

# UPDIG

## UNIVERSAL PHOTOGRAPHIC DIGITAL IMAGING GUIDELINES

Version 2.0



ADVERTISING  
PHOTOGRAPHERS  
OF AMERICA



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# UNIVERSAL PHOTOGRAPHIC DIGITAL IMAGING GUIDELINES

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These 12 guidelines—provided as a Quick Guide plus an in-depth Complete Guide—aim to clarify the issues affecting accurate reproduction and management of digital image files. Although they largely reflect a photographer’s perspective, anyone working with digital images should find them useful. The guidelines have three primary goals:

- ◆ Digital images should look the same as they transfer between devices, platforms and vendors.
- ◆ Digital images should be prepared in the correct resolution, at the correct size, for the device(s) on which they will be viewed or printed.
- ◆ Digital images should have metadata embedded that conforms to the IPTC standards, thereby making the images searchable, providing usage and contact information, and stating their creators or copyright owners.

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## Who Wrote These Guidelines?

The guidelines were prepared by the [UPDIG Working Group](#), an ad-hoc industry consortium whose logos are shown below, along with allied trade groups and manufacturers.

The UPDIG guidelines aim to clarify issues affecting accurate reproduction and management of digital image files. Although they largely reflect a photographer’s perspective, anyone working with digital images should find them useful.

If you are interested in joining this initiative please contact UPDIG ([info@updig.org](mailto:info@updig.org)) and indicate the trade organization or group that you are representing.

## Quick Guide

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### 1. ICC Color Management

ICC profile-based color management defines color information in standard terms necessary for proper reproduction of images. Devices such as monitors, printers, scanners and, ideally, cameras should be profiled. Working and output spaces, such as Adobe RGB, sRGB, SWOP CMYK, (etc.), should be embedded and preserved when opening files. *Discussion and further details on page 5.*

### 2. Monitor Calibration

Monitors should be calibrated and profiled with a hardware device. Visual calibration is not adequate for professional image editing. An accurate visual representation of the image is extremely important to the imaging process. Calibration standards range from:

- ◆ Gamma: 1.8 to 2.2
- ◆ White point: 5000K to 6500K
- ◆ Brightness levels: 80cd/m<sup>2</sup> to 140 cd/m<sup>2</sup>

As a general calibration guideline, use Gamma 2.2 and 6500K for both Windows and Mac. If you are preparing files for offset printing, you may find that most printers use Gamma 1.8 and 5000–5500K, particularly if they are using Mac computers. Brightness levels are set in relation to the room’s ambient lighting.

A calibrated and profiled monitor, in conjunction with good print profiles, will allow you to “soft-proof” the intended output. A daylight (5000K) light source at correct brightness is necessary to visually match monitor to print. *Discussion and further details on page 6.*

### 3. Color Space

Camera settings for color space are critical when shooting TIFF or JPEG files. Color space for RAW files does not need to be set in the camera because it can be set in post-production. Choosing a large-gamut space such as Adobe RGB is better for image editing, while shooting a narrow-gamut space such as sRGB is convenient if images do not require color correction or editing, or if the images are intended for Web or sRGB lab prints. One consideration: A wide-gamut space can always be converted to a narrow space such as sRGB, but a narrow-gamut space converted to a wide space will not recapture the extra gamut.

Offset printing requires the CMYK color space, a very different color space from the RGB color space produced by digital cameras. Converting from RGB to CMYK requires knowledge and skill, not just a simple mode conversion in Photoshop. CMYK conversions are best when done by someone with knowledge of the specific press and paper type.

Photo lab prints usually require the sRGB color space. However, some labs may have a specific color profile either for embedding in the file or for use in soft-proofing. *Discussion and further details on page 7.*

### 4. File Formats

The best quality comes from shooting and editing in a RAW file format. The advantages of RAW file formats are: choosing color space when the file is processed; greater bit depth; ability to adjust white balance, saturation, exposure (to a degree) and tonal characteristics; adjustable noise reduction; and correction for lens aberrations—all in a non-destructive way. RAW files may be processed in a variety of software, from the camera maker’s own to many third party products, and even by using the built-in RAW processing of Apple and Windows operating systems.

Converting RAW files to DNG format is considered by many to be an excellent method for archiving RAW files. DNG is a more universal file format than camera-specific RAW formats like NEF or CR2. Camera formats are tied to each camera model and may not be supported by future software.

File formats include: lossy compression types such as JPEG; lossless compression types such as LZW, PSD and most RAW file formats; and uncompressed types such as standard TIFFs. For web, use JPEG. For printing, uncompressed TIFF is often preferred, although high-quality JPEGs (Level 10–12] can be visually indistinguishable from TIFFs and some printers prefer their smaller file size. *Discussion and further details on page 10.*

## **5. Naming Files**

To avoid problems with files that will be transferred across computing platforms, name files with only the letters of the alphabet, numbers, hyphens and underscores. Do not use punctuation or symbols. Keep the full name (including extension) to 31 characters or less, including the 3-letter extension. Use file names that will not be duplicated. Multiple files with the same name cause problems for computers and people alike. Including the numeric date is an excellent method for creating unique names. *Discussion and further details on page 11.*

## **6. Resolution**

Resolution of digital images is described either by pixel dimensions (width and height) for screen use or by physical size and resolution. Image resolution is expressed as pixels per inch (ppi), pixels per centimeter (ppc), or pixels per millimeter (ppm).

Inkjet prints normally need resolutions of 180 ppi to 360 pixels per inch (ppi) at the output size. Continuous-tone printing typically requires resolutions of 240 ppi to 400 ppi.

The offset-printing standard is often considered to be 300 ppi. But resolutions of 1.3–2 times the halftone-screen ruling for the project are considered safe. For instance, if the images will be printed at 150 lpi, the appropriate image file resolution range would be 195 ppi to 300 ppi. Higher resolution files do not necessarily produce better prints. *Discussion and further details on page 12.*

## **7. Sharpening**

Capture sharpening is required to compensate for the loss of detail that occurs during any digital capture process. TIFF and JPEG capture allows for sharpening in-camera or during post-production. RAW files are sharpened in post-production. Images should not be heavily sharpened early in the image-editing process.

Process sharpening counters the loss of detail in the reproduction process. It is done after color- and tone-correction, retouching, image sizing, etc. (In a RAW file program, capture and process sharpening can be done as one step.) The goal is an image that is acceptably sharp for viewing at its current size, but never over-sharpened.

Output sharpening is specific to the final output size and the output system (printing device, paper, ink, etc.) and is applied only as a final step before output. It is important to communicate whether output sharpening has been applied when images files are delivered. *Discussion and further details on page 12.*

## **8. Metadata**

The IPTC Core Schema is the current standard for embedding metadata in image files. Embedded metadata should include Creator and Copyright information as well as searchable keywords. Including useful and relevant information in metadata adds value to the image. *Discussion and further details on page 14.*

## **9. File Delivery**

Digital image files may be delivered on a variety of removable media, including hard drives, CD-Rs or DVD-Rs. Do not use adhesive labels on optical media, since they may separate and damage an optical drive. Printing directly on inkjet-writable CD-Rs or DVD-Rs is a good way to provide information such as your copyright, usage license, file lists and disclaimers. For speed and convenience, electronic delivery by FTP or e-mail may be used. All image files should have embedded metadata. (In the case of proprietary RAW files, the safest route is to have the metadata included in a sidecar file.) Image file delivery should include *ReadMe*\* files. *Discussion and further details on page 15.*

## **10. Guide Prints and Proofs**

Guide prints and proofs can serve as a valuable reference point for digital files, especially if the recipient is unknown or the output profile is generic. Creating guide prints and proofs that accurately represent offset CMYK printing requires knowledge of printer profiles and color management. The method in which the guide print was produced should be clearly conveyed. *Discussion and further details on page 15.*

## **11. Archiving**

It is important to address the issue of who will archive digital image files. Basic decisions include what kinds of files will be archived and how the archives will be protected from format obsolescence and media failure. *Discussion and further details on page 16.*

## **12. Digital Image Workflow**

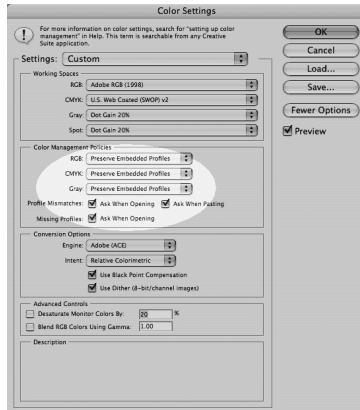
No single workflow suits all photographers or all clients. A good digital workflow is the most efficient and automated way to get the job done. It should satisfy the clients' needs, embed necessary information [metadata], embed color profiles, and automate the archiving and backup of files. A good workflow saves time and protects against both loss of images and loss of work done to the images. There are many software options to choose from when you are constructing a digital workflow. New programs that aim to be all-in-one solutions are constantly being introduced. You will need to test to see which programs, or combination of programs, give you the right combination of efficiency, speed, and quality. *Discussion and further details on page 18.*

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\*It is important to provide a *ReadMe* file in either PDF, HTML, or TXT format with all files that you deliver for output. Such files should specify image size(s), color space(s), the copyright owner's contact information, any licenses granted and, if certain rights are being withheld, the words "other uses, reproduction or distribution are specifically prohibited." The *ReadMe* file should also include disclaimers noting that recipients are responsible for following an ICC-based color management workflow.

## ICC Color Management

ICC\* profile-based color management is the standard. ICC profiles define color information in standard terms necessary for proper reproduction of images. All devices (scanners, printers, monitors and, ideally, digital cameras) should be profiled and profiles should be embedded in image files. When opening files, software needs to be configured to preserve embedded profiles and to warn of mismatched profiles or of files with no embedded profiles.



Photoshop CS2 color settings dialog, highlighted to identify the options of particular concern for color management.

**Camera profiles:** It is possible, but not strictly necessary, to create custom camera profiles. Used properly, they can offer a different color look or speed the workflow by saving time in post-processing. Profiling packages are available from [Gretag MacBeth](#) and [Integrated Color](#). The main issues with camera profiles are how well they work when the lighting changes from the profile setup, where and when the profiles should be applied, and how multiple cameras with separate profiles can be handled in a workflow. In addition, most digital camera sensors respond differently to tungsten lights and daylight, so at a minimum, you would need to have two profiles per camera for that reason alone. Another complication is that not all RAW processing programs support custom camera profiles. Given today's technology, photographers have to decide which combination of color look and workflow they like, or at least can live with.

**Adobe Camera RAW calibration:** [ACR](#) is one example of a RAW processing application that has built-in camera profiles (one for daylight and one for tungsten) for each camera model it supports. Although ACR does not support custom camera profiles, it does have a Calibration feature that allows you to adjust your camera sensor's response to a known color target such as the GretagMacbeth 24 color checker. The calibration process can be automated: Photograph the Macbeth 24 checker target, run [Tom Fors' script](#), name and save the resulting calibration. The calibration can be applied to all the RAW files of a particular camera model. Since Adobe Camera RAW applies different camera profiles for daylight and tungsten lighting, you need to run at least two calibrations. We say "at least" because the calibration may also change incrementally for different ASA/ISO settings. *A good guide to this technique can be found at the [Visual Vacations](#) site.*

**Inkjet and dye-sub printers:** You can easily bring printers (including desktop and wide-format printers) into a color-managed environment via profiles. If working with the manufacturer's printer driver, turn off all color management and print a copy of the color target file. Next, measure the printed target with a spectrophotometer to generate a profile for accurate output on a particular paper or other medium. Repeat this process for each paper stock and ink type that you use. If you do not own profiling software or a spectrophotometer, you can use one of several service providers, such as [Chromix](#). Most RIP (raster image processor) software offers profiles for a wide variety of papers. Many RIPs will also allow use of custom profiles.

**Offset printing:** Two organizations in the United States have produced standards for the printing industry that would allow for standardized CMYK profiles. They are the [SWOP Committee](#) (Specifications for Web Offset Publications), covering web presses, and [GRACoL](#) (General Requirements for Applications in Commercial Offset Lithography), which covers sheet-fed printing. The two standards, SWOP TR001, and GRACoL's DTR004, if widely adopted, would do away with the need to worry as much about custom CMYK formulas.

In Europe, organizations such as [FOGRA](#), [ECI](#) (European Color Initiative), and [IFRA](#) work on standardization of the printing industry. They have published general color profiles for several printing conditions. These profiles,

\*Web links for underlined items appear on pages 23–24.

based on the ISO 12647-2 standard, can be [downloaded from ECI](#). Several larger print houses recommend them as CMYK profiles for their production. They also have great acceptance as proofing profiles.

When a photographer has the expertise, it's best to provide the printer with CMYK image files embedded with the printer's custom CMYK profile. If the printer does not have a custom profile, it's best to consult with the printer or the client's production expert to determine the best color space for the delivered files. A standard Photoshop CMYK profile that matches the general press conditions—sheetfed coated or uncoated, or web coated or uncoated—may suffice, particularly if the printer adheres to ISO, SWOP or GRACol specifications. In this period of flux, communication is key. Profiles will also enable you to produce guide prints or aim prints (*see page 15*) for clients, providing a printed reference for the press operator to target for color-matching purposes.

## Monitor Calibration

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Computer monitors must be calibrated and profiled before they can be part of a professional workflow. Accurate monitor calibration and creation of a display profile requires a hardware device, such as the [Gretag-MacBeth Eye-One, Color Vison Spyder2](#), or [Monaco Optix XR](#). Another useful tool is a Profile Verification Kit (for instance, [the one by Pixl Ltd](#)). This is a digital file with an accompanying proof or print. After profiling your monitor, you view a comparison between the digital file, displayed in Photoshop (or other professional imaging software), and the proof print, as viewed under 5000K/D50 lighting, to indicate whether your monitor profile is accurate. If your work requires inkjet prints for display, you may do better to evaluate the images under 6500K/D65 lighting—and in some cases a dual-color viewing booth could be a useful investment.

**Working Environment:** No matter how good your monitor or how well you have it calibrated and profiled, you must take care that your working environment is subdued neutral lighting that does not vary throughout the day. Your computer desktop should be set to a neutral gray, and you should avoid having areas of bright color within your field of vision, or reflected in the monitor. This would include brightly colored clothing or brightly colored blinds, as any color reflected onto the screen is likely to influence your perception of the color it produces. If blocking off all windows in your editing room is not feasible or desirable, you can still achieve some measure of accuracy by creating a “daytime” profile and a “nighttime” profile, switching between the two.

**Display Types:** There are two types of display technology in use today: CRT and LCD. CRT (cathode ray tube) displays are rapidly being replaced by LCD (liquid crystal display) monitors. Professional grade CRTs such as the Sony Artisan are in fact no longer being made.

CRT monitors should be calibrated before they are profiled since they have hardware controls that alter the RGB amplifiers as well as controls for black level and luminance. The hardware device and software are used first to adjust the RGB guns to the desired white point (often called color temperature, although they are not quite the same concept) and black point (if available on your display system), and then the calibrated CRT is profiled. The display profile is then used by color-savvy programs such as Photoshop to display accurate color.

LCD displays often only have brightness controls, although some also have a contrast control. Some LCDs have color temperature controls, but these actually only adjust the CLUT (color look up table), and if much different from the native color temperature, can cause reduced color gamut and banding. For that reason, when profiling an LCD, it is best to adjust only the brightness control and contrast control, and let the profiling device set the desired white point through the display profile.

**Direct Digital Communication (DDC):** DDC allows for the display's brightness, contrast, white point and gamma to be adjusted through the profiling device and software. This will save time and improve precision when calibrating and profiling monitors. When shopping for a new monitor, its best to choose a DDC-compliant display if possible.

**A good guide:** Whether you use the Monaco Optix product or not, Monaco has an excellent [PDF manual](#) that explains in detail how to calibrate and profile both CRT and LCD monitors.

**Choosing white point and gamma settings:** The whole purpose of monitor calibration and profiling is to create a situation where the image on your monitor is a close match to the image as it will appear on a print, a proof, a press sheet—or, if your work is destined for the web, as viewed on the average un-calibrated PC or Mac monitor. The white point may range from 5000K (yellow–red) to 6500K (bluer). The gamma correction may vary from 1.0 to 3.0. The monitor’s luminance may vary from 80 cd/m<sup>2</sup> to 140 cd/m<sup>2</sup>.

There is not a single standard for white point, gamma and luminance because there is not a single standard for what you are trying to match. If you are working in pre-press, you will want to match press proofs and press sheets. For this, you may find that a white point of 5000K or 5500K and a gamma correction of 1.8 will give you the best match of monitor to proof or press sheet as viewed under a 5000K light. The appropriate luminance may be around 100cd/m<sup>2</sup>. If you are preparing files for ink-jet or light-jet printing, you may find that a white point of 6000K or 6500K will give you the closest match, although you should always view the prints under the color temperature of the lighting that will be used to view them. One reason that a higher (bluer) white point often works best for display prints is because optical brighteners are often used in display print media. Once again, monitor luminance should be chosen to match the appearance of the display prints in the viewing condition. The gamma correction (1.8 lighter, 2.2 darker) should also be evaluated with the viewing conditions and the contrast characteristics of the printer in mind. Image files being prepared for the web should be prepared on a monitor calibrated and profiled to the sRGB standard gamma of 2.2 and white point of 6500K. This will be a compromise between the uncalibrated Mac gamma standard of 1.8 and the uncalibrated PC standard of 2.4. It is also a reasonable compromise between a prepress monitor calibrated to 5000K, and an uncalibrated PC monitor, which may be in the 7300K–9300K range.

**Native white point:** There is a good argument for keeping things simple with the current crop of LCD monitors: Simply profile using native color temperature and native gamma, and let your eyes adjust to the difference between the monitor and the print or proof. The strength of this argument is that doing so will ensure that you get the widest dynamic range the monitor can produce. It will also minimize artifacts, banding and posterization, which become more noticeable as you force a monitor (especially an 8-bit monitor) farther from its native white point and gamma. If you do choose a custom white point and gamma, it is a good idea to evaluate the resulting profile with a utility such as Dry Creek Photo’s [Black Point Check](#) and [Grayscale Test](#).

**More about gamma:** There are more choices for gamma than 1.8 and 2.2. Some calibration software allows you to choose a custom gamma. Other software allows you to edit the gamma curve, and one product, Integrated Color’s [ColorEyes Display](#), has “L\* gamma,” which creates separate tonal curves for the shadow areas, mid-tones, and highlights. It is said to provide smoother transitions, and therefore more accurate color reproduction.

**Monitors of the future:** The current LCD technology uses a white fluorescent backlight. NEC has produced a new type of LCD that uses red, green and blue LEDs (light emitting diodes) that combine to produce a white backlight. The advantages are a wider color gamut, greater dynamic range, and the ability to adjust the white point without compressing the color gamut. NEC has made a [white paper](#) available that explains this new technology and its advantages.

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## Color Spaces

Camera settings for color space are critical when shooting TIFF or JPEG files. (Color space settings are irrelevant for RAW files, since color space will be determined in the RAW file processor.) Most professional digital cameras allow the output color space for JPEG and standard TIFF to be selected in the camera, with usually two options: sRGB and



Adobe RGB. Photographs meant for high-end printing should be captured in a large-gamut space, such as Adobe RGB. Photographs meant for consumer-level printing or only for the web can be captured in the narrower-gamut sRGB color space.

**Embed the profiles.** All digital files should have embedded profiles (should be “tagged”), unless otherwise noted. Photoshop’s color management policy should be set to “always preserve embedded profiles,” and the “ask when opening” boxes should be checked to alert you to profile mismatches and missing profiles. When profile mismatches occur, you should elect to preserve the embedded profile.

**Assigning vs. Converting:** Assigning profiles can change image appearance without changing the original image data. Assigning is used when the original file has no embedded profile or the embedded profile is of dubious origin. You may then assign an appropriate profile using the preview facility in Photoshop. This is necessarily a subjective decision, but it enables files to enter the workflow with a (hopefully well chosen) definition of intended color space.

Assigning a profile changes the appearance of an image, but not its pixel values. In contrast, converting to a different color space does the opposite: It changes the pixel values without adjusting the appearance. The purpose of converting is to transform the color space of the original file to the color space of the destination device as accurately as possible.

*See footnote for a primer on embedding, assigning and converting.*

### **Color Space Recommendations**

- a. **Open-ended uses:** When the final use of an image is not known, such as stock photography, or when the client will make multiple uses of the images, best practice is to supply a file in the Adobe RGB color space, with the Adobe RGB profile embedded.
- b. **World wide web presentations:** Convert images to sRGB and embed sRGB profile before delivery.
- c. **Display prints from professional digital color labs:** A custom profile, obtained from the lab and used for your soft proofing, is the only way to have some assurance over final output. Then submit either an sRGB or (more rarely) Adobe RGB file with that profile embedded. If a lab does not have a custom profile, it’s usually best to use the sRGB color space with that profile embedded, though the inability to soft proof means less control over the output process. A better solution would be to find a lab that fully implements color management and provides custom profiles.
- d. **Display prints from consumer digital-print vendors:** There is a free database of ICC printer profiles for digital labs worldwide at the [Dry Creek Photo site](#). The printers covered include Fuji Frontier, Noritsu, Agfa D-Lab, LightJet, Durst and Chromira printers, among others. Because most of these printers do not recognize embedded profiles, it is necessary to convert your files to their profiles, then save them with the profile

Every imaging device describes color in its own way, based on its physical characteristics. To use a metaphor, we may say that each device has its own “language” for color; some languages have a large vocabulary, others a small vocabulary, and some contain words that are simply not available in other dialects. To make translations possible among all the languages, we need a universal “reference language” with a huge vocabulary. This is the role of CIE Lab, which is a theoretical color space containing every color the human eye can perceive.

Continuing the metaphor, ICC profiles are dictionaries that provide the CIE Lab equivalent for every word in a particular dialect—that is, for every color that a specific device can represent. *Embedding* a profile in an image file is (metaphorically) sending the dictionary along with a document; it gives the recipient the information needed to understand all the words. It does not guarantee that the recipient’s language will have the words to translate the document perfectly, but where the words don’t exist, the recipient should be able to approximate the meaning with reasonable success.

*Converting* a file from one profile to another, in our metaphor, is writing out a translation. And, as with human languages, something is always lost in translation. It is therefore advisable to minimize the number of conversions that are done.

Failing to embed a profile amounts to sending a document without revealing what language it was written in, forcing the recipient to guess. Computer programs don’t guess, of course; they use a default setting and carry on blindly. A human operator, however, may try a number of different possibilities to see which one gives the most pleasing result. (This may or may not be the result that the sender intended.) This is done by *assigning* a profile to the image—instructing the program to act as though that profile had been embedded. Having settled on a profile, the human can then embed it to avoid further trouble. We are indebted to the Institute of Quality Assurance’s [Digital special interest group](#) for this metaphoric explanation.

embedded. Converting to these profiles will give you the best color fidelity and allow you to soft-proof your digital files before committing them to print.

Labs that don't use profiles usually require that submitted files be converted to sRGB. Using the sRGB color space instead of a custom profile may yield less accurate color that doesn't take advantage of the full gamut such printers can produce. To avoid confusion on *your* end, it's still best to include the embedded profile, even if the lab will ignore it.

- e. **Offset printing:** It's always best to begin by asking the printer or the client's production expert what file format, resolution and color space are preferred. RGB files contain many colors that cannot be reproduced by conventional CMYK printing. This has often led to a situation where the final result looks nothing like the screen version or the inkjet print of the file. There are three ways to avoid this confusion:
- ◆ If the photographer has the necessary experience and knowledge, digital images can be delivered as CMYK data. This can be the best way, since the photographer knows what the image should look like.
  - ◆ Files delivered as RGB files can be accompanied by a cross-rendered guide print (*see page 15*) that includes only colors reproducible in CMYK.
  - ◆ Files can also be delivered in both CMYK and RGB. This allows the photographer to make the artistic decisions about color rendering, yet also gives the printer more tools to recover from mistakes the photographer may have made in converting RGB to CMYK.

Ideally, CMYK image files should be converted from RGB using the printer's CMYK profile (*see below*) with that profile embedded in the file. However, it is not always possible to get the printer's profile, either because the printer does not have one or the client does not know who will print the images. In such cases, it's often best to deliver an RGB master file\*, with an embedded profile and a ReadMe file that explains that "for accurate color, the embedded RGB profile should be preserved when opening the file."

- f. **Inkjet and dye-sub printers:** Use a wide-gamut color space, such as Adobe RGB or ProPhoto RGB, for the source space. These printers have internal RGB-to-CMYK conversion algorithms, so they should be profiled in RGB and no secondary conversion to CMYK should be done. Use a custom profile\*\* for the printer-paper combination in the print space to get the best quality and the best match to a profiled monitor.

### Converting Images to CMYK for Offset

We strongly recommend that all offset printers adopt the ICC standards. Currently, there is tremendous variation among offset printers, and nothing can be taken for granted. For many years, offset printers used a "closed loop" color-management approach. They scanned film on drum scanners with software that output directly to CMYK. The CMYK was targeted to a proofing device, the customer approved the proof and the press was adjusted until its output matched the proof. Color settings were built into the workflow, not applied to files. This meant that printers could not offer custom CMYK profiles for digital files created outside their shops.

Today, with 60 to 80 percent of images intended for print arriving as digital files, offset printers are moving away from the closed-loop workflow. A single printed piece often includes digital image files from many different

\*RGB master files are Photoshop (.PSD) or TIFF files, optimized in a wide-gamut color space (such as Adobe RGB or ProPhoto RGB), at either at the digital camera's native file size or interpolated to a larger size (consistent with any possible future use) by a RAW file conversion program. They should be left unsharpened, or be sharpened only on a removable layer, since resizing for future uses is likely. Master files should be archived along with the RAW files for a project.

\*\*You can easily bring desktop and wide-format printers into a color-managed environment with the help of profiles. If working with the manufacturer's printer driver, turn off all color management and print a copy of the color target file. Next, measure the printed target with a spectrophotometer to generate a profile for accurate output on a particular paper or other medium. Repeat this process for each paper stock you use. Most RIP (raster image processor) software offers profiles for a wide variety of papers. Many RIPs will also allow use of custom profiles.

sources. It is increasingly likely that an offset printer will have a CMYK profile that describes its proofing device's color space. As a general rule, an offset printer should be able to match the output of its proofing device.

Many times, digital image files must go to several different printers, or a project is photographed and delivered before a printer has been chosen. In such cases, it may be best to deliver RGB master files. These should always have an embedded RGB profile to ensure accurate color when they are converted to each printer's specific CMYK profile.

Send RGB image files (especially Adobe RGB) to a printer only if the shop has experience converting RGB files to CMYK—and then only if the printer will provide a “random” or a contract proof. If a printer has a clear understanding of ICC profiles and requests RGB, it's best to submit files in Adobe RGB or, possibly, the narrower-gamut ColorMatch RGB. If a printer cannot ensure preservation of the embedded profile before converting to CMYK, it is better to provide files converted to a general-purpose profile, such as SWOP Coated V2 CMYK, ColorMatch RGB or sRGB, with the appropriate profile embedded in the file.

## **Resolution**

After color profile issues, file resolution is the issue that most often stands between you and high-quality reproduction. *This is the subject of its own discussion beginning on page 12.*

## **File Formats**

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File formats vary widely; they include lossy compression types such as JPEG and JPEG2000, lossless compression types (LZW, ZIP, most RAW file formats), and uncompressed types such as standard TIFFs. For images destined for the web, use JPEG. For printing, uncompressed TIFF is often preferred, although high quality JPEGs are usually visually indistinguishable from TIFFs and may be preferred by some because of file delivery or storage considerations.

Between capture and final output is an important intermediate step: **the RGB master file**. RGB master files are Photoshop (.PSD) or TIFF files, optimized in a large-gamut color space, such as Adobe RGB or ProPhoto RGB, at either the digital camera's native file size or interpolated to a larger size (consistent with any possible future use) by a RAW file conversion program.

(We should mention that there are some caveats with choosing an extra-wide gamut space such as ProPhoto RGB instead of Adobe RGB. While the larger gamut does imply a wider range of image data preserved ‘down the line,’ it also implies bigger image transformations, possibly with bigger shifts in the color of the image, when it is converted to a narrow-gamut color space such as CMYK. In addition, an extra-wide color space necessitates the use of 16-bit image editing to avoid problems such as posterization or banding.)

RGB master files should be left unsharpened or sharpened only on a removable layer, since resizing for future uses is likely. Master files should be archived along with the RAW files for a project.

**RAW File Format:** Although you should capture images in the best quality that your workflow requires, the best quality clearly comes from using the RAW file format. The advantages of RAW file format are:

- ◆ The photographer can choose a different color space each time the file is processed.
- ◆ The file offers greater bit depth.
- ◆ The processing operation can adjust white balance, saturation, exposure (to a degree), tonal characteristics, noise reduction, and lens corrections, all in a non-destructive way.
- ◆ Many RAW processors have sizing algorithms that (some say) are superior to interpolation in Photoshop, since they are working with the RAW data—the actual pixel data captured by the camera's imaging sensor.

- ◆ RAW files may be processed in a variety of software, from the camera maker's own tools to many third-party products, and even the built-in RAW processing of Apple and Windows operating systems.

**The RAW file issue:** While UPDIG advocates shooting RAW format files whenever your workflow supports it, there are several potentially negative issues with RAW file format as opposed to shooting JPEG or TIFF. Most serious is the issue of proprietary, undocumented RAW file formats becoming obsolete, unsupported, and eventually inaccessible. (A good analysis of this problem is found at the [Luminous Landscape site](#).) In addition, there are workflow problems associated with RAW file formats. Proprietary RAW files need to be converted to another format, or must be paired to sidecar files, before metadata can be safely added. If the RAW files are converted to a standard format such as TIFF or JPEG, they lose the ability to be non-destructively edited. If they are paired to sidecar files, they are harder to manage, and no cataloging software can read the information contained in the sidecar files. Even to proof-print RAW files, so your client can see your intended interpretation of the file, usually requires a batch conversion to another file format. There are several interesting ways that this problem may eventually be resolved.

- ◆ **OpenRAW:** The [OpenRAW](#) organization hopes to persuade camera makers to provide open documentation of their proprietary RAW formats. Open documentation would improve the archiving outlook. At the same time, it would enhance the ability of third-party developers to create better RAW file processors and more timely support for new cameras and their RAW formats.
- ◆ **DNG (Digital Negative):** Another approach is Adobe's open-architecture [DNG file format](#). While Adobe characterizes DNG as an openly documented format, some people have objected that it can contain undocumented information, such as camera-maker notes, and can even contain encrypted data. Others object to the fact that it is not universally accepted and can be used by only a few kinds of software or cameras. DNG, however has several important positive features. According to the [OpenRAW survey](#), Adobe Camera RAW has more than twice as many users as the closest competition; nearly 70% of photographers say they always, usually or sometimes use it. One of the reasons is that it is unique in its ability to combine the functionality of a standard RAW file with the capability of safely accepting metadata. In addition, a DNG file can contain a full-size, color-corrected JPEG that is visible to cataloging software. These JPEGs can be used to make prints, or can be extracted and delivered to clients as high resolution files. And, although it makes for a large file to archive, a DNG file can contain the original proprietary RAW file, which can be extracted and processed anew at a later time.
- ◆ **New RAW file handling software:** Competing with the camera vendors' software, Adobe's Bridge/Adobe Camera RAW, and such stand-alone applications as [Bibble](#), Nikon's [Capture NX](#) and Phase One's [Capture One](#) are new types of "RAW file handling" software. Examples include Apple's [Aperture](#) and Adobe's [Lightroom](#). These applications aim to be an all-in-one solution, handling everything from start to finish: ingesting files, browsing and selecting, rating, adding metadata annotations, cropping and image editing, printing, creating slide shows, and cataloging. Whether they prove to be indispensable tools is yet to be seen; it will depend on how they develop and how universally they are adopted.

## Naming Files

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To avoid problems with files that will be transferred across computing platforms, name files with only the letters of the alphabet and the numerals 0 through 9. Avoid punctuation marks (other than hyphen and underscore), accented vowels and other special characters. Keep the full name (including extension) to 31 characters or less for files on a network or removable media. Keep names to 11 characters or less (including the three-letter file extension) when burning to CDR, in case a recipient's computer doesn't support long filenames. Use a single "." (period) between the file name and the file extension.

Use file names that will not be duplicated. Multiple files with the same name cause problems for computers and people alike. There is a great risk that a newer file will automatically overwrite an older file if they have the same name. Including the numeric date as part of the name is an excellent way to avoid duplicate names. *For the complete guide to file naming protocol, see the [Controlled Vocabulary website](#).*

## Resolution

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Besides color profile issues, perhaps the biggest stumbling block to quality reproduction is inappropriate file resolution. Some digital cameras produce a native file that is marked as  $x$  inches high by  $y$  inches wide—at 72 ppi (pixels per inch). This sometimes results in printers receiving files of the correct height and width, but insufficient resolution. This mistake is so common that printers have a mantra that all files need to be 300 ppi when the image is sized to the final height and width to be printed. As a generalization, this is not bad. However, if you have good communication with a knowledgeable printer, you can use the more sophisticated standard of setting the file's resolution (expressed in pixels per inch) to 1.3 to 2.0 times the halftone-screen ruling (expressed in lines per inch) for the job.

Files that are of lower-than-optimum resolution will not deliver as much image detail and crispness as the output device is capable of. Excessively high resolution, on the other hand, is wasteful of computer resources; the surplus data can only be discarded, yet the file will take longer to transmit, more memory to process, and more disk space to store.

The resolution of digital images intended for computer displays is usually described by absolute pixel dimensions: width and height in pixels. For printing, width and height are often stated in inches, and a third value of pixels per inch (ppi) is then required. (Outside of the U.S., dimensions are stated in centimeters or millimeters, and resolutions are in pixels per centimeter [ppc] or per millimeter [ppm].) *Beware:* It's easy to confuse ppi with dpi (dots per inch), which refers to the resolution of a printing device, or with lpi (lines per inch), which describes a halftone grid or screen used for printing images on a press.

### Rules of thumb

- ◆ Low resolution images destined for computer displays (monitors) are best defined by pixel dimensions, such as 640 pixels wide by 480 pixels high.
- ◆ Inkjet prints normally need resolutions of 180 ppi to 360 ppi, such as 8 X 10 inches at 180 ppi
- ◆ Continuous-tone printing (e.g., on film recorders or dye-sub printers) requires resolutions of 240 ppi to 400 ppi.
- ◆ The offset-printing standard is often considered 300 ppi. But resolutions of 1.3–2 times the halftone screen for the project are considered safe. For example, if the images will be printed with 150-lpi halftones (often used for magazine printing), the appropriate image file resolution range would be 195 ppi to 300 ppi.

## Sharpening

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**Why sharpen?** To get the best quality out of any digital image, whether scanned from film or shot with a digital camera, you have to compensate for the mathematically unavoidable loss of perceived sharpness that results from digitization. Likewise, whenever an image is reproduced in a medium that relies on dots (whether they are the halftone dots of offset printing or the pixels of a computer monitor), there is additional, process-specific softening that must be anticipated and neutralized. Fortunately, there are good algorithms that perform the needed sharpening. For historical reasons, the sharpening process is often called “unsharp masking.”

**Capture sharpening:** Capture sharpening should compensate for softness introduced during capture. The goal here is to have the sharpest, clearest image for a client to view or use. If you are shooting JPEG and are trying

to minimize post-production time, it may work for you to find an in-camera sharpening setting that you like. If you put quality ahead of speed—and especially if you may want large prints later—it is best to do capture sharpening in post-production. If you are shooting RAW Files, you may find that using the sharpening controls available in your RAW processing program will work well for you. Sharpening with Adobe Camera RAW, for example, applies sharpening just to the luminance channel, which tends to minimize artifacts and noise issues. If you use another RAW processor, you should test the effect of sharpening on a noisy file to determine if the RAW sharpening adds to the problem.

**Noise:** All digital capture involves some level of noise. There are three situations where it's essential that noise removal be a part of the workflow:

- ◆ When shooting at high ISO.
- ◆ When shooting images where the highest possible quality is required, such as for stock or in images destined for large prints (even at lowest ISOs).
- ◆ Long exposures with early-generation digital cameras that do not have a built in noise removal feature.

If there are noise issues with your files that are more successfully corrected with a dedicated noise-removal program, it is best to sharpen after noise removal, and not before (that is, not in the RAW processor). One exception might be the new Bibble software which incorporates Noise Ninja into its RAW processor.

**Process sharpening:** Process sharpening is done at the end of whatever processing (editing, retouching, resizing etc.) is done to an image. Process sharpening corrects for the fact that changes in size, color, tone and color space all affect sharpness. It also may involve the photographer's creative decisions about how sharp the image *should* appear, including sharpening selected areas of an image for effect. This step may be left to the client if the photographer is delivering a quantity of images that are not being individually edited.

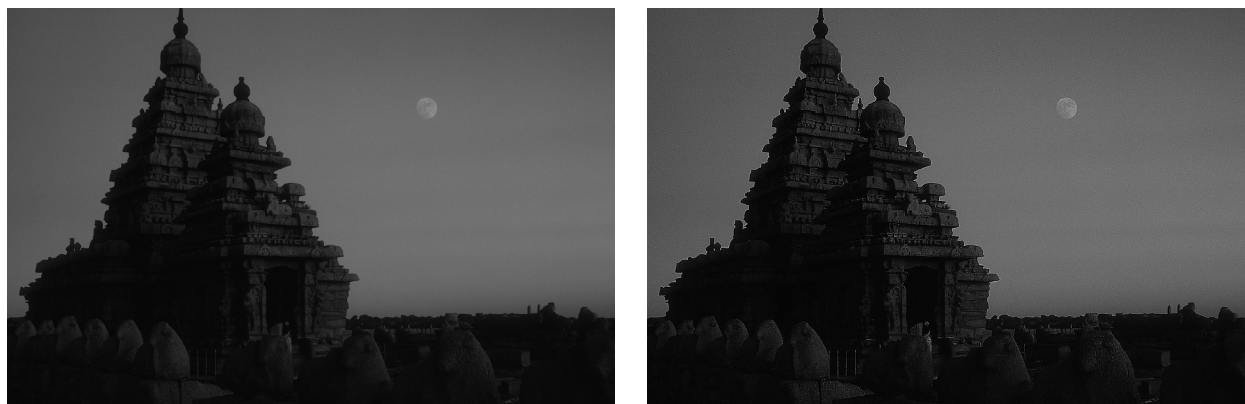
**Output sharpening:** Output sharpening compensates for the characteristics of the final output device, and it is based on variables such as final size, intended viewing distance and reproduction technology (offset, inkjet, dye-sub, etc.) It is applied only as the final step before output. Once again, you may choose to use Photoshop controls such as Unsharp Mask, Smart Sharpen, or one of the many third party plug-ins. If you are creating a master file (*see page 10*), you should save an unsharpened version, or save the sharpening on a layer, so that new sharpening can be done when the file is repurposed or resized. You never want to have to guess if a master file has been previously sharpened for output.

### ***Practical considerations***

It's important not to over-sharpen at any stage. The image should always be able to tolerate additional sharpening. Mild over-sharpening imparts a surreal impression, while gross over-sharpening creates obvious halos around objects.

In the example on the next page, the first image is correctly sharpened for its size, the intended display medium (offset printing) and the subject matter. The second image is over-sharpened, haloing the roof line.

**Who does it?** In principle, all sharpening could be deferred until final output. In practice, there are drawbacks: If you leave all sharpening decisions until the output stage, some photos may be rejected for apparent softness. In other cases, poor prepress work could mean the images are reproduced soft. If an image is shot sharp, it should be shown and delivered sharp. Using three stages of sharpening is ideal, but not always practical for workflow. Photographers should deliver images that at least have capture sharpening applied. If the photographer is editing or retouching images, he or she should then also apply process sharpening. Photographers should only deliver images with output sharpening if they are doing the final pre-press work. If the client or printer is going to resize or repurpose



The Shore Temple of the Seven Pagodas; photo © 1985 by David Riecks, [www.riecks.com](http://www.riecks.com).

the images, then the client or printer should be responsible for output sharpening. This should be clearly communicated when the files are delivered, perhaps with a ReadMe file. Some photographers like to deliver a final image file with output sharpening on a layer. By toggling the layer on or off, the client or printer can either use or redo the output sharpening—depending on whether the files are resized, retouched, or prepared for a different type of printer.

**Which tool?** Photoshop CS2's Smart Sharpen filter offers more control than Unsharp Mask because it can reduce sharpening amounts in highlight and shadow areas. There are also third-party plug-ins, such as Nik Sharpener Pro, Pixel Genius Photokit Sharpener, Focal Blade and others, that can fine-tune and automate the process. To accurately judge sharpening, the image should be viewed at 50% or 100% on screen. At other sizes, such as 33%, 66% or 200%, you do not see a true representation of the image; Photoshop is interpolating the pixels to create these views. It's also important to remember that the effects of sharpening look different on screen than they do when ink hits paper, so print tests should be made, ideally on the same device type that will be used for final printing.

## Metadata

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Metadata is “information about information.” In the case of images, we are including valuable information about the images that can then be entered in a database for later searches. Some metadata items, such as camera settings, document kind, size, resolution and creation dates, are automatically generated and embedded by cameras and software. Bulk-entered metadata or “repetitive” metadata, such as copyright notice, contact info, universal keywords, etc., can be added by the creator by means of an automated batch process. It is recommended that this bulk-entered metadata conform to the IPTC standard or, better yet, the newer [IPTC Core standard](#). Image-specific or higher-level “content rich” metadata, such as keywords and ratings, need to be added to specific image files or small groups of image files manually.

Bulk metadata can be added when image files are transferred to the computer by use of software programs such as iView [MediaPro](#) or [PhotoMechanic](#). Alternatively, bulk metadata can be applied in image-browser programs such as Adobe Bridge, or in cataloging software such as iView [MediaPro](#), Canto [Cumulus](#), or Extensis [Portfolio](#). However it is done, it should be done as early in the workflow as possible so that all derivative files of the same image will have the same metadata applied. If the original files are RAW files, there is an additional consideration, and that is whether you should attempt to insert bulk-entered and higher-level metadata into the RAW file, or use a sidecar file instead. There are enough instances of conflicts between metadata inserted with one kind of software and processing instructions inserted by another software that it seems prudent to either rely on sidecar files or convert to the [DNG file format](#). Conversion to DNG files removes the conflict issue since DNG files were specifically designed to safely hold metadata.

**The importance of metadata:** A good photograph of an interesting subject has value. That intrinsic value is multiplied by the inclusion of highly descriptive metadata within the file that:

- ◆ makes the image findable within image databases;
- ◆ describes the context of the image—place, time, etc;
- ◆ links the image to its creator.

The IPTC Core standard even has provisions for licensing information: the Rights Usage field, or in Photoshop, the IPTC Status field. The ability to connect an image to its author will likely become critically important if (when) the proposed [Orphan Works legislation](#) is passed in the United States and images without metadata become “orphans” in the eyes of potential users.

## File Delivery

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Digital image files may be delivered on removable media (removable hard drive, CD-Rs or DVD-Rs), or via FTP, web service or e-mail. If files are delivered on CD-R, the recommended disc formatting is ISO 9660 or “Mac OS extended and PC (Hybrid) CD.” When delivering images on a DVD-R, make sure the recipient can read the chosen format, since there are multiple standards.

Do not use adhesive labels on optical media, since they may separate and damage an optical drive. Printing directly on inkjet-writable CD-Rs or DVD-Rs is a good way to provide information such as your copyright, usage license, file lists and disclaimers.

Often speed and convenience require delivery by File Transfer Protocol (FTP) or a web-based service. Although not a preferred method, e-mail delivery usually works if image files are small in number and size and if both sender’s and recipient’s internet service providers permit large attachments. E-mail delivery sometimes works better if the image files are first compressed using lossless compression software such as WinZip or Stuffit. Check to make sure the recipient can access your specific version of compressed files. Delivery by FTP or e-mail usually precludes delivery of a guide print (*discussed below*), so a disclaimer should always be included to state that “accurate viewing and reproduction depends on the recipient properly applying ICC color management.”

It is important to provide a *ReadMe* file in either PDF, HTML, or TXT format with all files that you deliver for output. Such files should specify image size(s), color space(s), the copyright owner’s contact information, any licenses granted and, if certain rights are being withheld, the words “other uses, reproduction or distribution are specifically prohibited.” The ReadMe file should also include disclaimers noting that recipients are responsible for following an ICC-based color management workflow.

## Guide Prints and Proofs

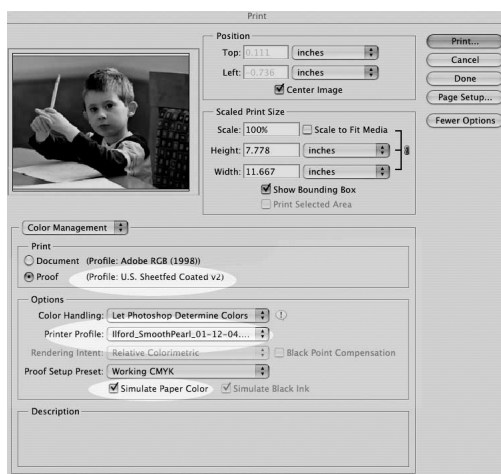
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Cross-rendered guide prints can serve as a valuable reference point for digital files, especially if the recipient is unknown or the output profile is generic. Profiling a desktop printer is critical for photographers who include digital guide prints with their digital files—a key part of these guidelines. This is particularly true with CMYK files submitted to an offset printer. Unless using a SWOP-certified proofing system, photographers should include disclaimers stating that guide prints are for color reference only and are not “contract” proofs.

Since inkjet prints made from RGB editing spaces may have wider color gamuts than available from an offset press, a guide print will more accurately reflect what is possible to achieve on an offset press if it is “cross rendered.”

Cross-rendering involves printing from your current output color space through an intermediate output color space to simulate the appearance of the final output space. For example, in the print dialogue, the “source” space





The Photoshop CS2 'Print with Preview' dialog, with highlighting to show the controls used in cross-rendering.

and special proofing media to closely simulate the actual press conditions. "Contract proofs" are considered guarantees by printers (or prepress houses) that press sheets will match the proofs.

A SWOP-certified proof provides additional precision when indicating the color of digital files delivered to an offset printer. SWOP-certified systems combine RIP software driving special proof printers. *More information on SWOP-certified systems is available from the [www.swop.org](http://www.swop.org) web site.*

## Archiving

It is important to address the issue of who will archive digital image files. Another basic decision is what kinds of files will be archived, how the archive will be protected from format obsolescence and media failure, and what kind of metadata scheme will be used to facilitate searches.

Without careful filing, it can be hard to find a specific image. However, most image file formats (including all of those that we recommend here) include space for metadata that facilitate cataloging and searching with a digital asset management programs (such as Extensis Portfolio or iView MediaPro). Embedding IPTC metadata in image files early in a workflow, paired with logical file numbering and naming conventions, speeds up cataloging and facilitates searching.

Storing multiple copies of image files on redundant hard drives is arguably the most convenient and least expensive solution to guard against data loss. Additional back-ups to CD-R or DVD-R media may be prudent. Note, however, that different brands and batches of CD-R and DVD-R media have different archival qualities. Use only media with high archival ratings; burn discs at lower speeds; do not use adhesive labels on discs; and write on discs only with non-solvent markers designed specifically for inscribing CDs and DVDs, writing only on the hub of the disc.

A prudent practice is to maintain a complete copy of your photo archive off-site. However, be aware of one potential problem with any type of online copy: If there is corruption in your primary copy and you have your system set to automatically clone it to the backup, you can corrupt the backup.

Over time, as operating systems change and new storage media emerge, it will likely be necessary to migrate your digital image files. Most businesses and institutions have been slow to recognize the need for digital asset management, so it generally falls to photographers to maintain digital image archives. It's wise to discuss archiving responsibilities with clients to avoid losing image files.

would be either the CMYK file or the CMYK proof space.

Choosing Relative Colorimetric as the rendering intent will limit a desktop printer's color gamut to the gamut of the CMYK file. If you use Absolute Colorimetric (or check the "simulate paper color" box in Photoshop CS2), you may more closely simulate the actual press sheet, since the whites will more closely match the duller white of the actual press stock.

Photoshop's settings for cross-rendering a print can be found in the Print With Preview dialog. Note that Photoshop CS1 does not have the "simulate paper color" checkbox.

A guide print should not be confused with, or referred to, as a "proof." That term refers to a "random" or a "contract" proof, provided by an offset printer or prepress house, and created from the actual films or plates used for press output. Direct-to-plate workflows create proofs with special printers, calibrated RIPs

## **Archival image formats**

RAW file archiving for DSLR users is likely to be one of the greatest challenges in the long-term maintenance of a digital archive. Because each camera model creates a unique file-type, the likelihood of files becoming unreadable at some time in the future is high. Photographers must develop a comprehensive strategy to use when confronting this issue: one that takes into account the probable obsolescence of file formats and the necessity of file format migration.

File format migration refers to the practice of conversing image files to a different (newer) storage format. This can come in the form of conversion to TIFF files, conversion to DNG files, or conversion to some future format not even in existence today. Each of these choices holds certain advantages and disadvantages regarding image quality, storage needs, and workflow requirements. Some of these concerns are outlined below.

**Conversion to TIFF files:** By converting images to TIFF format, the photographer is storing the images in the most accessible file format. Because TIFF is an open standard, it is likely to be readable for a very long time. TIFF also offers a workflow advantage: By converting to TIFF, you probably eliminate the need to reconvert the files again for many years, perhaps even for your lifetime. So images can be converted and archived with confidence that they are safely accessible long into the future.

There is a downside, however. TIFF files are much larger than RAW files. Converting image files to 16-bit TIFFs can make the files up to 10 times larger than RAW files, and 15 times larger than compressed DNG. This will clearly increase the cost of file storage (assuming other costs stay the same). The other downside to conversion to TIFF is that it precludes the use of better RAW converters that are surely coming in the future. Just as Photoshop CS2 does a better conversion than Photoshop CS does, it is likely that the RAW file conversion programs we will have several years from now will do an even better job than our current tools.

**Archiving RAW files:** If a photographer chooses to archive the RAW file, then he will be preserving the largest number of options for future conversion of the files. As conversion software improves, new versions of the file can be made that will have better color fidelity, or better noise reduction, or better upsizing interpolation. By keeping the RAW file intact, the largest number of future conversion options is preserved.

This, too, has its downside. RAW files will likely have to be converted to a more universal file format at some time in the future. This may involve the conversion and re-cataloging of hundreds of thousands of image files. If this conversion is not accomplished before that particular format becomes generally unreadable, then the conversion may simply never happen, and those images may be lost. Additionally, since RAW files are proprietary, it is not a safe practice to alter these files. This means that any work you do to these files, such as the addition of metadata or tonal adjustments to the image, should not be stored in the file itself. This is typically accomplished by the use of either “sidecar” files or the storage of these adjustments in some kind of larger database. The splitting of this information makes for a file-management challenge that may present a serious roadblock in the future, as you try to include this work in a conversion file. Although some software can add metadata to RAW files, there can be conflicts with Adobe Bridge not reading the processing information in the XMP file after metadata has been added to the file by another program. You should always test for anomalies before adding metadata to proprietary RAW files.

**Archiving DNG files:** RAW files can be converted to DNG, a documented TIFF-based format created by Adobe that can store the RAW image data, metadata, and a color-corrected JPEG preview of the image. The DNG file format provides a common platform for information about the file and adjustments to the image. Because of this, cataloging applications like iView MediaPro and Extensis Portfolio can see metadata that has been entered in Photoshop, and these programs can see the image adjustments made in Photoshop. DNG files can be re-opened in Photoshop as though they were RAW files, and offer the full range of conversion options in Photoshop that the original RAW file offered.

DNG is likely to be readable long after the original RAW format becomes obsolete, simply because there will be so many more of them than any particular RAW file format. Additionally, DNG offers significant file-size savings through a lossless compression that can reduce the file size by up to one third. DNG also offers the possibility of embedding the RAW file itself, so that it can be re-converted later if desired. Of course, this particular option makes the DNG almost double the size of the original RAW file, so it isn't always to be recommended.

There's a downside to DNG, of course. Conversion to DNG requires an extra step at the time of RAW file processing; it does not take terribly long, but it is an extra process. Also, by converting a RAW file to DNG, you currently preclude using the camera manufacturer's software for converting this file. If you like the conversions you get from the manufacturer's software more than the conversions you get from Photoshop, then DNG may be unacceptable.

The DNG converter attempts to copy "Undocumented Maker Notes" to the metadata of the DNG file. These maker notes might include information that could be useful in converting the file at a later date (such as "dust reference" information, or information helpful in correcting for chromatic aberration). By converting to DNG today, you may lose this data, since it is currently undocumented and it may not be copied correctly.\*

## Digital Image Workflow

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No single workflow suits all photographers or all clients. A good digital workflow is the most efficient and automated way to get the job done while capturing the most image information in the widest gamut for the widest possible uses in the future. It should satisfy the client's needs, embed necessary information (metadata), embed color profiles, save derivative files, and archive and back up files. A good workflow saves time and protects against both loss of images and loss of work done to the images. Choosing the best software to achieve these aims is key. Because digital photographic imaging is relatively new, photographers must regularly explain to clients the trade-offs between quality and cost in different workflows.

A film-based workflow is simple. Photographers deliver film, designers or art directors decide how pictures will be used, and offset printers and prepress houses handle conversion of the film to printing plates.

Digital cameras, along with scans from film by photographers and agencies, are now replacing historical workflows. While clients have been quick to embrace the speed and convenience of digital capture and delivery, they do not universally understand what is required to achieve the same quality levels that they used to expect from film. With the exception of those involved in high-volume, quick-turnaround workflows, most photographers must decide how to handle file preparation. Some photographers want to avoid the distraction of file preparation. Others have embraced it, because it allows powerful control over the reproduction of their images. Profiles and soft-proofing allow photographers to see how their files will look as display or press prints. Looking at soft proofs on their calibrated monitors, those who embrace file preparation can deliver to printers files that will reliably (if not precisely) reproduce on paper the optimized image files the photographers see on their monitors.

With some photographers embracing and others avoiding the details of file preparation, clients are understandably confused about who does this work and how much it costs. Many have tried preparing image files without first calibrating their monitors, yielding disastrous results. Some assume printers are accustomed to working with RGB files. However, a survey released in February 2005 by *Printing Color Digest* found that, of some 800 offset printers queried, only four accepted RGB files in their workflow. When you send an RGB file to an offset printer, the biggest risk is that a pre-press worker will open it in the wrong RGB color space, altering the color, then lock in the mistake by immediately converting the file to CMYK. If the printer receives an untagged RGB file, and

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\*This analysis of archival image formats was prepared by Peter Krogh. A more in-depth discussion of these issues, as well as all issues related to the creation and maintenance of a digital archive, can be found in his book, *The DAM Book: Digital Asset Management for Photographers* (O'Reilly, 2006). It's available [directly from the author](#), from [O'Reilly](#), or from [Amazon](#) and similar distributors.

there has been neither communication with the printer nor the inclusion of a ReadMe file that indicates the color space of the files, prepress will probably open the file in the shop's default RGB space, which may or may not be the space in which the file was optimized. Even when an image file is correctly tagged and its profile preserved when it's opened, there may be problems if a printer uses a RIP for CMYK conversion. Most RIP software does not use black-point compensation, and without it, some conversions can appear flat and unsaturated (muddy).

The workflows below are general in nature. They aim to illuminate options and possibilities rather than offer step-by-step guides. The ideal workflow is a moving target. It varies based on the nature of the project, the photographer's capabilities, the client's needs, and perhaps most importantly, the overall budget and time constraints. Photographers should adopt and adapt workflows to fit project parameters.

### ***High Volume, Quick Turnaround Workflow***

*Examples:* Most photojournalism, sports for newspapers and magazines, events, and most public relations.

The focus is on speed. There is a calculated trade-off between ultimate quality and speed of delivery. Consequently, such workflows were the first to replace film with quick digital capture. Some issues and solutions include:

- ◆ High quality JPEGs, captured in either Adobe RGB for print or sRGB for web, are suitable in many situations.
- ◆ Professional digital SLR cameras offer white-balance controls (with surprisingly accurate auto settings), in-camera sharpening and custom tone curves that can be applied at capture to generate JPEGs that are often adequate—if not optimal—for reproduction.
- ◆ Sometimes JPEGs must be reduced or compressed in the camera or afterward to meet transmission limits of bandwidth and time.
- ◆ It is expected that news organizations and printers have staff trained to receive transmitted photos and prepare them for either print, broadcast or web.
- ◆ Software such as PhotoMechanic allows embedding IPTC data on-the-fly as image files transfer from memory card to computer, saving time and ensuring that the file recipients have all necessary captioning, cataloging and crediting information.

### ***High Volume, Moderately Quick Turnaround Workflow***

*Examples:* Monthly magazines, institutional brochures, annual reports, web sites, theater and dance performances, and some types of advertising.

There is more focus on balancing competing needs for speed, quality and cost. This leads to many questions about who should do what. Some approaches and concerns include:

- ◆ *Whether to capture RAW files or high-quality JPEGs.* A single assignment can generate thousands of images that could take many hours to process from RAW files. If the photography is straightforward, the lighting is good (or at least not mixed), and the intended use is web, broadcast, newspapers or magazines printed on web presses, then JPEG capture may be fine. If the intended use is higher-quality, sheet-fed printing, if the lighting is mixed or requires a high ISO setting, if the final output will be full page or larger, or if there is a strong chance for higher-quality uses later, then capturing RAW files provides the best quality.
- ◆ *Presenting images to the client, art director or editor.* Although there are many good image file browsers, including Photoshop's companion browser Adobe Bridge, speed and convenience often require posting a web gallery for editing. If not captured in sRGB, which is the default color space for most web browsers,

copies of image files should be converted to that narrow-gamut space before posting to a web site. Usually, it's also best to reduce the resolution and compress the files to fit the viewer's screen and load quickly. Typically, proof images should be 500 to 1,200 pixels at their largest dimension (width or height), unless an editor or designer needs to see minute details. If you are using a DNG workflow, you can include an sRGB JPEG preview in the DNG file which can be used for creating HTML proofs, so you don't have to run a separate batch just for proofing JPEGs.

- ◆ *Delivering files for reproduction.* Clients have two basic choices: 1) order optimized image files from the photographer; or 2) receive camera files and take responsibility for optimizing their reproduction. Either way, if good reproduction is the goal, someone who understands color correction, contrast enhancement and sharpening techniques will need to optimize the files. Some formats for file delivery include:
  - ◇ Photographer delivers uncorrected, high-resolution JPEGs or TIFFs. At the very least, the photographer should embed and note the color space of the files, unless instructed otherwise by the printer. If the delivery method (bandwidth, size of media) can accommodate large files and the client has the needed software, hardware and expertise to deal with them, then 16-bit (48-bit RGB) TIFF files are probably best.
  - ◇ Photographer delivers proprietary RAW files. Although not recommended, this is now an option, since Photoshop's Adobe Camera RAW supports most camera RAW formats. However, the photographer should include .XMP files (the small "sidecar" text files that describe how the RAW file will be processed). Without them, the client won't likely know the photographer's intentions for color and tone. Working with RAW files also requires high-end computer equipment, recent software, a color-managed workflow and a good understanding of digital photographic processing.
  - ◇ Photographer delivers DNG files. If the photographer made corrections for color, exposure, etc., and then created DNG files with the full size JPEG preview option enabled, the recipient of the file would have the flexibility of a RAW file and the intentions of the photographer. Until more RAW processing software supports DNG format, this would limit conversion options primarily to Adobe Camera RAW and a few others, such as [Pixmantic RAWShooter](#), [DXO Optics Pro](#), and [Silkypix Developer Studio](#). Other RAW developers, such as [Phase One](#), have promised support, so the list should expand soon. (Most of these products now can only read a DNG file and convert it to TIFF or JPEG. Full support, with capability to read *and write* a DNG, may take longer to evolve.) The same requirements as for proprietary RAW files—high-end computers, current software, color-managed workflow—would apply.
  - ◇ Photographer delivers optimized, high-resolution TIFFs or JPEGs in an agreed RGB color space tagged with the appropriate color profile. Budget requirements—along with the variance of exposure, contrast and color between images—dictate whether and how much the photographer optimizes each file, or whether he or she batch processes them. Tradeoffs between cost and quality, along with the client's responsibility for adjusting final output, must be clearly understood by all. Some issues to consider include:
    - Whether to deliver 16-bit TIFFs to allow the widest possible adjustment by others further along the workflow. Client must have storage space, knowledge and processing power for such files.
    - Whether to sharpen the image before delivery. Sharpening is only appropriate for images delivered at final reproduction size and when the photographer fully understands the sharpening needs for the final use. If an image file is sharpened, this should be noted in an accompanying ReadMe file, on the delivery medium (e.g., the CD-R label), on the delivery

memo, or on the border of the image. Sharpening a duplicated, composite layer within an image file (TIFF or PSD only) allows a client better resizing options.

- Whether, how much and when to compress images as JPEGs. JPEG files are handy when many images must be delivered or delivery must take place with limited bandwidth or storage. But each time a file is saved as a JPEG, it loses image data and gains digital artifacts. The more a file is compressed, the more damage is done. When editing a JPEG file (whether created by the camera, scanner, or in post-processing), it's best to save the changed image as a TIFF or PSD (native Photoshop) file. Ideally, a photographer should only deliver JPEG files that are compressed slightly (10, 11 or 12 quality), optimized and sized precisely for output.
- ✧ Photographer delivers RGB master file.\* If the final use is offset printing, consider creating and archiving RGB master files. An RGB master file is used to create targeted CMYK files, which are sized, sharpened and profiled for the intended offset printer or press. The photographer can help ensure things go smoothly by delivering a “cross-rendered” guide print, as described in the earlier section on guide prints and proofs.

### **Low-Volume, High-Quality Workflow**

*Examples:* High-end advertising, photo-illustration, portraits, high-end editorial, architecture.

High-resolution cameras capturing RAW files, or high-quality film scans (usually from medium- or large-format film), are standard. Retouching, blending images and other special Photoshop procedures are common. Some photographers perform this work themselves, while others hire digital assistants or retouchers. Time and effort invested in postproduction often equals or exceeds that spent on image capture. Generally, post-production work yields an RGB master file.\* How such files are prepared for final uses depends on the clients' production needs. (*See the discussion of sharpening for more info.*) In some cases, it's best to deliver several different file versions derived from an RGB master file, such as a high-resolution Adobe RGB file, a screen-resolution sRGB file and an CMYK file optimized for the expected press conditions, possibly sized and sharpened.

### **High-Volume, High-Quality Workflow**

*Examples:* Product and catalog photography.

Methods are often similar to low-volume, high-quality photography. However, to speed production, the large number of image files often requires help from a digital service bureau or pre-press house. Some studio workflows—particularly for catalogs—where all conditions can be carefully controlled, can benefit from a JPEG workflow.

### **Workflow Tools and the UPDIG Guidelines**

Digital capture proved to be revolutionary in the sense that it provided options beyond film. Now that digital capture has become such a large factor in the creation of photographs, a second revolution is occurring, and that is the proliferation of software tools photographers can use to produce, edit, process and manage their digital image files. We are seeing a shift from Photoshop-style pixel editing to metadata-based image editing. This shift is occurring largely because of the nature of RAW files themselves. RAW files are not image files in the same way that JPEG or TIFF files are. RAW files are raw camera sensor data and do not become image files until they are processed according to a set of instructions created by RAW processing software in conjunction with user input.

\*RGB master files are Photoshop (.PSD) or TIFF files, optimized in a wide-gamut color space (such as Adobe RGB or ProPhoto RGB), at either at the digital camera's native file size or interpolated to a larger size (consistent with any possible future use) by a RAW file conversion program. They should be left unsharpened, or be sharpened only on a removable layer, since resizing for future uses is likely. Master files should be archived along with the RAW files for a project.

### **Preserving appearance**

***“Digital images should look the same as they transfer between devices, platforms and vendors.”***

Unlike JPEG or TIFF files, which (if properly color-managed) always look the same as they transfer between devices, platforms and vendors, RAW files will look different depending on the RAW processor and the user’s inputs.

The challenge, as UPDIG defines it, is to seek the emergence of a RAW file processing ecology that will allow the photographer or image creator to fix a RAW file rendering over applications and over time. As we discussed in the File Formats section, there are currently two ways to transfer a RAW file’s rendering intent: the use of some type of sidecar file (e.g., XMP, BIB), or the inclusion of a JPEG preview (the DNG approach). The trouble with sidecars is that they are separate files and might get lost, deleted, overwritten, or detached from their original RAW files. Additionally, most cataloging software—those who do not consider Apple’s Aperture or Adobe Lightroom to be effective cataloging solutions yet would say “all”—cannot read the sidecar files, with the result that the rendering intent is not reflected in those programs. Even if other applications could be made to read a variety of sidecar files, rendering intent would still very much depend on the rendering engine being used. Both the Mac OS and the new Windows Vista OS will have RAW file rendering built in, but the rendering results probably will be different. The implication is that a RAW or RAW + sidecar would render differently depending on the OS, browser, or cataloging software. This type of subjective rendering is precisely what UPDIG was created to combat in the digital file realm. If we adhere to UPDIG principles, the DNG format is the only RAW format that currently fixes rendering across applications and platforms, and hopefully over time, although that is by no means assured at this point. All the other RAW file formats, so far, operate in closed proprietary systems, so that fixed rendering requires conversion to another file format for proofing, cataloging, or delivery.

### **Preserving metadata**

***“Digital images should have metadata embedded that conforms to the IPTC standards, making the images searchable, providing usage and contact information, and stating their creators or copyright owners.”***

Competing with fixed rendering and the safe insertion of rendering metadata in RAW files is the need to insert the other kinds of metadata outlined above. It has been a consistent problem that there are no standards among the proprietary RAW file formats as to where this metadata should be put and how other applications can discover and use this information. Some proprietary RAW processing software actually removes such metadata, creating a workflow problem and requiring this information to be re-inserted in derivative files.

Adobe’s DNG file format is the only RAW file format that safely contains this kind of metadata without using a sidecar file. Those who want to use RAW file processors that don’t at least *read* DNG will have to continue to archive and manage proprietary RAW files. They will have to keep their metadata in sidecar files or database libraries. They will have to be mindful of the need to arrange their workflow so that metadata is either preserved in the conversion to derivative files or, if necessary, added afterward to the derivative files. In addition, photographers whose work depends on processing thousands of files quickly may well settle on a different set of workflow software tools than those who seldom shoot or process more than 30 or 40 image files per project. You should evaluate your software tools based on your needs (and the capabilities of your computer equipment) so that you can make the correct compromises among perceived quality of rendering, speed of processing and ease of adding metadata.

There is quite a bit of confusion concerning the suitability of the emerging RAW file handling software such as Apple’s Aperture, Adobe’s Lightroom and Nikon’s Capture NX. Some people report that these all-in-one programs unify and improve their workflow, while others complain that they are slow, unstable, or unable to

handle batch processing. Much of this conflicting information has to do with whether the program is being used on tens of files or thousands of files, and whether they are installed on the fastest dual-core processor computers with 4+ GB of memory or on older hardware. Its no wonder that a favorite phrase on digital photography forums is “your mileage may vary.”

## **Web Links**

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### **ICC Color Management**

ICC – [www.color.org](http://www.color.org)

Gretag MacBeth – [www.gretagmacbeth.com](http://www.gretagmacbeth.com)

Integrated Color – [www.integrated-color.com](http://www.integrated-color.com)

ACR – [www.adobe.com/products/photoshop/cameraraw.html](http://www.adobe.com/products/photoshop/cameraraw.html)

Tom Fors’ script – [fors.net/chromoholics/download](http://fors.net/chromoholics/download)

Visual Vacations site – [visual-vacations.com/ColorManagement/cm\\_101/04camera.htm](http://visual-vacations.com/ColorManagement/cm_101/04camera.htm)

Chromix – [www.chromix.com/ColorValet](http://www.chromix.com/ColorValet)

SWOP Committee – [www.swop.org](http://www.swop.org)

GRACoL – [www.gracol.org](http://www.gracol.org)

FOGRA – [www.fogra.org](http://www.fogra.org)

ECI – [www.eci.org](http://www.eci.org)

IFRA – [www.ifra.com](http://www.ifra.com)

ISO – [www.iso.org](http://www.iso.org)

downloaded from ECI – [www.eci.org/eci/en/041\\_offset.php](http://www.eci.org/eci/en/041_offset.php)

### **Monitor Calibration**

Gretag-MacBeth Eye-One – [www.gretagmacbeth.com/index/products/products\\_color-mgmt-spec.htm](http://www.gretagmacbeth.com/index/products/products_color-mgmt-spec.htm)

Color Vison Spyder2 – [www.colorvision.com/profis/profis\\_view.jsp?id=101](http://www.colorvision.com/profis/profis_view.jsp?id=101)

Monaco Optix XR – [www.xritephoto.com/product/optixxr](http://www.xritephoto.com/product/optixxr)

the one by Pixl Ltd – [www.pixl.dk/Download\\_documents/Profile%20verification%20UK2003.pdf](http://www.pixl.dk/Download_documents/Profile%20verification%20UK2003.pdf)

PDF manual – [www.xrite.com/documents/manuals/en/MonacoOPTIX\\_User\\_Guide\\_en.pdf](http://www.xrite.com/documents/manuals/en/MonacoOPTIX_User_Guide_en.pdf)

Black Point Check – [www.drycreekphoto.com/Learn/Calibration/monitor\\_gradient.htm](http://www.drycreekphoto.com/Learn/Calibration/monitor_gradient.htm)

Grayscale Test – [www.drycreekphoto.com/Learn/Calibration/monitor\\_black.htm](http://www.drycreekphoto.com/Learn/Calibration/monitor_black.htm)

ColorEyes Display – [www.integrated-color.com](http://www.integrated-color.com)

white paper – [www.necdisplay.com/corpus/S/6/LCD2180WG-LEDTechPaper\\_121605.pdf](http://www.necdisplay.com/corpus/S/6/LCD2180WG-LEDTechPaper_121605.pdf)

### **Color Spaces**

Institute of Quality Assurance’s Digital special interest group – [www.iqa.org/digital/](http://www.iqa.org/digital/)

Dry Creek Photo site – [www.drycreekphoto.com](http://www.drycreekphoto.com)

see our page on guide prints and proofs – [www.updig.org/g2/proofs.php](http://www.updig.org/g2/proofs.php)



## **File Formats**

Luminous Landscape site – [www.luminous-landscape.com/essays/raw-flaw.shtml](http://www.luminous-landscape.com/essays/raw-flaw.shtml)

OpenRAW – [www.openraw.org](http://www.openraw.org)

DNG file format – [www.adobe.com/products/dng/main.html](http://www.adobe.com/products/dng/main.html)

OpenRAW survey – [www.openraw.org/2006rawsurvey](http://www.openraw.org/2006rawsurvey)

Bibble – [www.bibblelabs.com](http://www.bibblelabs.com)

Capture NX – [www.nikonimaging.com/global/products/software/capturenx/index.htm](http://www.nikonimaging.com/global/products/software/capturenx/index.htm)

Capture One – [www.phaseone.com](http://www.phaseone.com)

Aperture – [www.apple.com/aperture](http://www.apple.com/aperture)

Lightroom – [labs.adobe.com/technologies/lightroom](http://labs.adobe.com/technologies/lightroom)

## **Naming Files**

Controlled Vocabulary – [www.controlledvocabulary.com/imagedatabases/filename\\_limits.html](http://www.controlledvocabulary.com/imagedatabases/filename_limits.html)

## **Sharpening**

master file – [see section on File Formats](#)

## **Metadata**

IPTC Core standard – [www.iptc.org/IPTC4XMP](http://www.iptc.org/IPTC4XMP)

MediaPro – [www.iview-multimedia.com](http://www.iview-multimedia.com)

PhotoMechanic – [camerabits.com](http://camerabits.com)

Cumulus – [www.canto.com](http://www.canto.com)

Portfolio – [www.extensis.com/en/products/asset\\_management.jsp](http://www.extensis.com/en/products/asset_management.jsp)

DNG file format – [www.adobe.com/products/dng](http://www.adobe.com/products/dng)

Orphan Works legislation – [www.asmp.org/orphanworks](http://www.asmp.org/orphanworks)

## **Guide Prints and Proofs**

SWOP-certified systems – [www.swop.org/certification/certmfg.asp](http://www.swop.org/certification/certmfg.asp)

## **Archiving**

open standard – [home.earthlink.net/~ritter/tiff/](http://home.earthlink.net/~ritter/tiff/)

documented TIFF-based format – [www.adobe.com/products/dng/](http://www.adobe.com/products/dng/)

directly from the author – [www.thedambook.com/index.html](http://www.thedambook.com/index.html)

O'Reilly – [www.oreilly.com/catalog/dambk/index.html](http://www.oreilly.com/catalog/dambk/index.html)

Amazon – [www.amazon.com/gp/product/0596100183](http://www.amazon.com/gp/product/0596100183)

## **Digital Image Workflow**

Pixmantic RAWShooter – [www.pixmantec.com/products/rawshooter.asp](http://www.pixmantec.com/products/rawshooter.asp)

DXO Optics Pro – [www.dxo.com](http://www.dxo.com)

SilkyPix Developer Studio – [www.isl.co.jp/SILKYPIX/english](http://www.isl.co.jp/SILKYPIX/english)

Phase One – [www.phaseone.com](http://www.phaseone.com)

This document, prepared by the UPDIG working group, represents the industry consensus as of October 2006. Because digital production standards and best practices continue to evolve, we recommend checking the UPDIG web site, [www.UPDIG.org](http://www.UPDIG.org), for updates and supplements.

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