Workflow Guidelines

Practical guidelines and references for digital photographers

These guidelines are the result of collecting information from different sources on the Internet, several books and my own knowledge on these topics. New information will be added and old text rewritten in an attempt to create something up-to-date and maximize its usefulness. This PDF version replaces the original 'Workflow Guidelines' thread at the forum of www.fredmiranda.com.

Many questions about the digital workflow are common. This article will give recommendations or suggestions about the digital workflow or aspects related to it. I won’t give too much background information; there are much better sources for that. I strongly suggest exploring the links and references throughout this text.

The most important factor in (digital) photography is maximizing and preserving the quality of the picture through the entire workflow within the practical boundaries.

Remember: Google is your greatest friend!

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About the version numbering system.

x.yz. (Example 1.23)
x: a change of the whole numbers indicates a significant change or addition to these guidelines, for example adding a new chapter or rewriting of an old chapter. Reading these changes is recommended.
y: first decimal change indicates a small change. For example adding or rewriting text to make it better understandable, adding a picture. Reading these changes can be considered.
z: the second decimal change indicates insignificant changes, like correcting writing errors or layout changes.
Introduction

Know your camera

Many photographers own expensive, fancy camera’s, but can’t use them properly. You should know how to use all those great features. Did you read the manual? Take your manual and start with page 1. and continue until you have read the last page. Now take your camera and start all over, but now with your camera on your lap, trying all those settings and features.

Yes, I know it will take a day, but you now know how to handle your camera a little bit better and know the terminology.

Act like a photographer

Did you read the manual as I advised? Well, you should now know how to avoid and disable most of the features.

A ‘real’ photographer shoots in manual mode. You make the decisions and you select the correct aperture and shutter speed. Know your camera’s metering pattern. Learn how your camera ‘sees’ the world and learn when you need to adjust the meter’s exposure. Knowledge of the zone-system can be useful. If you have spot-metering, use it. Basic knowledge of photography is essential. Terms like aperture, f-stop, shutter-speed, iso, focal-length, rule of thirds, depth of field, are examples of basic terms and you should know these and their relationship between each other.

In my opinion ‘shutter priority mode’ and ‘aperture priority mode’ should be used with care, but ‘full automatic mode’ should be avoided, unless you need to work very fast or want to degrade your camera to a simple point-and-shoot camera.

So landscape mode, portrait mode, macro mode …forget them! By the way, do you know why they are called this way and what happens when you select these settings?

If you can, use your digital camera’s thumbnail image histogram. It is one of the best features digital photography has to offer, but use it correctly and know its limitations.


The histogram is even essential if you want to capture the maximum amount of information (read: quality).
Capture the maximum quality

Most of the time, you only have one chance to capture the maximum quality, that is the moment you press the shutter release button. All you have to do is to set your camera correctly.

The absolute best choice is to use RAW-mode. When an image is captured by your camera’s digital sensor, a series of settings are applied as alterations to the original 12-bit raw data. In almost all digital SLR cameras, this raw data can be retrieved “un-touched” as a RAW file. The power is to change these alterations like sharpness, contrast, white-balance, and color-space, after you have made the picture. Besides a better dynamic range, you can produce 48-bit images (16-bit color channels)!

You will need a RAW converter to ‘develop’ your RAW files. It’s worth the money.

If you don’t want or can’t use RAW-mode, select jpeg-mode. Make sure you select the highest quality, so you encounter the least amount of compression artifacts. Remember, you can only produce a 24-bit image (8-bit color channels). Don’t lower the pixel count (such as switching from 6MP to 3MP), since higher resolution files stand up better to the degradation that accompanies compression and you may need the higher resolution. Use low or no sharpening. There are better tools available for sharpening and it’s impossible to remove sharpening artifacts.

Did you know that the information captured by a digital camera in RAW format is not distributed evenly across the tonal range from Black to White? The tones between pure White and one stop less; actually contain fully half of the tonal range of the capture. Each stop below that contains progressively half the tones. See example below:

Assuming a tonal range of 5 stops and a 12 bit image:

Within the first F/Stop, which contains the brightest tones, 2048 levels available

Within the second F/Stop, which contains bright tones, 1024 levels available

Within the third F/Stop, which contains the mid-tones, 512 levels available

Within the fourth F/Stop, which contains dark tones, 256 levels available

Within the fifth F/Stop, which contains the darkest tones, 128 levels available

What does this mean? Use the RAW format, use your histogram and expose for the right!
Read www.luminous-landscape.com/tutorials/expose-right.shtml for an explanation.
Color space

A color space is a sort of color container, with a fixed size (gamut). Without a description of this color space, the RGB values have no meaning. 255,0,0 represents ‘pure red’, but not what kind of red. You need a description of this space. The main variables are the color and brightness of the colorants (primaries (like the phosphors of your monitor or the inks of your printer), color and brightness of the white point and black point and the ‘tone reproduction characteristics’ of the colorants. I will not go in detail, there are better sources, but you can remember: the farther from the centre of a color space, the more saturated the colors become. The more you go to the centre, the more desaturated the colors. A large color space can hold more colors compared to a smaller color space.

Figure 2. The horseshoe-shaped plot (CIE x,y Chromaticity Diagram), represents the gamut of human vision. The green dots represents the most saturated green (R0/ G255/B0) in Adobe RGB and sRGB color space.

Figure 3. Color spaces sRGB and Adobe RGB (1998) are plotted. Notice that the place of the red, green, and blue primaries are different. When they move farther out from the center, they are closer to the maximum saturation of human vision.
Every digital camera, display or printer, has an unique gamut (color range), which is dictated by the characteristics of that device and can be described by device-color-profiles. Even devices from the same type and manufacture are not identical. A device color space simply describes the range of colors, or gamut, that a camera can see, a printer can print, or a monitor can display.

Editing color spaces or working color spaces, such as Adobe RGB or sRGB, are the same all over the world. When you work with digital images, you need to select your working color space. The image’s color data will be translated to this color space. When the gamut of your image contains colors outside your selected working color space, you lose them (they are ‘out-of-gamut’).

**How do you choose your working color space?**

24-bit RGB images are made up of three 8-bit color channels. Red, green, and blue. Each of these channels can define 256 (and only 256) shades. When you edit an image, you change the RGB values of pixels altering the pixels’ tone and color. But you can only alter the pixel values in the 256 increments imposed by the 8-bit channels: A pixel can take on a value of 128 or 129, but never a value in between.

The size of the working space’s gamut determines the spacing of the 256 possible values of each channel. In a large gamut space, the values are spread farther apart than in a small gamut space. A wider gamut gives you a wider range of color, but it doesn’t give you more colors. The same number of colors is simply stretched over a larger color range. This means you don’t have as fine control over the color as you would in a smaller-gamut space.

In a smaller gamut space, you have finer control over color and tone, because the data points are packed closer together, but you lose the ability to specify the very saturated colors that would be available in a larger gamut space.

You want a working color space that can hold most or ideally all of the color data your camera can capture, but don’t want to choose a working color space that’s way too big and with that, risking delicate colors getting compressed into a single level.

Using 48-bit RGB images, having three 16-bit color channels, eliminates many of the negative aspects of working with large gamut color spaces. It has 65536 levels per color channel, compared to 256 with 24-bit images! [Well, being more honest, when a 16-bit file is opened in Photoshop you’ll notice that the maximum pixel value is 32768, its how Photoshop works.]

With the release of Adobe Photoshop CS, complete high-bit editing is possible. I highly recommend working with these 48-bit images. Unless you have a good understanding of the theory I recommend choosing Adobe RGB as your working color space. Adobe RGB is a medium-gamut space. It’s the printers-industry standard.

If you want to retain all data your camera can capture, you may want to consider an even larger color space like ProPhoto RGB. ProPhoto RGB is an example of a large gamut color space. It even has imaginary colors, that don’t exist and no printer or light source can create. Working in this color space can be useful on some specific cases, but you absolutely don’t want to use this with 24-bit images because of the risk of posterization and banding. Read [www.luminous-landscape.com/tutorials/prophoto-rgb.shtml](http://www.luminous-landscape.com/tutorials/prophoto-rgb.shtml) for more information.

sRGB is a small-gamut space, has a limited color gamut, approximating that of the average computer monitor. Frequently it’s too small to hold the color data of your image and you throw many colors
away. All colors outside sRGB are gone forever. Converting sRGB to a larger color space is useless. You simply risk losing even more color data. Some people claim that the gamut of portraits or weddings is very small, even smaller than sRGB, but that’s not always true. If you’re forced to work with low-bit (24-bit) images and you need to make major corrections on an image with delicate colors, sRGB is the better choice, reducing the chance of posterization and banding compared to a larger working space like Adobe

**Summary**: Adobe RGB is the preferred working color space. sRGB is not a good choice. If you have to work with low-bit images, sRGB can sometimes be considered. Perfectionists sometimes use ProPhoto RGB, but they also know how to handle it.

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**Figure 4**. This is a picture that dramatically demonstrates the wider gamut of colors on the inkjet printer (left R2400) compared to the sRGB space (right). It’s a small part from my test image I use to test printers. The grey areas contain colors that are out-of-gamut.

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**Figure 5.** Here you can see the gamut plot of sRGB and an Epson 2400 inkjet printer (Premium Glossy Paper). From this view, it appears there are colors within sRGB that are outside the gamut of the Epson 2400, but you also see there are many colors that fall far outside sRGB, but within the gamut of the printer. If you used sRGB as a working space, you would not be able to output these more saturated colors this printer is capable of reproducing.
**Color space: the flexible approach.**

More and more photographers use ProPhoto RGB as their standard working space, regardless of the contents of the image. Articles like ‘Understanding ProPhoto RGB with subtitle ‘Preferred Working Space for Digital Photographers’ suggests such a way of thinking and working.

I too try to maximize the quality of my images. I always used ProPhoto RGB as my standard working color space, afraid of losing colors, but not anymore. Since I mostly shoot portraits, ProPhoto RGB does not always provide a benefit, since all colors captured often fit in a smaller color space, like Adobe RGB or sRGB. I want to use a workflow that combines the benefits of a large color space (not throwing colors away) with the benefits of a smaller color space (finer control over color and tone, because the data points are packed closer together). I call this a flexible approach.

High-bit editing gives you (many) more levels per color channel, but your tools in PS are not adjusted accordingly when you work with high-bit images. For example, when you select curves, you notice you still have 0 to 255 levels to manipulate (each level containing 128 levels of image data with 16-bit channels). With a very large color space, even very small adjustments can cause problems.

ProPhoto RGB has no advantages if the color gamut of your image fits in another smaller color space. Therefore it’s wise to check for out-of-gamut (OOG) colors in a smaller color space and adjust your working color space accordingly.

Put into practice:

- No OOG colors in sRGB, then sRGB is the preferred working color space.
- No OOG colors in Adobe RGB, but OOG colors in sRGB, use Adobe RGB.
- No OOG colors in ProPhoto RGB, but OOG colors in Adobe RGB, use ProPhoto RGB.

The question is, are those OOG colors that important? Well, that’s for you to decide. When I see many OOG colors, or important OOG colors I will use a larger color space (like ProPhoto RGB) and sacrifice some fine control. Remember, what you throw away now, maybe can be printed or displayed in the future.

**How to check for OOG colors?**

The easiest way is to use the histogram in your RAW converter and check for color channel clipping. If there is none, you are OK; otherwise a larger color space can be considered. Clipping means that these colors are outside the color space you selected or use. You can also check within PS for OOG colors in a smaller color space (selecting a smaller color space in the soft proof window), using soft proof and the Gamut Warning.

There is one exception …if you want to boost the saturation of your images or use filters that work this way. Colors that are not OOG can become OOG after your edits. Most of the times you’re safe, though, but keep this in mind.

For people who are interested in some more information about this subject, read this article from Jeremy Daalder ([www.jeremydaalder.com/singleArticle.php?articleID=6](http://www.jeremydaalder.com/singleArticle.php?articleID=6)).
Figure 6: Here you see three histograms from a RAW file containing the image of a sunflower in three different color spaces. The first (A) is in sRGB; you see clipping of a significant amount of color data. The second (B) is Adobe RGB; here you see no real clipping, but it is tight. I have to watch the highlights when I sharpen or otherwise edit the image to prevent clipping. The third (C) is ProPhoto RGB, plenty of room left.

The last image (D) is a gamma plot of the actual image data (dots) in relation to sRGB and the much bigger ProPhoto RGB. If I would choose sRGB, I would loose many colors that fell actually inside the gamut of my printer (not shown here).
Monitor calibration and profiling

The monitor is your window to your digital world (of photography). Therefore you need to be sure your window is clean, without a colorcast and is ‘performing’ well. The purpose of monitor calibration and profiling is to get correct true colors, neutral grays and the best dynamic range without too much artifacts. Often you want to bring it to a desired pre-determined state.

Calibration is to bring your monitor as close as possible to your desired state, using the hardware controls. Profiling (after calibration) is measuring your displays’ unique characteristics and building profiles that can be used to correct the monitor’s image to the desired state.

A hardware calibration device is essential if you are any serious about your photography.

A Gamma of 2.2 is recommended on both Windows and MAC.

On a CRT monitor you use 6500K (D65). On a LCD (TFT) monitor it’s recommended to leave your LCD at its native white point and let your colorimeter and software make the corrections through the lookup table in your video card.

In order to avoid eye strain and extend the life of your display, it’s recommended to set a suitable display luminance in relation to the ambient lighting on and around the work surface. The brightness or luminance level is difficult to set, because there is no ‘one good value’. You need to determine what works for you based on your environment and comfort. In brightly lit environments, you will need a brighter monitor and lighter black point to see detail well. In a dark environment you will want a dimmer display. Recommended luminance values are between 85-95 cd/m2 for CRT displays and often a higher value for LCD screens (100 – 140 range?). The ambient lighting on and around the work surface or room lightning condition should be mid-level or below (dimly lit); no direct light should shine on the screen. Absolute darkness is not a normal viewing situation and is not recommended.

An aid can be this Monitor Black Point Check: [www.drycreekphoto.com/Learn/Calibration/monitor_black.htm](http://www.drycreekphoto.com/Learn/Calibration/monitor_black.htm).

There are also grayscale patches on various websites like on dpreview at the bottom of every review page to make some checks that your current settings aren’t causing a loss of detail (clipping) at the white or black ends.

Sometimes you need to tweak the different settings, like gamma, to remove artifacts or banding.

…but my prints are darker (lighter) compared to my monitor?

If the monitor is very bright but the room lighting is dim, the printed piece will appear much darker. If you use a lower brightness setting for the display and view the print under very bright lights, the problem will reverse. How much of a difference is seen will depend on the situation as well as the content of the image.
If you use Adobe Photoshop and a third-party hardware calibration device, make sure you have **removed the gamma loader** from the startup folder.

Proceed as follows (Windows):

Click on “Start”.
Hover over “Programs” and then over “Startup”.
Right-click on the Adobe Gamma Loader and choose “Delete” from the dialog box.


**Variation between displays and between applications.**

You will see the most true colors and neutral grays on a well calibrated and profiled display in an ICC-aware (=profile aware) application, like Photoshop. The ideal world does not exist and even in this ideal situation your display is the limiting factor. The more correction is needed to set your display to your wanted state, the more artifacts will be created, because it’s always a compromise. On a given point, it cannot be calibrated and profiled anymore. The artifacts are too much for your work and you need to buy a new display.

The second best situation is to view images on a well calibrated display, but outside an ICC-aware application (like Internet Explorer) or without a profile, in this situation the raw numbers of the image are thrown to the screen. It’s much better compared to an uncalibrated display, because you already tuned your hardware as close as possible to your wanted state. In this situation you will have reasonable neutral colors and black and white points were you want them, colors…especially saturated colors are more difficult…you will need a profile.

The worst situation and how most people surfing on the internet watch their pictures, is viewing images on a non calibrated and profiled display. The biggest variation is in this group. Your fine tuned image will have a blue cast on one display, a green cast on another, too bright on a third and so on. Everything is possible.

Oh,…and would you ask ‘why can’t I trust my eyes?’ Take a look at this great Big Spanish Castle ([www.johnsadowski.com/big_spanish_castle.html](http://www.johnsadowski.com/big_spanish_castle.html)) and for more ‘optical illusions’: [www.michaelbach.de/ot/](http://www.michaelbach.de/ot/)

Image below: There appears to be a yellow stain, though there are only blue or black gratings on the white background. From: Akiyoshi Kitaoka ([www.ritsumei.ac.jp/~akitaoka/index-e.html](http://www.ritsumei.ac.jp/~akitaoka/index-e.html))
**Saving and archiving**

In the older days, a long time ago, people used film to capture an image. I know it sounds odd. It had one big advantage compared to digital ...a longer life.

[Quote from: http://www.clir.org/]

If William Shakespeare had written *Hamlet* on a *word processor*, or...
If Thomas Jefferson had saved his drafts of the *Declaration of Independence* with a computer text editor, or...
If Alexander Graham Bell had documented his experiments with the telephone on *floppy disks*, or...
If Leonardo da Vinci had used a computer graphics system to create the *Mona Lisa*...

Would Their Great Achievements Still Be Available To Us Today?

Unless they copied their work to a more durable medium, the answer is **no**.

It’s not a question if media will fail, but when it will fail. I have several harddisks as paperweights on the desk.

Keeping track of your images is another difficulty all photographers have to face. Only a few weeks before this first writing I wanted to use a great image from the granddad of my wife. I had it in the main folder of my photography disk. Ready to edit, but I can’t find it anymore. I really hope it’s still somewhere on one of my back-up drives, but I fear it’s really gone. This is only one image (well, …I hope it is only one), but what about your wedding pictures, your first baby shots or an important client you cannot afford to lose?

Data preservation is one of the biggest worries of today’s librarians, archivists or historians. A large amount of data of our recent past is already lost or is nearly lost. Most shocking …we don’t know it until we try to recollect it.

We all need to know the process of how to take images from data cards, then catalogue, index, keyword, raw process, final process and archive them. You need to know something about DAM.

The term “**digital asset management**” refers to the protocol for downloading, renaming, backing up, rating, grouping, archiving, optimizing, maintaining, thinning, and exporting files.

For all photographers, amateur or professional, I strongly suggest buying:

The DAM Book: Digital Asset Management for Photographers - by Peter Krogh, O'Reilly Media, Inc.; 1 edition (November 22, 2005), ISBN: 0596100183

http://www.thedambook.com/

[edit: I happily can say, I found the lost image again. It had another name. :) ]
**Editing**

Did you buy all Plug-ins and actions from Fred? Well, if not …do it now! OK, I agree, you don’t need everything, but take a good look at what you do need. The quality is great, especially if you take the price into account. An action is nothing more then an automated series of steps. If you’re a Photoshop wizard, you can do this yourself; otherwise I highly recommend his actions. Save yourself a lot of time.

A long time ago, I did a test here with interpolation tools Genuine Fractals PrintPro3, S-Spline Pro (now called PhotoZoom Pro) and Fred’s SI Pro. Up to 200% there were no differences in print on an Epson 2100. Most expensive tools are for **pixel measurebators**¹ with too much money. I would first try the cheaper solutions before buying expensive tools, unless of course there is only one ‘king of the hill’.

Adobe Photoshop (PS) is the professional standard in desktop digital imaging. There are other good editors, but they lack some of the nice features. Almost all good instruction books or other useful sources aim at the PS user. As if nothing else exists. If you can, consider this piece of software. I know it’s expensive, but so is your camera. Don’t panic, even if you don’t use PS, you can still do an astonishing amount of editing with the other editors.

Before you start, you should take a look at your working color space. You should match your working color space with the color space of your image. When you selected sRGB on your camera or RAW converter, then sRGB is your PS working space. Set your Color Management Policies to ask by profile mismatches or missing profiles.

**Never convert images** (one color space to another), unless you need to work with different images captured in different color spaces on the same project.

Never convert to a smaller color space, like sRGB, unless you **need** a smaller gamut (like posting on the Internet). Save your image before conversion and use the image with the largest color space for your archive.

When you load an image into PS and it asks to convert it to the “working color space” or “leave it as is”, choose “leave it as is”. Every conversion will degrade the image a bit. Change your working space to match your images, if the message irritates you.

When the image doesn’t contain a profile, you should **assign** the correct profile. When you know you shoot sRGB, assign the sRGB profile. When you assign the wrong profile, the numerical color data will be interpreted wrongly and this will lead to color shifts. Therefore, don’t assign a profile if you don’t know it. Leave it un-color-managed. Another possibility is to guess the missing profile by assigning a profile and choose the best by evaluating it on your screen or print.

**Don’t** do any corrections on color or tone on an un-calibrated/profiled monitor. Same is true for soft-proofing. You can’t trust what you’re seeing. Maybe you’re changing the image, but it’s the monitor at fault.

The more you learn, the more confident you will work with your images. Controlling Color is one aspect. For example when you convert to a profile, the out-of-gamut colors need to be taken care of. There are four methods of handling out-of-gamut colors and are called **rendering intents**; the two most relevant are Perceptual intent and Relative Colorimetric intent. Perceptual intent is the best choice when there are significant out-of-gamut colors, because it preserves the overall color relationships. Perceptual rendering attempts to compress the gamut of the source space into the gamut of the target space. Relative Colorimetric is often a better choice for images that don’t contain significant out-of-color colors, because it preserves more of the original colors, but relative colorimetric rendering clips

¹ [http://www.kenrockwell.com/tech/7.htm](http://www.kenrockwell.com/tech/7.htm)
out-of-gamut colors to the nearest reproducible hue. Relative colorimetric rendering can cause a loss of detail when used on images with many out-of-gamut colors. It isn’t easy to say which is best. It’s highly dependent on the contents of the image, so some experience or experimentation is necessary. Knowing its limitations can be helpful to maximize the output quality. Matrix based color profiles (like most working color profiles) can only use Colorimetric rendering (Relative or Absolute) to handle their out-of-gamut colors, even if you select Perceptual! Use soft proof to judge the impact of a conversion (banding artifacts, clipping and loss of detail). Fortunately, If you go directly from a matrix based color space (like ProPhoto RGB) to print space, you can use all the available rendering intents.

The suggested workflow below is a suggested workflow. Therefore, modify it for your own needs.

**The workflow (subsequent order):**

1. ‘Develop’ your image with a RAW image converter. All big corrections are done with the RAW converter, using the RAW data. What you want to do in the RAW converter and what part with Photoshop or other specialized tool, is up to you. There is no ‘golden standard’ or one good workflow. Normally you choose your working color space, correct the white balance and do some exposure compensation. It’s important to learn all settings, strengths and weaknesses of your converter. Normally you ‘develop’ your image to a 16-bit lossless TIFF format. If you can, avoid the lossy JPEG format or 8-bit mode.

When you want to edit images saved in JPEG format, first convert them to a lossless format like TIFF or PSD (Photoshop file). JPEGs use a compression method that sacrifices image information to reduce the file size. Every time you save an image as a JPEG, some of the original image data will be lost even if you use the Fine setting.

2. Optional Noise reduction. You can use different tools, like the RAW converter, Fred’s plug-ins or other specialized software like Noise Ninja or Neat Image.

3. Optional low sharpening early in the image-editing process to restore any sharpness that was lost in the capture process. You can use PS, Fred’s plug-in, or other specialized tool.

4. Color-correction, curves adjustment, etc. Use high-bit images if you want to avoid, posterization or banding (the ‘combing effect’ in histograms).

5. Retouching

6. Save your work before you customize your image to his final destination. Preferably use a 16-bit lossless format and attach the icc-profile.

7. Any last corrections you encounter after your conversion to another color space (Soft Proofing)

8. Upsizing/downsizing with Fred’s Plug-ins, or use another specialized tool

9. Final sharpening. Image already sized to final output resolution, and is now getting tailored to a specific type of output process

10. Convert to final color space (e.g. sRGB for web images)

11. Convert to 8-bit

12. Save your final tailored image with icc-profile if you want.

(Figure 9.) You should learn **Non-Destructive Photoshop techniques**, like using adjustment layers. You have succeeded when you can say: “No pixels were harmed during the creation of this photograph.” [from Kevin Ames, The Art of Photographing Women]
**Printing**

Do you think printers are small-gamut output devices? Well, they are, but many printers can print outside the sRGB color space, so why demand most printing services sRGB images? They are lazy or just ignorant. sRGB is a safe color space. Color management can be ignored for the most part and all point-and-shoot cameras’ ‘shoot’ sRGB. Therefore convert your images to sRGB if you need to and send these to your print lab. Use copies of course; you don’t want to change your originals.

A good lab (and they are rare) have profiled their printers and use these printer-profiles. Ask if they have printer profiles. Printer profiles only describe the unique characteristics of one specific printer. Printer profiles will let you use the printer’s full capabilities. This profile is useless, unless you are printing on that specific printer or use the profile for soft proofing in PS. For the best output, the large gamut image is converted to the printer profile. **Always ask the operator what color space they expect you send.**

Most photographers own their own (inkjet) photo printers. It’s recommended to use maximal quality settings for best performance. Select the correct paper, select ‘highest print quality’, ‘high speed’ disabled, select the optimal ‘rendering intent’, etc…read the manual and use the Internet for more information.

When you want to use ‘soft proofing’ in PS or want to use the printer’s full capabilities, make profiles for your printer. Every paper/settings/ink combination needs his own profile. Fortunately, your paper choices are the most variable and normally you only need as many profiles as papers you use. Use one of the many proved profiling services on the Internet for custom-made profiles. It’s the cheapest solution. Some ‘canned’ profiles (profiles from your manufacturer) are pretty good and can be good enough.

Third-party products can be very good or damaging bad. They are not recommended unless they have proven their quality and don’t ruin your printer.

**RIPs (Raster Imaging Processors).** This is heaven on earth according some people. The printing experience can be a truly orgasmic experience! This software takes your image and text and tells the printer where and how to place each squirt of ink on the paper. Hey, that’s also what your normal printer-driver does! What is different? Well, I really can’t tell you. A popular software RIP is ImagePrint. It’s expensive. I tried three different versions of ImagePrint in the last couple of years and I couldn’t get better or even get equal results on my printer compared to the standard printer driver and custom-made profiles. I know it must be my own fault.

Third-party papers are a good alternative. Many will give exceptional results with your printer. Many times you need Custom-made profiles for best results, but sometimes you’re lucky and the canned or downloadable profiles give results that are good enough.

Third-party inks are not recommended, unless they have proven their quality. Most printers are optimized for their own inks. The color gamut of these third-party inks is often less than the gamut of the originals. It can cause problems with the functionality of the printers, like clogging the jets. The manufacturer of your printer will sometimes void your warranty. Third-party inks can be considered if they improve the print quality, but only if they are safe for your printer.

Custom-made profiles. Already mentioned. Highly recommended if you want the maximum quality from your printer. Consider this if your canned profiles are not good enough.
**Something about pixels, dots and resolution.**

**Pixels** (short for: Picture Elements) are simply blocks of color arranged in a grid. If the individual blocks are small enough (or if the image is viewed from a distance), we perceive the image as having a continuous tone instead of many small blocks of color.

**Pixel Count Resolution** is simply the amount of pixels a digital image contains, or is made up of. It is expressed in either **megapixels** or pixel dimensions.

**Pixel Dimension** represent another, more descriptive method of designating pixel count resolution. By stating the pixel dimensions of a digital image, the pixel count is inferred. In addition, the aspect ratio of the image is revealed, as are the exact dimensions.

Pixel Count Resolution or Pixel Dimension is a **fixed property** of an image. Unless the image is resampled or cropped the image remains the same number of pixels. This fixed pixel attribute doesn’t mean anything about reproduction dimensions until resolution is taken into account.

**Spatial Resolution** relates to the number of pixels in a spatial measurement of a physical image - for example: pixels per inch. Spatial resolution does not apply to an image file (except as a temporary/variable specification thereof), only to a physical image. An image literally can not have a spatial resolution if it doesn’t take a physical form - it can’t have any given number of pixels per inch if it doesn’t have physical dimensions.

The spatial resolution of an image is commonly referred to in terms of “dpi” (dots per inch). What is being specified is pixels per inch (**ppi**); however “dots” per inch has gained a foothold in common (but not correct) terminology.

Spatial Resolution is a variable property of an image file - it only becomes a fixed property of an image once it is output in permanent form, i.e. printed. As this resolution is conditional upon output, this resolution is commonly called **output resolution** or print resolution.

Pixel Count Resolution and Spatial Resolution are related in that pixel dimensions and pixels per inch are **image size** - pixel dimensions divided by pixels per inch yields output (print) size. On their own, pixels don’t have a clue about 2 dimensional space. Pixels have no fixed size. We combine pixel dimensions (how many actual pixels there are in a file) with resolution (how many pixels fit in an inch) to determine the file’s output dimensions.

**dpi properly used - for printer resolution**

dpi is also used to refer to dots per inch in terms of printer resolution. Inkjet printers’ manufacturers list resolutions like 2400 x 1220 dpi. This printer resolution is independent of and unrelated to image resolution. The “dpi” in such inkjet printer specifications refers to ink dots, not pixels. Inkjet printers can lay down different amounts of ink dots per inch, irrespective of how many pixels they are reproducing per inch. This is the dpi referred to in inkjet printer specifications. “ppi” or “dpi” as associated with image resolution refers to pixels and is a conditional property (it only applies to the printing) of the image being sent to the printer. So, a 1440 dpi inkjet printer printing a digital image at 300 ppi is using 1440 ink dots per inch to render 300 pixels per inch.

Typical cathode ray tube computer displays (**CRT**) are generally capable of 72 to 130 pixels per inch. The dot pitch (smallest physical visual component on the display) of a computer display determines the absolute limit of possible pixel density. When you select a lower monitor resolution, multiple monitor dots are used to display one pixel element of an image. That’s how you can use different resolutions (640x480; 800x600; 1024x768; 1280x1024; etc).
A commonly held misconception is that Web graphics files with a high ppi contain more information than files with a lower ppi. Changing the assigned PPI after a digital image is created does not change its pixel resolution, size or quality.

We know that displays are measured in pixels (e.g. a 1024x1280 display), and that screens are at a given width (e.g. 17”), it seems logical that the pixels/inch setting should affect the size of the displayed image. Logical maybe, but wrong. Although monitors do have a measurable figure for ppi (pixels per inch), the ppi information in an image is NOT used for monitor display in web browsers. The way you control how large an image appears on someone’s monitor screen when viewing your images on the web is by changing the height and width in pixels (Pixel Dimensions).

For print — the “right” resolution is a balance between file size and pixel data. Too little data and the image can look coarse and jagged. Too much and working with the file becomes difficult, archiving it is unnecessarily costly and the printed result can actually suffer. The “best” resolution is the one that’s appropriate for your end result.
**Other sources**

Everyone needs some form of education. You can follow lessons, search the information on the Internet or buy good education books. Below are some suggestions.

Books:

‘Real World Adobe Photoshop CS2’ by *Bruce Fraser, David Blatner*, Peachpit Press (October 21, 2005), ISBN: 0321334116

‘Real World Color Management’ by *Bruce Fraser, Fred Bunting, Chris Murphy*, Peachpit Press; 2nd edition (September 8, 2004), ISBN: 0321267222 (Basic color management)

‘Real World Camera Raw with Adobe Photoshop CS2’ by *Bruce Fraser*, Peachpit Press (May 23, 2005), ISBN: 0321334094


Internet:

http://www.fredmiranda.com/software/ (your start)

http://www.digitaldog.net/ (general tutorials, also good articles on color management)

http://www.creativepro.com/ (general reviews and tips)

http://www.creativepro.com/printerfriendly/story/11132.html (Color-Correct Vocabulary)

http://www.computer-darkroom.com/ (general tutorials and reviews)

http://www.sphoto.com/techinfo/histograms/histograms.htm (a practical guide to interpreting RGB histograms)

http://www.pixelgenius.com/tipsandtechniques.html (sharpening and other)

http://www.drycreekphoto.com/ (color management, but do NOT use their profiling service!!)

http://www.normankoren.com (tutorials)

http://www.cleaningdigitalcameras.com/ (cleaning your camera)

http://www.rawformat.com/ (Digital Raw format)

http://www.colorbytesoftware.com/ (ImagePrint RIP)

http://www.photoshopnews.com/ (general Information)
If you have any questions on this article, notice any errors or would like to discuss something, please contact me or start a thread at the forum of Fred Miranda (Post-processing & Printing).

Special thanks to Fred Miranda member ‘paulhodson’ for his reliable ‘bumping’ of the original thread at Fred Miranda, saving me countless of times reviving the thread from the archive and saving me a lot of work. Even when he went for a holiday he notified me about his absence. Of course also many thanks to all others that gave suggestions, comments or contributions to this thread.

ABOUT THE AUTHOR
Hendrik van der Veen is an enthusiastic photographer with a special interest in the digital workflow. His goal is to invest more time in his photography improving his results and level of professionalism. He’s moderator at Fred Miranda (www.fredmiranda.com) and wrote these guidelines in an attempt to give members basic information about recurring questions at the forum. Besides photography he’s a passionate martial arts practitioner started at an early age of 5, and has experience in Judo, Wu Shu and Jiu Jitsu. Today he’s active in Jeet Kune Do and Knife Fighting. Too much of his time he works as a physician in a large general hospital. He lives in the Netherlands with his greatest love: his wife and two children.
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