast majority of which are 8 bit RGB; you can buy monitors that have a larger color space, but they are expensive at around $3000 to $5000. sRGB color is inkjet printer friendly, you don't need a fancy photo inkjet printer to print out acceptable 4 x 6 or 5 x 7 prints on a low end inkjet printer in sRGB.

*** Slide 15 If given the choice, you should always set your camera to the largest color space available. For most high end point-and-shoots and DSLRs, this means you have to go off the program (or auto) mode to get access to AdobeRGB. Now, this being said, you also have to know where your destination for the image is going to be: is it going to be print or screen? If print, then you should shoot RAW with AdobeRGB color space. If it's going to the screen / Internet / email or small (less than 8 x 10 print) then you can use JPEG / JPG color space. The nice thing about JPEG / JPG images off the camera is that they have already been processed to some extent; there has been some saturation adjustment, some sharpening, and contrast adjustment. If you were to compare the same image in JPEG / JPG and RAW side by side, most people would like the JPEG / JPG simply because it has been processed. RAW images need to be tweaked, which is what image editors like Adobe Photoshop / Photoshop Elements / Lightroom and Apple Aperture are for.

*** Slide 16 Color has a temperature, and it is backwards from how you'd think it would go. Color temperature is measured in degrees Kelvin, and blue colors have a higher K temperature than red colors. Remember that we identify reds with warm and blues with cool? Well, to the camera this is exactly opposite. Think of someone blacksmithing. The iron to work is heated, and it slowly turns from red to orange to yellow to white as it heats up.

*** Slide 17 Everyday items can be measured by this Kelvin temperature. Candlelight and firelight are around 1900-2000 K. Sunrise / sunsets are about 3100-3200 K. Midday is at 5500 K. Most camera flashes are around 5900-6000 K. Calibrated monitors and LCD screens have a white point of 6500 K. Overcast sky is 7000 K. Clear skylight in open shade, or snow, come in at 12,000 K.

*** Slide 18 A preview of white balance, which should more accurately be called color balance, for what the camera is measuring is the color temperature of the light. If you shoot RAW and your white balance is off, then changing it in Adobe Camera Raw is just a matter of moving a slider. Is the image too yellow? Add blue. Too blue? Add yellow. Remember that JPEG / JPG images are processed? The white balance is encoded into the image, so if it was off in the camera, then you can't correct it in the image without some photo editing in an image editor to remove the color cast. So besides having a larger color space available for RAW images, you have the ability to correct for white balance gone bad.