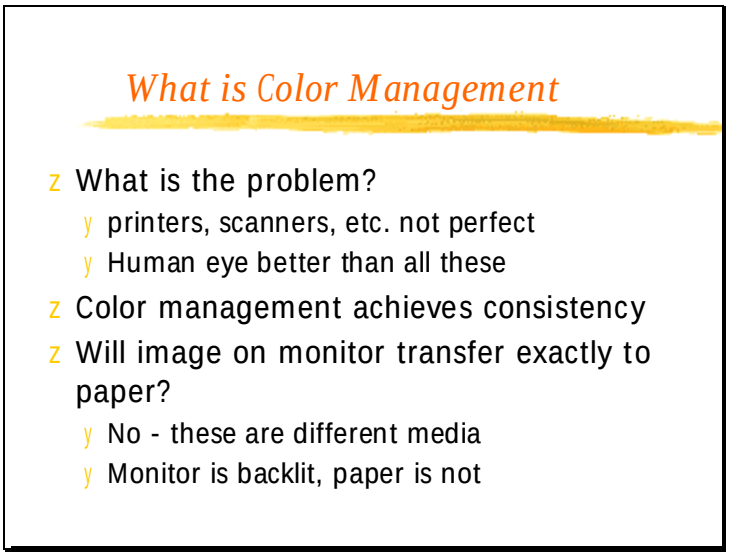
Slide 1

Color management is the process of achieving consistency when transferring images from capture devices, such as cameras, scanners, etc. to display and print devices, such as computer monitors and printers.

The operative word here is **consistency**, not perfection.

Color management does not make the process of capturing an image and printing that image perfect, but it can make it consistent from image to image.

Slide 2



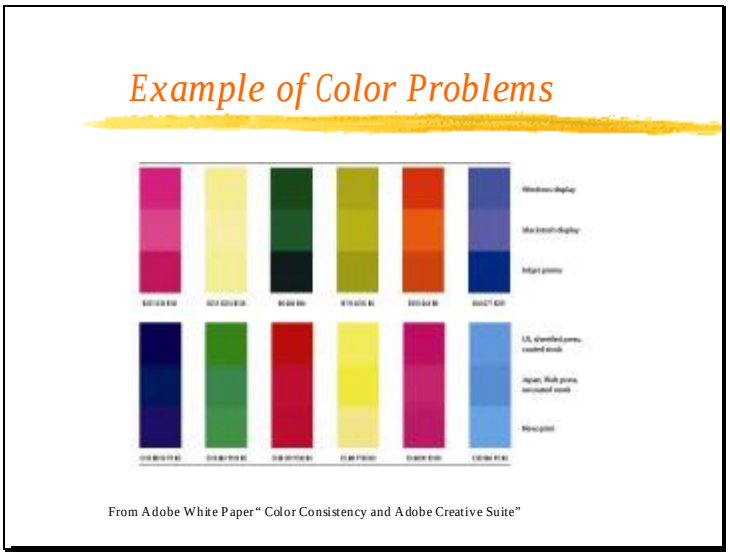
There are really two problems. The first problem is that each physical device, or combination of device and media (e.g. printer and paper type) can display a slightly different part of the color spectrum. This will be shown graphically later.

The second problem is that the colors are represented by a number inside the computer, since computers represent everything as numbers, and each device will produce a slightly different color when sent the same number. Ideally, we could calibrate all the devices to produce exactly the same color when sent the same number, and the devices would not change over time, but life is not as simple as that.

Also, our eyes can see a much larger part of the color spectrum than any device can capture or display.

The human eye will perceive images differently, depending upon the source of the image, and of course, the range of the color spectrum that is present in the image. For example backlit images, such as those displayed on a computer monitor, will be perceived differently than those displayed on paper.

Slide 3

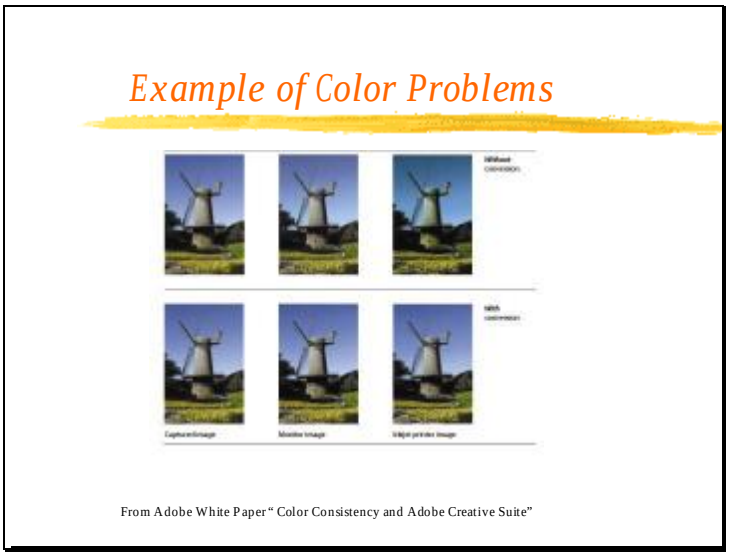


This image shows how a set of colors are displayed differently on different displays and printers.

Why is there such a discrepancy? The number for the color (see this just below each color patch) sent to each device instructs the device on how much colorant to use. With printers, the number tells the printer how much cyan, magenta, yellow and black ink to put on the paper. With displays, RGB numbers tell the display to fire electron beams of a given strength for the red, green and blue electron guns in the case of a CRT or the strength of the red, green, and blue filtration in the case of an LCD monitor (flat screen).

Theoretically, we could calibrate all devices to produce exactly the same color for each number. With literally hundreds of manufacturers and millions of devices, this is not practical. Instead, we use Color Management.

Slide 4



What does Color Management do? It defines how each color is "translated" into the number for each device so that the color will be perceived as being the same by the human eye.

How does Color Management accomplish this? It uses data files, called profiles, and software, called a color management module, which is built in to Photoshop and other image editing software, to perform the translation. Some printers have a color management module, but photoshop does a better job.

Example: Suppose a person from Chicago plans to speak to two groups of people. She plans to start by saying "I would like to address all of you". When she speaks to the group from New Jersey, she says "I would like to speak to all you guys", and when she speaks to the group from Texas, she says "I would like to speak to all ya'll". How did she know to use the two terms? She had a "profile" that said in New Jersey, "all of you" translates to "all you guys" and in Texas "all of you" translates to "all ya'll".

If we have the correct profiles, we can translate colors to be consistent across different devices.

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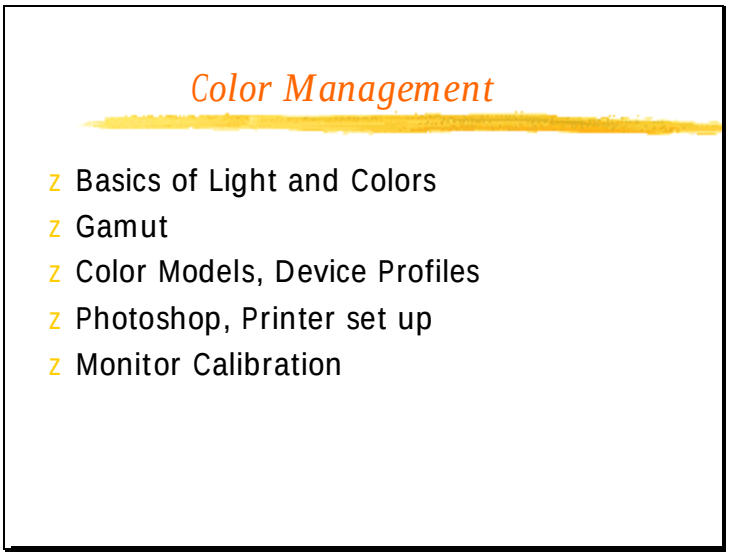


Let's drop back and discuss some fundamentals of light.

Gamut, which rhymes with Dammit, and that is how you will feel about this until you understand the ideas, describes how much of the spectrum of light that a particular device can handle. That is, how many colors a camera or scanner can record or how many colors can be printed on paper. Gamut does not address the intensity of the light, as would be measured by a light meter, only the color.

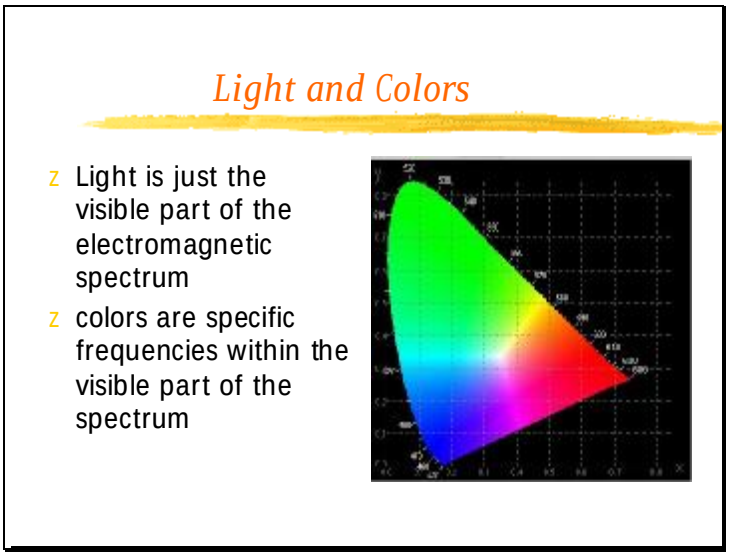
Gamut is not the same as Gamma. Gamma is a measure of the linearity of a device not its color reproduction ability.

A Color model describe the Gamut of devices. We can also select different color models inside Photoshop.

Device profiles describe how to translate from one Gamut to another.

We will discuss how to set up Photoshop and printers, and a little bit on how to calibrate your computer display.

Slide 6



What is light? Light is energy traveling as electromagnetic waves and the waves have a frequency. Sound has frequency, thus we can talk in a low frequency, or a high frequency, and we call this the pitch of the sound.

In light, the low frequency waves are perceived as red, and the high frequency waves are perceived as blue. This frequency is sometimes expressed as the wavelength of the light, wherein a longer wavelength occurs with a lower frequency. Thus, red has a wavelength of nearly 700 nanometers, and blue has a wavelength of about 400 nanometers.

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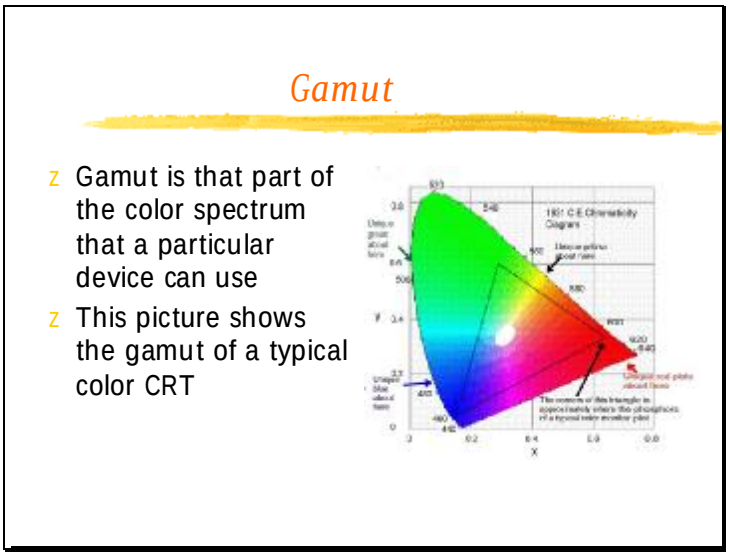

Every device, such as a camera, film scanner, printer, etc. can reproduce only a part of the color spectrum. Thus far, no one has created a device that can capture or reproduce the entire color spectrum.

As you can see here, the gamut of a typical CRT computer monitor is much smaller than the entire spectrum. The gamuts of most cameras and printers are similar, but not exactly the same, as a CRT.

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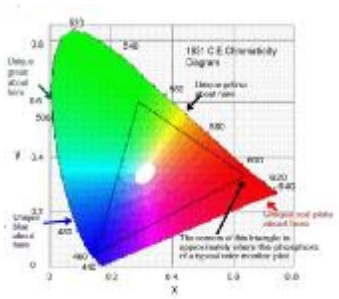
Color Models, Profiles

- Color models each represent a particular gamut
- This picture also shows the gamut of the sRGB color model



sRGB is one of the more common color models. Most digital cameras use this color model.

sRGB was designed to be the same as the gamut of a CRT.

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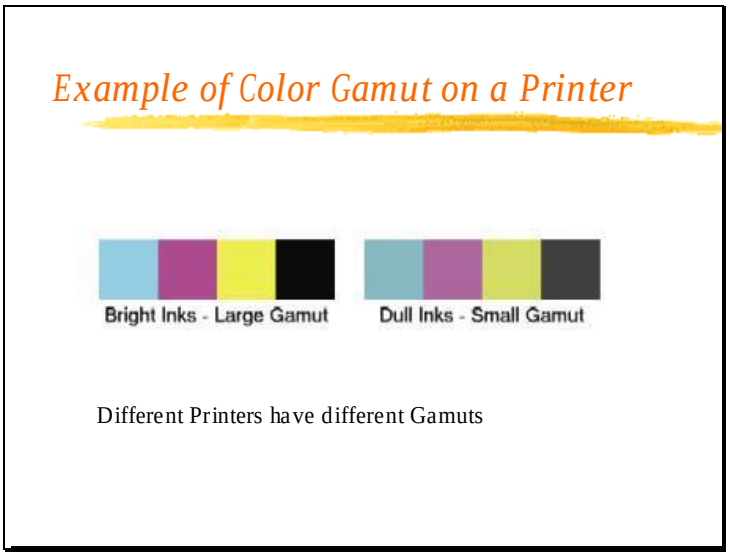

This shows how two different printers might reproduce several colors.

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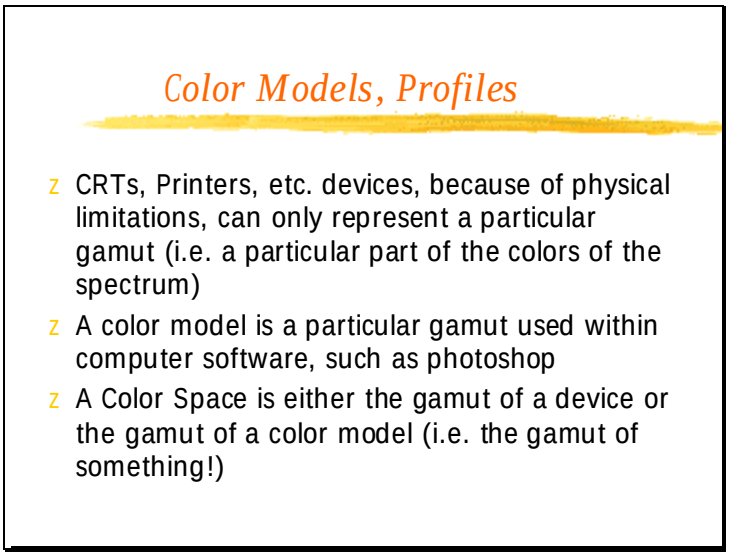

The terminology used here is not as consistent as I would like to see in the literature about this subject. As you read articles and books, you will see these terms used differently by different authors.

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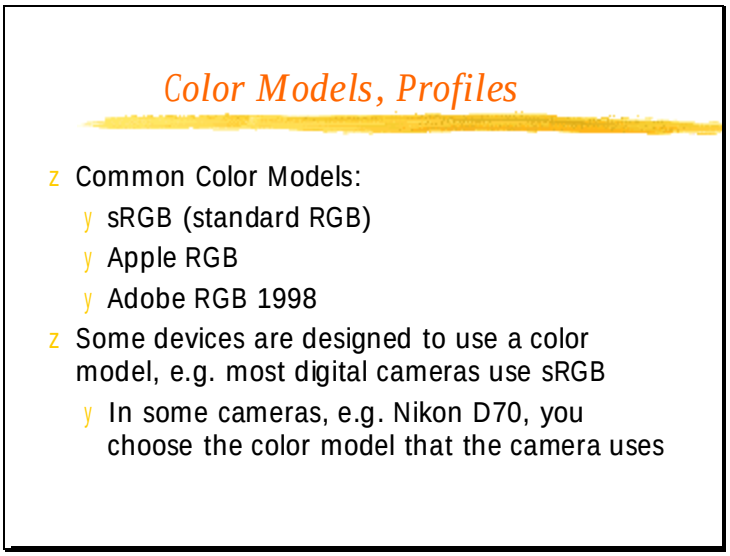

sRGB was developed to match a CRT computer monitor.

Adobe RGB was developed by Adobe to be broader than either sRGB or the CMYK gamut used with printers.

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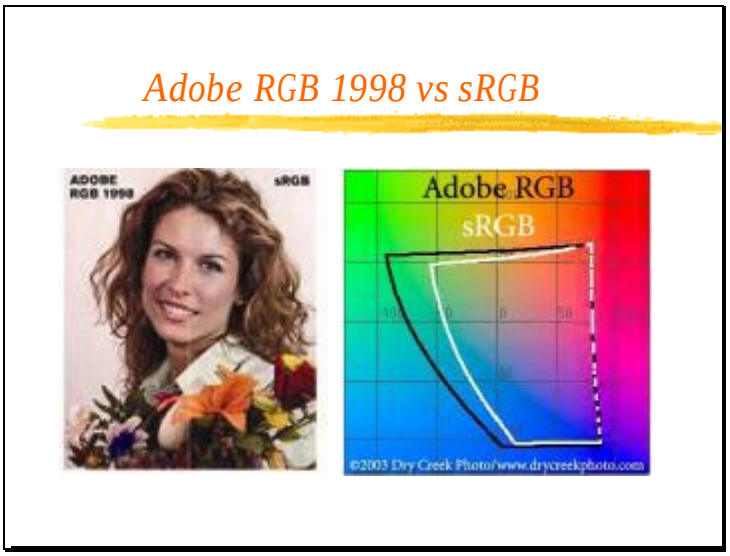

Notice that the Adobe RGB gamut is larger than the sRGB gamut. It would seem that we should always use the Adobe RGB gamut if it is available. Not so fast! According to an article in the latest Outdoor Photographer, sRGB would appear to be the best for most people.

Also, both these seem to display the same range of reds in the spectrum, so I question how accurate this picture represents these two gamuts. The model's face seems to have more red in Adobe RGB, but the two gamuts shown would seem to me to display red essentially the same.

This picture came from a Popular Photography article in which the author said these represented the two color models on a Canon EOS 1Ds in which the sRGB had less red than the Adobe RGB model, so those models may not be accurately represented by the chart shown on the right.

The point is that these gamuts are different, not that one is better than the other. We will see some other reasons later as to why they are just different.

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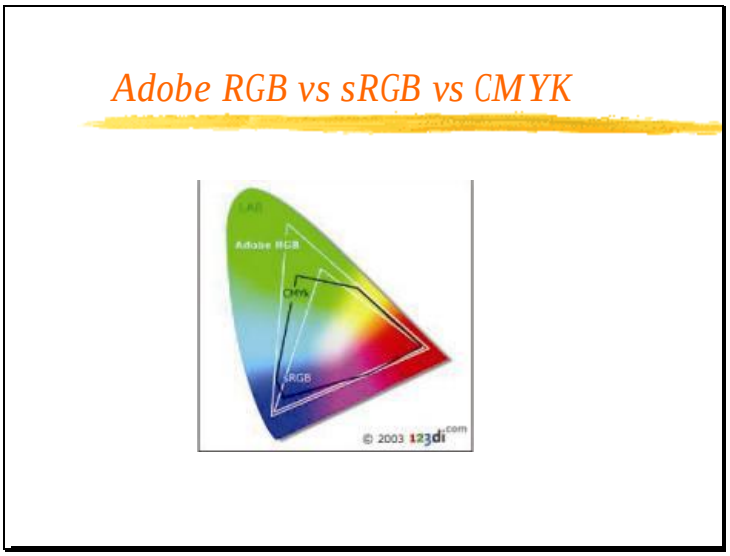

This diagram is from a DP Review article on color space. It shows how Adobe RGB, sRGB and CMYK match up. As you can see, Adobe RGB has a larger gamut than sRGB and CMYK. This can cause problems when a color has to be translated and the color does not exist in the receiving gamut. We will discuss this more later.

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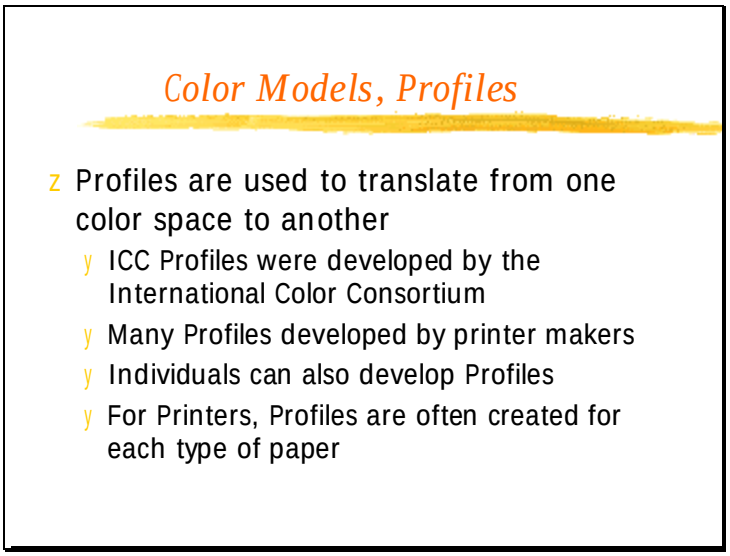

What is a profile? It is a method of translating from one model to another. Actually, the method of translation is well defined. The profile only contains the data that the method uses to perform the translation.
For example if a certain hue of red in sRGB is 255(R), 10(G), 10(B) and that same hue of red in Adobe RGB is 250(R), 15(G), 12(B), then the profile to translate this color from sRGB to Adobe RGB might be -5, -5, -2 and the method would merely add the profile data to the sRGB data to get the Adobe RGB data.
Someone has to develop these profiles. The International Color Consortium developed the profile concept and has also developed some profiles. Most, however, are developed by the manufacturers of the devices. For example, I downloaded the profiles for my Epson printer from Epson. Photoshop and Photoshop Elements contain the profiles for translating from Adobe RGB to and from sRGB.
There is software available to help you develop your own profiles, if you desire.
There are usually many profiles for each printer, at least one for each type of paper that the printer can use. For example, I found three different profiles for the Epson 2200 printer for Premium Glossy paper.

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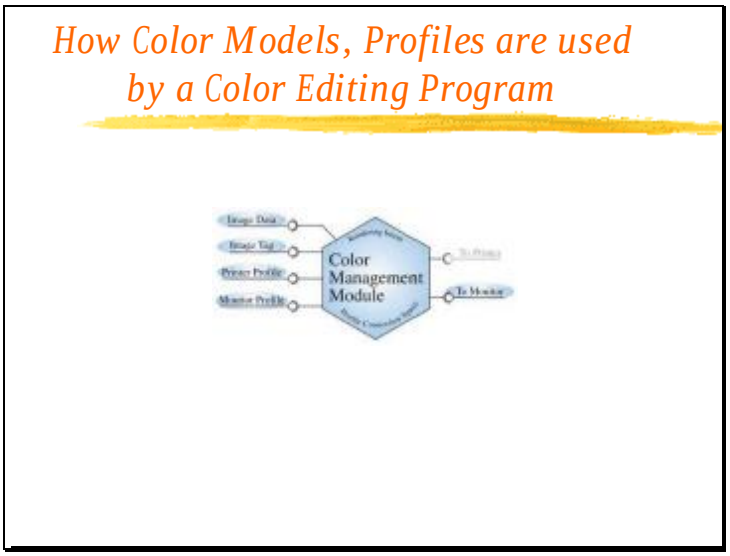

This diagram shows how profiles and the software work together. Protoshop would ask the color management module to translate an image into the color model of a display or printer. The color management module would get the display or printer profile, read the image data, translate the image data using the profile, and display the image on the device.

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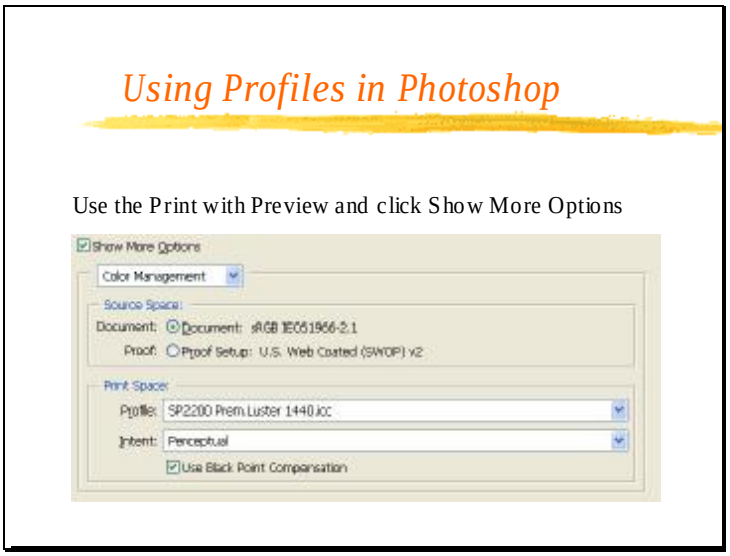

How do you use these profiles in Photoshop? You start printing the image using the print with preview option and on the Preview print screen, you click the show more options box. Once you click the show more options box, the Color Management area is displayed.

Select Color Management from the drop-down list and the other two areas will be displayed.

The Source space is usually defined by the image you have already displayed, for example, this image was captured in the sRGB model. The other numbers after the sRGB indicate a refinement of the sRGB space, which you may or may not have.

The Print Space is where you set the profile that will be used to translate the image to the printer color model. In this example, I am using the Premium Luster paper and the Epson 2200 printer profile. There are generic profiles for various types of papers and printers, but for best results use a profile the is specific to the paper type and printer type you are using.

We will discuss the Perceptual Intent and Black Point Compensation later.

This completes the setup in Photoshop.

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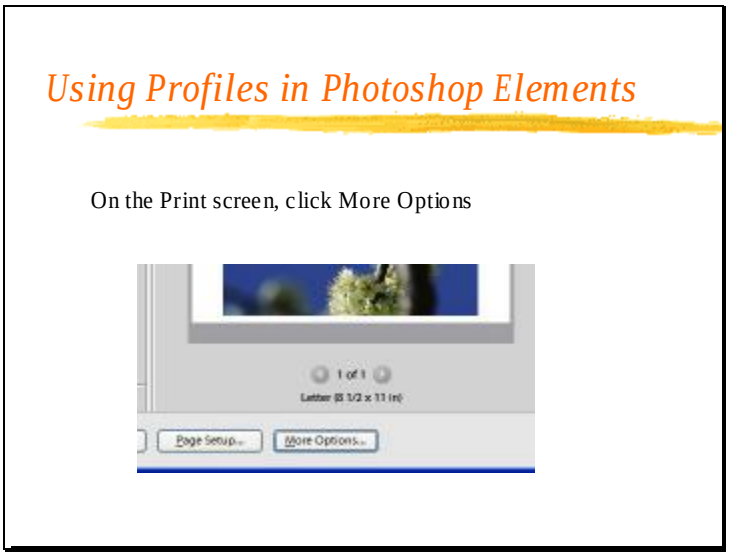

Photoshop Elements is essentially the same, but the screens look different.
Elements 3 always prints using the print with preview option and on the Preview print screen, you click the more options button.

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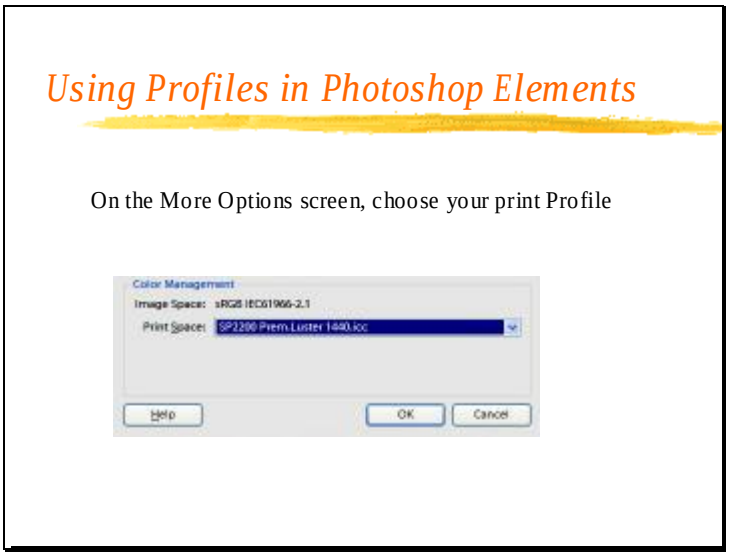

Once you click the more options button, the Color Management area is displayed.
In Elements, the Source space is defined by the image you have already displayed, for example, this image was captured in the sRGB model.
The Print Space is used to set the profile that will be used to translate the image to the printer color model. Again, I am using the Premium Luster paper and the Epson 2200 printer profile.
This completes the setup in Photoshop Elements 3.

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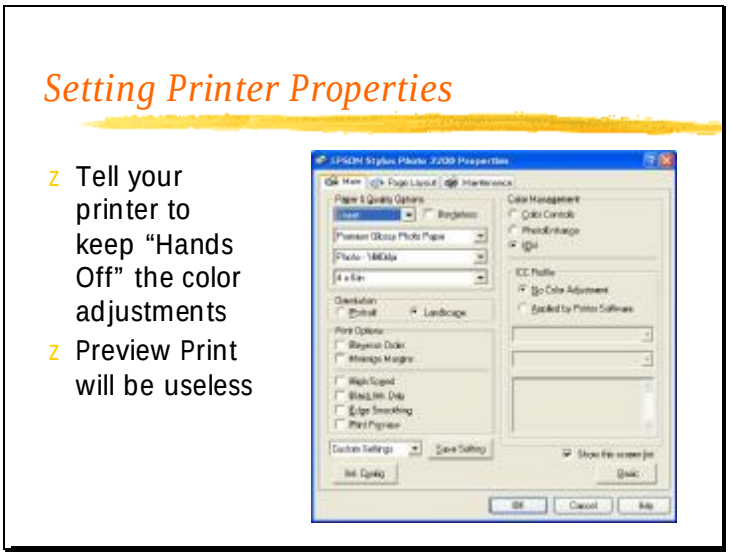

Since Photoshop or Photoshop Elements is performing the translation using the profile, you need to tell the printer not to perform its own translation, otherwise, the result will be a disaster!

To get to this screen, you need to click Page Setup, then click printer to show the printer screen, and then click the Properties button to show this screen.

Once this screen is displayed, set the paper type and size, and click the ICM button and the No Color Adjustment button

Since the translation occurs before your image reaches the printer, the print preview will not work, and instead, you will see an image that is very off color. Once the image is printed, however, the color will be correct.

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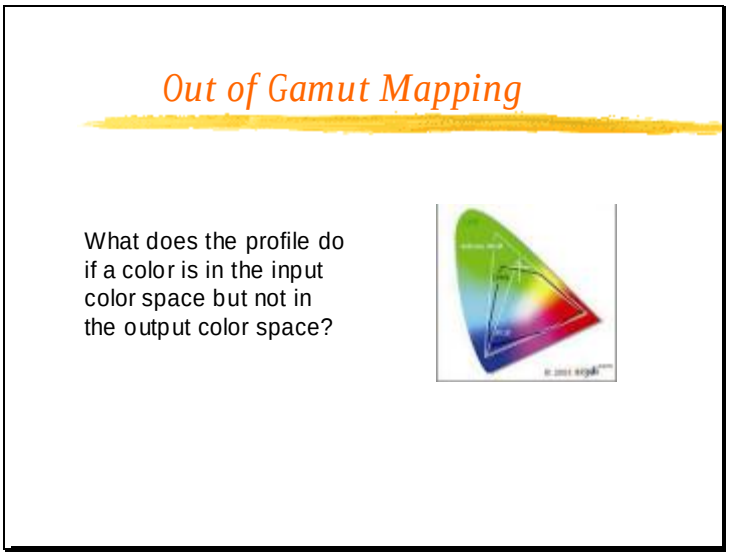

Profiles work to translate colors from one gamut to another, if the colors are in both gamuts. What happens to colors that are not in the target gamut, for example, if you are translating this point from Adobe RGB or sRGB into CMYK for the printer?
This is where the Perceptual Intent comes into play.

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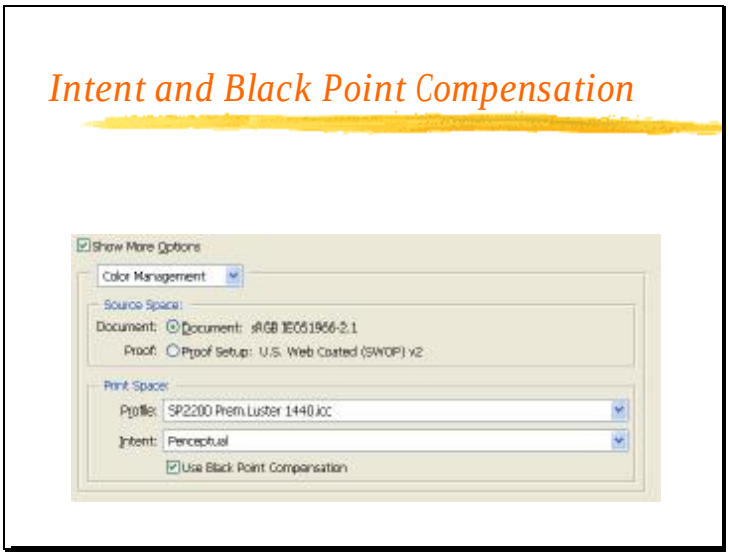

When a color is not present in the target gamut, the Intent selection determines how the color will be translated. Perceptual Intent causes the color to be translated to the closest color present in the target gamut.

There are other intents, but Perceptual is the best to use.

Black Point Compensation scales the dynamic range of the image to fit the dynamic range of the printer/paper. Leave it on, otherwise some colors may be clipped when printed.

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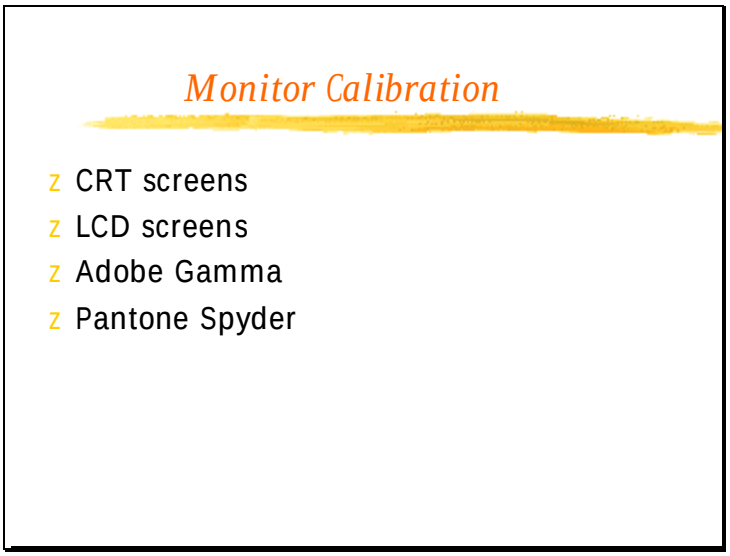
Setting color space in Photoshop

Slide 23

Setting color space in PS Elements

Slide 24



There are several ways to calibrate your monitor so that it reproduces the colors of the color model you choose. Since sRGB was developed for color monitors, your monitor should be calibrated for this model.
The Adobe gamma program, which comes with photoshop, can be used, but it is not very accurate.
The best device is the pantone Spyder, which you can purchase for a tidy sum at Fry's.
My experience with LCD monitors is that they do not need to be calibrated.

Using Color Management

- Calibrate your monitor
- Select a desired Color Space for the input device (i.e. camera, scanner, etc.)
- Select a desired Color Model within Photoshop or Elements
- Select a Color Profile to map the color space from Photoshop, or Elements, to your Printer and specific paper
- Set the printer to “Hands Off”