The Digital Coach™

Easy-to-understand training in Digital Imaging & Color Management

Getting the Most From Your Printer,Tutorial.

I am sure if you are using a color managed workflow you are getting some nice prints. But are you getting all you can from your printer? Do you know your printers dynamic range? How does it compare to the dynamic range of your monitor? What is the dynamic range of your monitor? How does your monitor profile compare to your printers profile? What is the best ink coverage setup? Can you print all that you see on your monitor? Do 3rd party inks give you better results? Is 3rd party paper any better?

What about my scanner? What is it really capable of? How can I test all these things without spending a fortune? Isn't a custom profile of my printer enough to give me the best result?

Throughout my life I have always had great success by knowing how something is supposed to work, then being able to determine how it is working, which leads to a path to improve how it does work.I have enjoyed a reputation as a "better idea man."

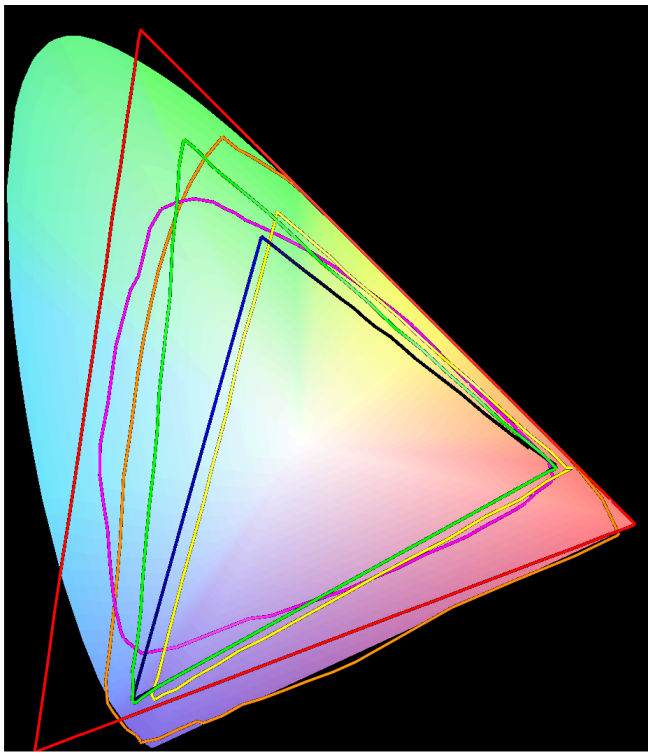
When I began teaching seminars on digital imaging back in 1990, I did so after attending several that turned out to be an exhibition of what the presenter knew how to do. The attendee did not really learn anything. So I thought there must be a better way. That led to breaking down digital imaging into how it was supposed to work and why, then reducing the mystery to what the attendees already knew and how to expand on that. That is my goal with my tutorials as well.

In order to get the maximum results from our printer we need several things. We need to get all the quality possible from the printer. We need to have a monitor than allows us to see exactly what the info in the digital file looks like.

I like to test all of my devices and know what each is capable of. So, isn't a custom ICC profile all I need in order to know what my printer can do?

Before we begin testing the printer we need to take a step back and make sure we understand a few things about color management. Specifically color spaces. Each device has it's own capabilities. Starting with the human eye lets look at the color space each is capable of.

Here is a 2 dimensional representation of the different devices.



In this representation, the multicolored inverted horseshoe represents what the human eye can see. The large red triangle is the Pro Photo Working space. The Green triangle is the Adobe 1998 working space and the Dark Blue triangle is the sRGB working space. The working spaces are used in Photoshop to determine how much area to spread out our image data into. In order to know which space is best for us we need to look further at

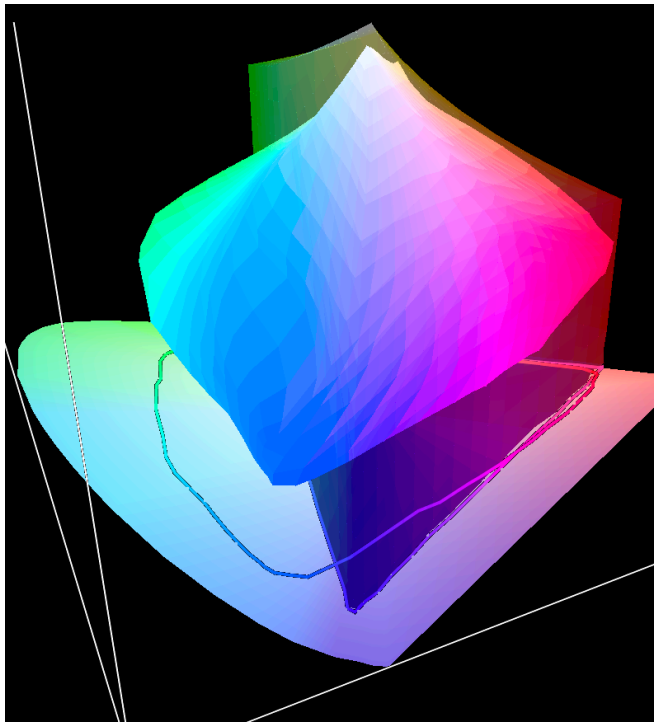
the capability of our scanner, printer and monitor to find the best fit. The orange line is what a Hasselblad X5 & Imacon 949 scanner can capture. The Yellow triangle is what my iMac monitor can see. Some high end Monitors designed for graphics can see close to the complete Adobe 1998 color space. The irregular magenta shape is what an Epson R3000 printer can print on glossy paper. The different paper types will have a different colorspace. Matte paper is a smaller area then glossy.

Looking at a monitor and working space combination that best matches up to the printer, it would be Adobe 1998 colorspace and a monitor that can cover that working space.

sRGB working space would compress our image data too much and we would lose the more vivid colors. However, for web publishing it would be the proper choice.

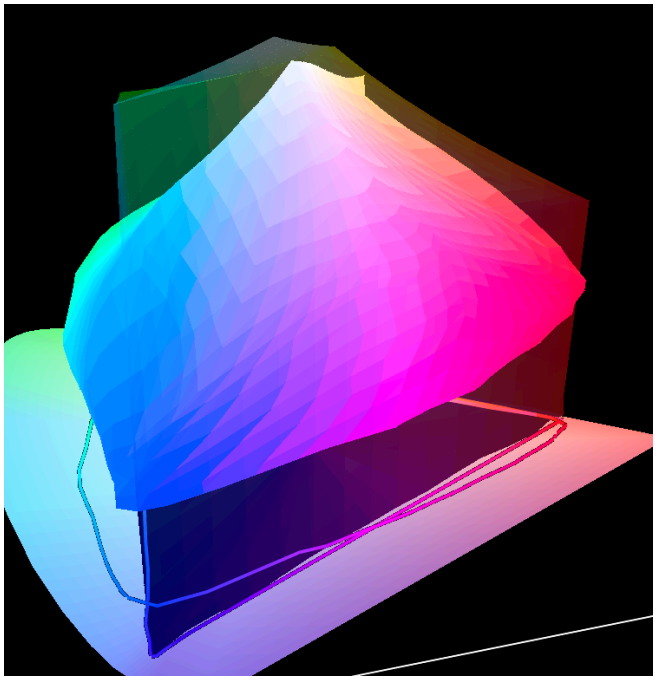
Some users might say, isn't Pro Photo better? Maybe as an achieve space, but it would hold a lot of data that can't be seen on printed.

Here is a 3 dimensional display of the printer and the iMac display.



Notice the large mass of blue/green info that the printer can print but the monitor cannot see, if we are using the iMac display. We could use the sRGB working space and the monitor display would cover it. But we would be clipping off the more brilliant colors that the printer can print. Lets look at how the Adobe 1998 compares to the printer.

Here is Adobe 1998 compared to the printer.



Here we can see only a small part is outside the working color space. If we had a monitor that covered Adobe 1998 working space we would have a good matchup. Even with the monitor that has a smaller color space, we will get more vivid prints. Actually, with the matte paper I use, the printer color space is smaller and the match to my monitor is pretty good. If I do choose to print on glossy paper I will still get good results. I will just need to be careful with edits in the deep shadows.

One tool that is very valuable in this instance is the Histogram tool. Even though you may not be able to see some detail on the monitor, You can rely on the Histogram to set the correct shadow point in the image. This can get the image data into the range of the printer and print the full detail.

Now that I know what I am working with in terms of how my devices match up, I can got to work on the dialing in the printer.

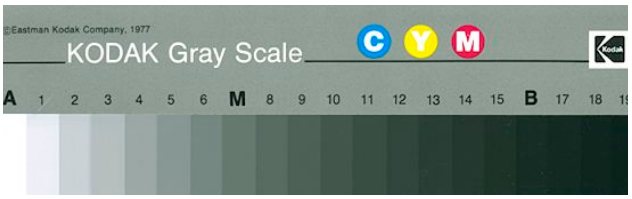
The first thing I want to know is, what is my printer capable of? How can I test that?

I have the advantage of having grown up in the graphic arts industry, starting in the days of hot metal type and etched photos. As the industry advanced into offset printing and halftone photo images, we needed process control.

The most common device was a gray scale. We had reflective gray scales and transmissive gray scales. We even had special ones for color separations. The other control devices were as simple as sample prints to compare to and as sophisticated as densitometers.

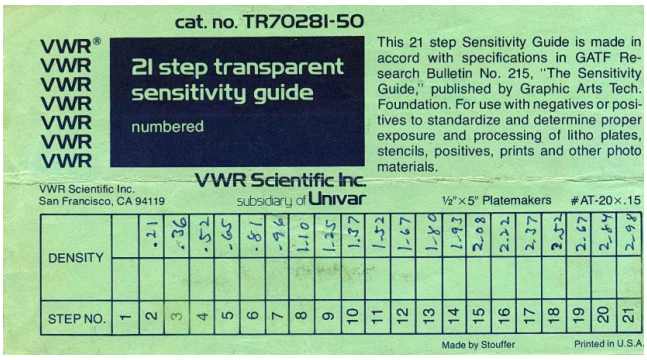
We will look at some of these that can still be used today as we discuss each piece of equipment we dial in. Basically a gray scale is a piece of material with different steps of gray from the maximum to the minimum. They were produced on photographic paper, film and pigment based materials as well.

Here is a typical Reflective Gray Scale.



This one has indicators as to where to place the Highlight, Midtone and Shadow values.

Here is the envelope for a 21 step sensitivity scale.



I show the envelope here to illustrate how the individual steps were measured by densitometer to know their actual value. These guides can be used to check the dynamic range of scanners.

As digital imaging came of age we needed new ways to use some type of controls. That came to light one day when one of my industrial photo labs got a flatbed scanner and asked me how to tell when they have the correct result? I asked him, how did you know before on the process camera? He said by the gray scale. I told him put a gray scale in the scanner along with the photo. Problem solved.

This leads to a 3rd type of gray scale. A digital one. Of course most all digital imaging softwares have an Info tool that allows us to measure the value and the color of anything on screen. Here is an easy way to make a digital grayscale using Photoshop.

To do this first make a rectangular box of a handy size, like 1" x 6" at your printing resolution such as 360 DPI. Then select an area the full length and about 2/3 of the area, starting at the top. Confirm Foreground and Background Colors are set to Default (Black & White.) Select the Gradient Tool. Hold down the shift key and draw from the left end all the way to right end of the selection box.

This will produce a box filled with a continuous gradient from 0 to 255 in value. This by itself can be a useful tool, but we will continue on.

Now go to Image> Adjust> Posterize and select the number of steps you want. I like 21, just like the old time tool. Now you have a 21 step digital gray scale. Use the info tool to see the RGB value of each step. You can then use the Type tool to put the value under each step in the blank area. Name it and save it. Now that we have this tool we can use it to show the capability of our devices.

For this tutorial I am going to use the example of printing with the manufacturers print driver. Printer RIP's offer additional controls, but we are going to discuss working with the tools in the factory print drivers.

The first thing we want to get a handle on is the amount of ink the driver puts on paper. Different papers absorb a different amount of ink. The factory settings work OK as long as we are using the factory ink and paper. Even then it is good to test to see if another setting works even better..

What about using 3rd party inks and paper? For my personal use, I like ink from Marrutt in my Epson printers. I use refillable cartridges and pigment inks. Not only do these inks save a great deal of money, the colors are rich and match or exceed the factory inks in both color and how long they last without fading. Check them out at www.marrutt.com.

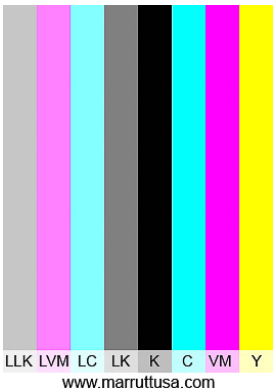
For paper I prefer a matte paper and use Epson's, Marrutt's and even a paper from Office Depot made in Germany. The factory drivers do not give me selections for the 3rd party products. The 3rd party companies do offer custom profiles but that comes later.

The first thing we need to do is make sure our printer nozzles are clear. Use the nozzle check to see if all nozzles are firing and clear. The factories use a shot gun approach to clean the nozzles. Flushing large

amounts of ink through all the nozzles to clear them.

This is a giant waste of ink. You can waste a whole cartridge of ink clearing a clogged nozzle. The biggest problem is it wastes ink from the colors that were not clogged. Is there a better way? Marrutt offers free files that print solid blocks of color that are effective at clearing the nozzles. Their website is www.marruttusa.com. They also have an office in the UK but I am not sure if it has a different URL.

Here is an example of a file that prints all the colors.

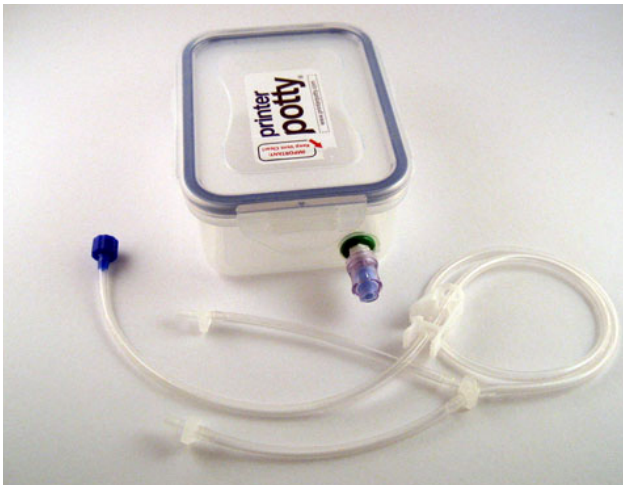


They also have files for the individual colors. So if just one color is clogged you can print just that color. If the nozzles for a color are clogged you will see lines instead of a solid patch.

This procedure offers a couple of additional advantages. You are putting the ink on the paper, not into the internal sponges. This can save the sponges, called waste pads from getting filled too soon.

While on that subject. Here is another tip. The internet is full of how to do it's and products to redirect that excess ink from nozzle cleanings etc. to an external storage container. I like one called Printer Potty. www.printerpotty.com. It is well made and custom fit to my printer.

Here is the Printer Potty for an Epson R5000.



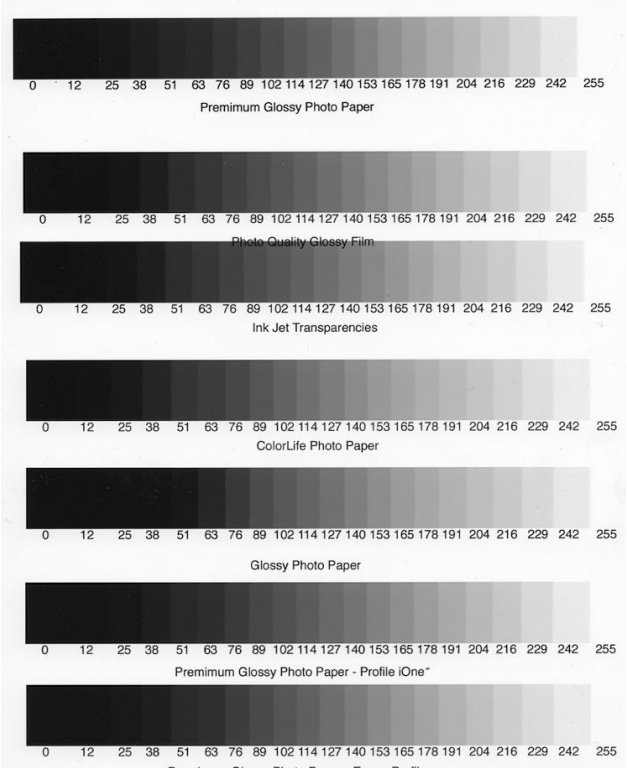
It also comes with a reset code for the waste pads. The factory print driver keeps track of the number of prints made and sends a message that you have to get your printer serviced before using again when you reach a certain number. The code resets the printer. Not all printers work like this. Their website will tell you if yours does.

So what if all this doesn't unclog the nozzle? Several 3rd party manufacturers as well as internet home remedies offer cleaning methods and products. I like a product called Magic Bullet from Marrutt. It is a special solvent that dissolves the clog. Their website has instructions of how to use it. You can resurrect printers otherwise thought dead with it.

OK, now that we have our nozzles firing on all colors, let's get back to testing. Select a paper you want to use. Open the application you want to print from. Set up in profile test target print mode where you do not apply a printer profile at this time. We just want to see how the printer applies ink on paper without adjustments. One way to do this is with Adobe Color Printer Utility Application.

Select a print driver, paper selection that best describes your paper such as Premium Glossy Paper. This will set the amount of ink the printer applies. Position your digital gray scale at the top of the page and type in the setting you chose under it so you will know which paper setting the printed scale is showing.

Here is a sample test page.



Put the paper in your printer and print. Move the gray scale down the page far enough to clear the previous image, put the same paper back in your printer,label and print another setting. You can repeat the process for as many settings as might be applicable.

Note the number of steps that can be seen. Where do you see the break in the highlight and the shadows. In the first setting on this original I can see the break in the shadows at 38, in the highlights it's 255. So my range on this setting is 217 or 18 steps. I also want to note any color cast. I am looking for the greatest number of steps that I can find. That is the paper setting from the driver that gives me the greatest dynamic range in my print.

I also want to see a nice solid black. If I don't get to solid black the print driver is not putting down enough ink. However, if I have a short range the driver is putting down too much ink.

If my color is not neutral grey the driver is giving me the wrong mix of colors. Even though I am printing a black to white image the printer uses more that black ink to achieve its gray tones. There is a chemical reaction to the ink and paper and that reaction can affect color. In addition the different papers have a different color tint to them.

Now that I have determined the proper paper setting to get the best ink coverage I can go to work on getting the best printer profile.

Before doing that, I think I'll take a look at my monitor. In judging my profile results, I want to make sure my monitor is right and showing me an image that is representative of what is in the image file.

In the old days of CRT monitors it was a 2 step process. Calibrate, then profile the monitor. While modern monitor profile software generally just uses a one step approach to profiling, is there any more that can be done?

Many 3rd party monitors give us a user control panel called an OSD, on screen display. This menu gives us additional modes and often individual RGB controls that allow setting the color balance on the monitor itself. So before going to the profiling software I check out what I have to work with there. The closer I can get the monitors in the OSD the less the profile has to do. The other advantage is with apps that are not color managed, the display looks better.

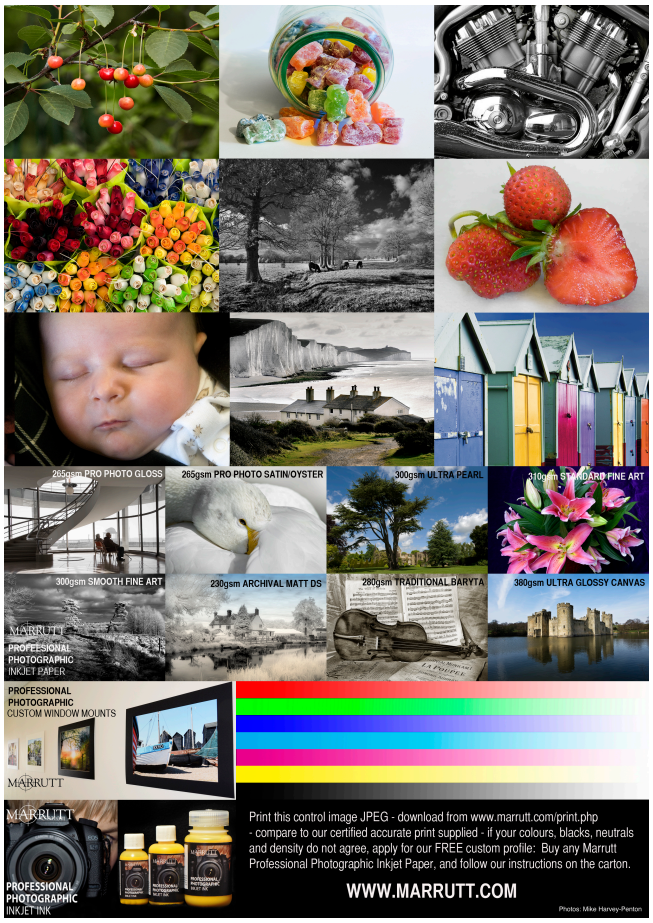
Lets open up the digital gray scale we made. How does it look compared to the printed version. Can I see all the steps that are in the printed version or more? Where is the break where I see a difference. Do the different values look about the same? The most common complaint is that prints look darker than on screen. We perfect the image on screen but the shadow detail is lost in the print. By comparing the gray scales we can see the problem. Most of the time we set our brightness too high on the monitor. The white of the screen should be close to the paper white of the paper we are printing on.

Most monitor profiling software may give you a recommended brightness setting of 120. That is just too high. To get a good match you need 80 to 90 as a brightness setting to match the print. For web content however, you may want a separate profile with a setting of 120 to 140 because the casual observer is going to have their monitor uncalibrated or set too bright. So you need a different profile for web viewing.

While the gray scale will help you determine the best brightness value, you will need a test image to evaluate the best profile for your monitor and your printer. There are lots of images out there for that purpose. Below are a couple of examples. One of

my old favorites is this PDI image above. Although PDI is long gone the image has been in the public domain and can still be found. There are several things I like about this image. The skin tones of the kids are very good to evaluate. It has gray scales and the Color Checker which can be compared to originals as well as measured. The binocular case show subtle changes. I have used this image for so many years I don't need a reference print to compare to.

Another target I like is this one from Marrutt. When you purchase paper from them they will send you a



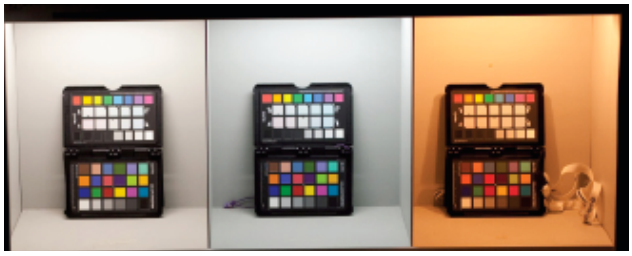
calibrated print that you can do a side by side comparison with the print you make. This file is nice in that it gives you some B&W Images as well. If you buy paper from them, they send the print on the paper you purchase. There are other test print files available or you can make your own.

Now that we know our best paper setting, have determined the monitor is right, we are ready to test existing profiles or make a custom profile.

You have several choices and several variables at this point. If you are using the manufacturers ink and paper, choosing one of the factory profiles may work. If you are using a 3rd party ink or paper one of their profiles may work. Many of the companies will make a free custom profile for you, or you can have a consultant make a custom profile for you. If you have the equipment and software you can make your own profile.

A word of caution here. If you are making a print to create a custom printer profile either yourself or to have someone else make it for you, be sure no profile is being applied for that print. I have run into that problem lately on various Mac OS versions. Colorsync is not well documented these days and it is difficult to tell when it is applying a profile in the background. Some versions of Photoshop had problems with that as well. I always make a test print to check and see if this is happening. I can also tell from the test target for the profiling software. Adobe Color printer Utility.app is a good app. to use for printing your targets.

In order to trust the print you are viewing you must make sure you are viewing the print under the right viewing conditions. Assuming you set up your monitor for daylight D65 or 6500 degrees Kelvin, you have to be viewing the print under D50 or 5000 degrees Kelvin to have a match.



Viewing Booths

One simple way is a light box. Commercial units like on the right, are available or you can make your own. Above is a light box showing Daylight, Fluorescent and tungsten light sources. You can see the effect of the different light sources on the Color Checker. I made the above light box out of cardboard banker boxes with 3 different light sources. You can

A viewing booth, like this one from X-Rite, provides accurate light simulation under a variety of lighting conditions, so you can be sure the colors you are judging are accurate.

make one to view your test prints or just light the whole room with daylight lamps.

You must also make sure the room isn't casting a color influence. I paint my walls neutral gray to be sure. You might also be casting a color reflection yourself when working on your computer. Don't wear strong colors if doing critical color adjustments.

Now that we have good viewing conditions, does the print and monitor match? If they do not, what is off. If the overall color is right but the print is darker or lighter, we have a couple of things to check.

The brightness number in the monitor profile may be off. It may need to be lowered or raised. Re-profile the monitor and compare again.

If the color is off, which one is wrong, the monitor or the print. If we have a known reference print we can compare it to both the print and the monitor. A Color Checker is a good reference. You can find digital versions online or photograph one to print.

If the monitor is off, try creating a new profile and check again. If the print is wrong, retrace your steps and try again.

If you have a good match, make and save a print to use as a future reference print. Make notations of the settings and materials used as well as the date. It's a good idea to make another print in a few months to confirm everything is the same. If you don't use your printer often it's a good idea to make a print or at least do a nozzle check often to keep the nozzles clear. You will use less ink to keep the nozzles clear than to clean them.

One other important point. If you are making a print for a client, ask them where they will be viewing or displaying it. Ask about the light source. If it isn't the same as your viewing environment, the color will look off. That's where having a light box with different light sources is handy to show them the effect.

So what can you expect if you go to all this trouble? Above is a scan of a print I made several years ago for a class I was teaching. This is four different applications printing the same image on the same piece of paper.

I made a custom profile and used it in four different applications. I used the same paper setting in each case. On the top left is Photoshop CS4, top right is Lightroom 5, lower left is Apple Preview and the lower right is Apple Colorsync Utility. Any ICC compliant application should give you good results.

Here is one more important concept for your ink jet printer. What is the best resolution to make your digital file in order to get the best print. Number one to get the best detail and sharpest print you should prepare your image file as a common fraction of the printers native resolution.

For example if you printer has 2880 as its native resolution you want to use a number that can be divided evenly into the native resolution. If 2880 is the resolution, that would be a huge file if you prepared your print at 2880 PPI. It would take forever to print. What you want to do is make a list of resolutions that fit evenly into the native resolution. The first would be 1440. This means 2 pixels of the printer would be used for a single color. Next would be 720. 4 pixels would be used for a single color. Next would be 480. That's 6 pixels. Next would be 360. 8 pixels would be used. Next step down would be 288. 10 pixels used. Next would be 240. 12 pixels used. Finally 180. 16 pixels used.

Many pieces of information suggest 300 PPI for a print resolution. Thats ok if your output device is designed for 300 PPI. It the case of our example printer that would mean 9.6 pixels would be the same color. That's not possible. So the software has to interpolate the data to figure out how many pixels to make what color. Any time you have to interpolate, you will lose quality.

So what is the best resolution to use. I suggest you do your own test to see just where you can see a drop in quality. You can make multiple prints on a sheet of paper like the 4 up example above.

Pick a nice test file with a lot of detail. Some skin tone is good too. Print the first sample at a higher resolution than you think you might need such as 720 PPI. Examine the print at the proper viewing distance. Print the next example at the next lower resolution such as 480. Examine the print, can you see any difference in quality? If not, print at 360. Any difference? If not try 288. Next would be 240. Etc.

At some point you will detect a slight loss of quality. That next higher resolution is your standard. My experience is that it will probably be 288 to 360 on a good paper.

Remember proper viewing distance. If you are making a large mural, you are not going to get as close to it as an 8 x 10 print. So your resolution can be lower without seeing a difference.

Another thing to remember, if you must print a small file larger than it's original resolution allows, before you enlarge the file, try a lower resolution on the printer. The result may be better than the enlarged file printed at a higher resolution. Enlarging the file usually lose quality.

OK, I know there are speciality softwares and special techniques to enlarge in Photoshop etc. But they may be more time consuming. The final proof is the result you get.

I always say, :"If the results differ from the theory, believe the results and invent a new theory."

I hope you find this tutorial helpful. If so feel free to send a donation to help encourage me to keep providing them. You may do so with PayPal. Just send to gyaeger@mac.com. Thank you very much for your support.

Copyright 2018 Gerry Yaeger .

Useful Websites-

Marrutt USA, Pro Inks, Cartridges, CIS systems, Paper, Nozzle cleaner and how to articles.
www.marruttusa.com

Printer Potty, printer waste collection tanks.
www.printerpotty.com

Chromix, Profile services, software to view and compare profiles, Color Management products
www.chromix.com

Adobe, Adobe Color Printer Utility download here.
https://helpx.adobe.com/photoshop/kb/no-color-management-option-missing.html

X-Rite Photo, Hardware and software profiling solutions. www.xritephoto.com

DataColor, Hardware and software profiling solutions. www.datacolor.com