UPDIG — universal photographic digital imaging guidelines

v 4.0

Photographers Guidelines

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Acknowledgments

Managing Editor: Richard Anderson
Technical Editor: Michael Stewart
Contributing Editor: David Riecks
Contributing Editor: Peter Krogh
Copy Editor: Greg Smith

UPDIG Content Contributors:

Andre Cornellier	Bob Marchant
Bob Croxford	Sam Merrell
Dennis Dunbar	Alan Newman
Kevin DePalmer	Michelle Alvarado Novak
Robert Edwards	Betsy Reid
Ken Fleisher	Stanley Rowin
George Fulton	Jeff Sedlik
Judy Herrmann	Ulrik Södergren
Reed Hoffmann	Tamra Stallings
Rick McCleary	Eddie Tapp
	Mike Upstone

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Advertising Photographers of America (**APA**)
Advertising and Illustrative Photographers Association (**AIPA**)
Australian Institute of Professional Photography (**AIPP**)
American Society of Media Photographers (**ASMP**)
American Society of Picture Professionals (**ASPP**)
Associação Brasileira dos Fotógrafos de Publicidade (**ABRAFOTO**)
Association of Photographers [UK] (**AOP**)
Australian Commercial + Media Photographers (**ACMP**)
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National Press Photographers Association (**NPPA**)
Picture Archive Council of America (**PACA**)
PLUS (**PLUS**)
Professional Photo Companies and Photo Agencies Association [Sweden] (**BLF**)
Professional Photographers of America (**PPA**)
Stock Artists Alliance (**SAA**)

Foreword

Vision Statement: The photography industry is undergoing great change. New ways of making and working with photographs are replacing older methods. The broad capabilities and efficiencies of digital capture and delivery have revolutionized the image marketplace. But in doing so they have exposed gaps in creative and quality control that frequently lead to confusion, inefficiencies, loss of quality and unnecessary expense. We recognize the need for worldwide imaging standards to facilitate reliable and repeatable image reproduction.

Film-based photography workflows relied on transparencies or prints to establish and share color and tonal information. Digital imaging lacks such tangible references. Integrated color management with accepted ICC workflows fills that void. After more than a decade of regular use and adjustment, ICC (also known as ICM) has proved itself a mature technology used by thousands of professionals. As the first link in the image supply chain, photographers must establish and adhere to the best practices of color management. And those who work with their photographs must follow the same standards in order to accurately reproduce those photographs.

The media for delivery and storage of images have also changed. Digital Asset Management offers a set of standards to replace film-based workflows. Our task is to identify terminology and workflow for image creation, image delivery, accurate reproduction and archiving. Implementing the standards and practices in these guidelines will enhance creative control and economic efficiency.

Mission Statement: The UPDIG Coalition is a global initiative of industry organizations working to identify, define and share best technical practices for reproducing, exchanging and archiving digital images.

The UPDIG Coalition brings together industry experts representing creators, distributors, users, technology providers and others dedicated to this mission.

The UPDIG Coalition collectively publishes and promotes the *Universal Photographic Digital Imaging Guidelines.*

Objectives:

1. Make digital imaging practices clearer and more reliable by developing standards for quality and terminology.

2. Develop web resources for imaging professionals that establish common digital imaging terms.

3. Demonstrate the creative and economic benefits of these guidelines.

4. Develop industry guidelines and suggested workflows for various types of image reproduction.

5. Establish consensus on these issues among professional photography trade organizations, image distributors, archives, printers, software developers and manufacturers.

Standardization Goals:

1. Color Management: ICC Workflow, Hardware Calibration, Guide Prints and Proofs.

2. File Delivery and Archiving: Naming Conventions, Resolution, Sharpening, Digital Workflow.

3. Metadata: embedded IPTC and XMP data, including PLUS Licensing Language.

4. Industry Terminology.

Quick Guide

Main Principles

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

- Digital images should be prepared in the correct resolution, size and sharpness for the device(s) on which they will be viewed or printed.

- Digital images should have embedded metadata that conform to the IPTC and PLUS standards, making them searchable while providing relevant rights and usage information – including creator's name, contact information and a description of licensed uses.

- Digital images should be protected from accidental erasure or corruption and stored carefully to ensure their availability to future generations.

1. ICC Color Management

ICC profile-based color management defines color information in standard terms necessary for proper reproduction of images. 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.

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 (or L*).

- White point — 5000K to 6500K.

- Brightness levels — 80cd/m² to 140 cd/m^2.

As a general calibration guideline, use gamma 2.2 and 6500K for both Windows and Mac. A white point of 5000-5500K is a common recommendation for offset printing. Set brightness levels 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/D50) light source at correct brightness is necessary to visually match monitor to print.

3. Color Space

Camera settings for color space can be critical when capturing TIFF or JPEG files. For raw image capture, it makes little difference how you set the in-camera color space, since you can set it just as effectively during postproduction. It's generally better to choose a large-gamut space – such as Adobe RGB (1998), ECI-RGB or ProPhoto RGB – for JPEG and TIFF captures, and for image editing. It may be convenient to capture images in a narrow-gamut space, such as sRGB, if the pictures will not require color correction or tonal editing and you intend the images for web or sRGB lab prints. Note, however, you can convert a wide-gamut image to a narrow space such as sRGB, while a narrow-gamut image converted to a wide space will not (re)capture the colors of the wider gamut.

Offset printing requires image files saved in a CMYK color space, which has a very different and narrower gamut than digital image files captured in RGB color. A good CMYK conversion requires both expertise and knowledge of the specific press and paper type. Simple mode conversions in Photoshop are not recommended.

Photo lab prints often 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.

4. Resolution

Describe resolution of digital images either by pixel dimensions (width x height) for screen use or by physical size and resolution for print use. Express image resolution as pixels per inch (ppi), pixels per centimeter (ppc) or pixels per millimeter (ppm). But note resolution is only relevant when paired with output size (e.g., 8x10 inches at 300 ppi). Here are recommendations for common uses:

- Inkjet prints: 180 to 360 (some say up to 480) ppi.

- Continuous-tone printing: 240 to 400 ppi.

- Offset printing: 300 ppi is often specified, but resolutions of 1.3- to 2-times the halftone screen ruling are considered safe. This means 195 to 300 ppi for a 150-line screen. Newspapers usually print with 85- to 100-line screens, requiring – at most – images at 170 to 200 ppi.

5. File Formats

The best quality comes from capturing 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; the 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 manner. 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 an excellent method for archiving raw files. DNG was designed as a more universal file format than camera-specific raw formats such as NEF or CR2.

File formats include: lossy compression types such as JPEG; lossless compression types such as LZW compressed GIF and TIFF, PSD and most raw file formats; and uncompressed types such as standard TIFFs. Some formats, such as JPEG2000 and HD Photo (JPEG XR), offer both lossy and lossless compressions. For the 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 sizes.

6. Naming Files

To avoid problems with files transferred across computing platforms, name files with only the letters of the Latin alphabet (A-Z, a-z), numbers, hyphens and underscores. Do not use other punctuation or symbols. Keep the full name to 31 characters or less, including its three-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 and the photographer's name is an excellent method for creating unique names.

7. Sharpening

Capture sharpening compensates for the loss of detail that occurs during any digital capture process. TIFF and JPEG capture allows for sharpening in camera or during postproduction. Sharpen raw files during postproduction. Do not sharpen heavily early in the image-editing process.

Process sharpening counters the loss of detail in the post-production process. Process sharpening is also used for creative effect. Perform it after color and tone correction, retouching, image sizing, etc. or for creative effect. The goal is an image that is acceptably sharp, but never over-sharpened.

Output sharpening should be specific to the final output size and the output system (printing device, paper, ink, etc.) and applied only as a final step before output. It is important to communicate when delivering whether output sharpening has been applied.

8. Metadata

EXIF, IPTC, IPTC Core Schema and PLUS are the current standards for embedding metadata in image files. Embedded metadata should include creator and copyright information, as well as searchable keywords and license information. Including useful and relevant information in metadata adds value to an image.

9. File Delivery

Digital image files may be delivered on a variety of removable media, including hard drives, CD-Rs and DVD-Rs. Do not use adhesive labels on optical media, since they may separate and damage an optical drive. Printing directly on inkjet-writable or LightScribe media 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, deliver by FTP or e-mail. All image files should have embedded metadata. (For proprietary raw files, the safest route is to include the metadata in an XMP sidecar file.) Image file delivery should include *ReadMe* files.

NOTE: Provide a *ReadMe* file in PDF, HTML or TXT format with all files delivered for output. Such files should specify image size(s), color space(s), the copyright owner's contact information, any licenses granted, (or PLUS code) 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 recipients are responsible for following ICC-based, color-management workflows.

10. CMYK Guide Prints and Verifiable Proofs

CMYK guide prints and verifiable proofs can serve as valuable reference points for digital files, especially if the recipient is unknown or the output profile generic. Creating CMYK guide prints and verifiable proofs that accurately represent offset CMYK printing requires knowledge of printer profiles and color management. Clearly convey the method used to produce the guide print.

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.

12. Digital Image Workflow

No single workflow suits all photographers and 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 losing images and the work performed to optimize them. Many software packages can be part of a digital workflow. New programs appear regularly, some aiming to be all-in-one solutions. You will need to test to see which program or programs give you the right combination of metadata handling, efficiency, speed and image quality.

PHOTOGRAPHER GUIDELINES
1. ICC Color Management

ICC profile-based color management is the standard. ICC profiles define color information in the consistent terms needed 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. Configure software, when opening files, to preserve embedded profiles, warn of mismatched profiles and warn of files with no embedded profiles.
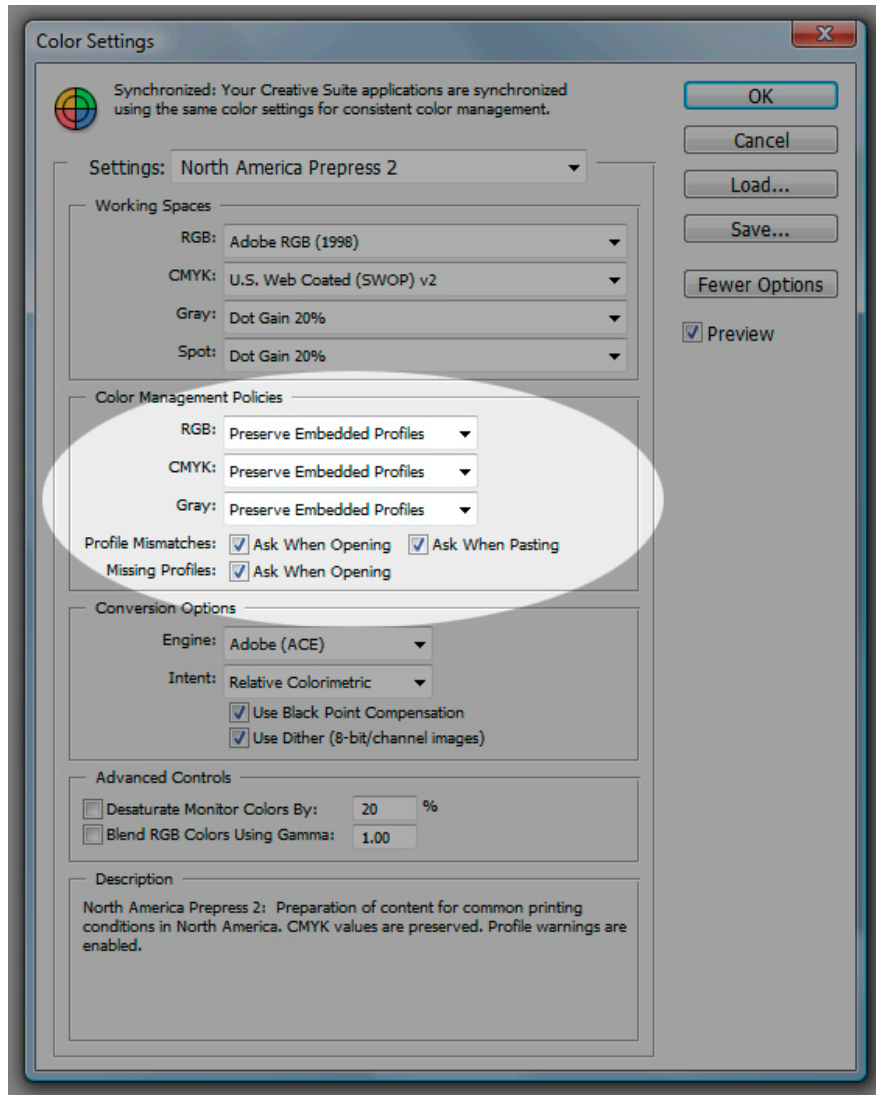
Photoshop CS3 Color Settings / Color Management Policies: "Preserve Embedded Profiles" turned on and "Ask When Opening and Pasting" checked for mismatches and missing profiles.

Camera profiles: Each camera, even compared to others of the same model, has unique characteristics. Although not so essential as monitor and printer profiles, camera profiles aid in reproducing accurate color. Used properly, they can offer more accurate color, a different color

look and/or speed the workflow by saving time in post-processing. Profiling packages are available from X-Rite and Integrated Color, PictoColor, among others.

The issue with custom profiling cameras is the ability to apply that custom profile in raw processing software. Capture One Pro is the only commonly used raw Processor we have found that supports ICC camera profiles.

The DNG 1.2.0.0 specification formalizes the idea of a "camera profile" by expanding the color-handling capability of Adobe's universal raw format in several important ways, related both to the handling of color tags – including proprietary and custom color spaces – and to the integrity of image data.

The new specification provides a structure for non-Adobe software to embed both Adobe Camera Raw profiles and custom color profiles in DNG files. Since other manufacturers' raw converters may use a variety of profiles, this should enhance interoperability and forward compatibility for all software using the DNG format.

Adobe has also opened its Camera Raw rendering for third parties to insert more profiles. This enables others to create profiles that match the look of in-camera conversions or to create new profiles that allow custom, highly styled conversions. Because a custom profile can be embedded in the DNG file, computers without that profile installed can now accurately render and display a custom look.

New metadata tags added in the specification define the use licenses of embedded profiles. Adobe has created a very broad license for its own profiles, and the revised DNG format permits other profile makers to tag their profiles as narrowly or openly licensed.

In addition, Adobe has added to the specification two new tags. Software can use these to verify that image data – including embedded raw files – are not corrupt. This allows development of tools that automatically review a collection of DNG files, ensuring with a high degree of accuracy the integrity of all image data.

Adobe Camera Raw calibration: ACR uses built-in or "base" camera profiles as a starting point for rendering raw files. These are actually a blend of two profiles, one for tungsten light and one for daylight. ACR blends the two according to the white balance of the raw file. Before Adobe developed the Looks Editor, the only method for customizing ACR raw rendering was to use the ACR Calibration Tab. It allows you to automatically adjust ACR's rendering based on your camera'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' ACR Calibrator 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 ISO settings. A good guide to this technique can be found at the Visual Vacations site. Rags Gardner has a site with even more information on raw camera calibration using Adobe Camera Raw and scripts that work with other color targets. Lee Varis has suggested and explained another approach in his book *Skin*.

Inkjet and dye-sub printers: You can 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 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: Three organizations in the United States have produced standards for the printing industry that allow for standardized CMYK profiles. They are: the SWOP Committee (Specifications for Web Offset Publications), covering web presses; GRACoL (General Requirements for Applications in Commercial Offset Lithography), which covers sheet-fed printing; and ANSI (American National Standards Institute), which has created a Newsprint standard CMYK profile. The three standards – SWOP TR001, and GRACol's DTR004, and ANSI's SNAP (Specifications for Newsprint Advertising Production) – if widely adopted, would ease worries about custom CMYK profiles.

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, based on the ISO 12647-2 standard, are available for download from ECI. Several larger print houses recommend them as CMYK profiles for their production. They also have garnered wide acceptance as proofing profiles.

If you have 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 – SWOP Coated, GRACol, or SNAP – may suffice, particularly if the printer adheres to ISO, SWOP, GRACol or SNAP specifications. In this period of flux, communication is key. Profiles will also enable you to produce guide prints or aim prints (see section 10 CMYK Guide Prints and Verifiable Proofs) for clients, providing a printed reference for the press operator to target for color-matching purposes.

2. Monitor Calibration

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 require a hardware device, such as the X-Rite EyeOne Display 2 or Color Vision Spyder 3 Elite. Another useful tool is a Profile Verification Kit (such as this 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 ensure your work environment features subdued, neutral lighting that does not vary. 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 includes brightly colored clothing or brightly colored blinds, as any color reflected on the screen will likely influence your perception of the color displayed. 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: The two most common types of display technology in use today are LCD and CRT. LCD (liquid crystal display) monitors are rapidly replacing CRT (cathode ray tube) displays. Production of professional-grade CRTs, such as the Sony Artisan, has ceased. LCD displays with LED backlighting show a very wide gamut that closely matches the Adobe RGB color space.

Calibrate CRT monitors before profiling, since they have hardware controls for their RGB amplifiers, as well as controls for black level and luminance. First, use the hardware device and software to adjust the RGB guns to the desired white point (often called color temperature, although this is a slightly different concept) and black point (if available on your display system). Next, profile the calibrated CRT. Color-savvy programs, such as Photoshop, then use the profile to display accurate color.

LCD displays often only have brightness controls, although some also have contrast settings, too. Some LCDs also have color temperature controls, but these actually only adjust the CLUT (color look up table. If the adjustment differs substantially from the native color temperature, this can cause reduced color gamut and banding. For that reason, when profiling an LCD, it is best to adjust only the brightness control and any contrast control, then let the profiling device set the desired white point through the display profile.

Direct Digital Communication (DDC): DDC allows adjustment of the display's brightness, contrast, white point and gamma 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.

Monaco Optix Guide: Regardless of whether you use their product, Monaco has an excellent PDF manual that explains in detail how to calibrate and profile both CRT and LCD monitors.

White Point and Gamma: The purpose of monitor calibration and profiling is to create a situation where the image on your monitor closely matches 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. Desired white points range from 5000K (yellow-red) to 6500K (bluer). The gamma correction may vary from 1.0 to 3.0, or be based on L* gamma. The monitor's luminance may vary from 80 cd/m² to 140 cd/m². Adjust these settings based on viewing conditions. If comparing the monitor with proofs in a viewing booth, adjust to the best match. The correct luminance also depends on ambient light conditions. High-end color work should take place in ambient light controlled for color temperature, flare and luminance. For work in bright office or studio environments, you might need a luminance of more than 140 cd/m2 to see shadow detail on your monitor.

There is no single standard for white point, gamma and luminance, because there is no 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 a white point of 5000K or 5500K will give you the best match of monitor to proof or press sheet viewed under a 5000K light. The appropriate luminance may be around 100cd/m². If you are preparing files for ink-jet or Lightjet 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 where they'll be displayed. Once again, monitor luminance should match the appearance of the display prints in the viewing condition. Prepare image files for the web 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. Modern LCD monitors usually have a native white point around 6500K.

Native White Point: Some argue for creating monitor profiles using native color temperature and native gamma, and let your eyes adjust to the difference between the monitor and the print or proof. Doing so will ensure 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 a standard, 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. That stated, if your goal is matching your monitor to your prints, or more critically, a printer's proofs, choosing native white point is not the best practice. Minor banding is much less of an issue than failure to match print output.

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, midtones and highlights. It reportedly provides smoother transitions, and therefore more accurate color reproduction. If you are working in Adobe Photoshop, monitor gamma will not affect the appearance of image files, since Photoshop automatically corrects the gamma of the image as it is displayed on the monitor. Choosing a gamma has more to do with allowing your monitor to operate in its particular sweet spot, and avoiding loss of gamut, banding or posterization that may appear if you force it to run too far from its native gamma.

The LEDs are coming: The current TFT-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. The NEC MultiSync LCD2180WG-LED was the first commercially available monitor of this kind. Although still very expensive as desktop displays, LED display technology has even emerged in some of the new Apple laptops.

3. Color Spaces

Camera settings for color space are critical when capturing TIFF or JPEG files. (Color space settings are largely irrelevant for raw files, since color space will be determined in the raw file processor.) Most professional digital cameras allow selection of the output color space for JPEG and standard TIFF, with usually two options: sRGB and Adobe RGB (1998). Capture photographs meant for high-end printing in a large-gamut space, such as Adobe RGB (1998). Capture photographs in the narrower-gamut sRGB color space if they are intended only for consumer-level printing or the web.

Embed the Profiles: All digital files should have embedded profiles (such files are called "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 profiles.

Assigning vs. Converting: Assigning profiles can change image appearance without changing the original image data. Assign when the original file has no embedded profile or the embedded profile is of dubious origin. Choose an appropriate profile with the help of the preview facility in Photoshop. While choosing the profile based on an image's appearance is necessarily a

subjective decision, it enables a file to enter the workflow with a (hopefully well-chosen) definition of its intended color space.

Assigning a profile changes the appearance of an image but not its pixel values. Converting to a different color space does the opposite: It changes the pixel values while attempting to retain 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.

NOTE: Every imaging device describes color in its own way, based on its particular characteristics. We might say each device has its own "language" for color. Some languages have a large vocabulary, others a smaller one, and some contain words simply not available in others. To make translations possible among all the languages, we need a universal "reference language" with a huge vocabulary. This is the role of CIELab, which is a theoretical color space containing every color the human eye can perceive.

Continuing the analogy, ICC profiles are dictionaries that provide the CIELab equivalent for every word in a particular dialect – that is, for every color a specific device can represent. Embedding a profile in an image file is like sending the dictionary along with a written document: It gives the recipient information needed to understand all the words. It does not guarantee the recipient's language will have the words needed to translate the document perfectly, but if exact 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 analogy, 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 explanation.

Color Space Recommendations:

a. ***Open-ended uses:*** When the final use of an image is not known, as with images created for stock photography or when the client will use the images in several media, it's best to supply a file in the Adobe RGB (1998) color space, with the profile embedded. The European printing and publishing industry is standardizing on ECI-RGB, an RGB profile with a slightly different gamut than Adobe RGB (1998). However, like Adobe RGB (1998), ECI-RGB contains the entire gamut of the standard CMYK profiles.

b. ***World Wide Web presentations:*** Convert images to sRGB and embed the sRGB profile before delivery.

c. ***Images prepared for screen and electronic presentations:*** PowerPoint and similar programs vary in their abilities to read color profile tags, so it is best to convert images to sRGB and embed the sRGB profile before delivery.

d. ***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. After adjusting your proof view, submit either an sRGB or (more rarely) Adobe RGB (1998) file with the profile embedded. If a lab does not have a custom profile, it's usually best to use the sRGB color space and embed that profile, 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.

e. ***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 models from Fuji Frontier, Noritsu, Agfa D-Lab, LightJet, Durst and Chromira, 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 profiles 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 conversion of submitted files 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.

f. ***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 they prefer. RGB files contain many colors that cannot be reproduced by conventional CMYK printing. This can result in a printed piece different from the screen version or from the inkjet print of the file. There are three ways to avoid this confusion:

   1. If the photographer has the necessary experience and knowledge to convert from RGB, digital images can be delivered as CMYK data. This can be the best solution, since the photographer knows how the image should look.

   2. Accompany an RGB file with a cross-rendered guide print ([see our page on guide prints and proofs]()) that includes only colors reproducible in CMYK.

   3. Deliver files in both CMYK and RGB. This allows the photographer to make 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, convert CMYK image files from RGB using the printer's CMYK profile (see below), and embed it in the file. If you can't get the printer's exact CMYK profile, you can deliver an RGB master file with an embedded profile and a ReadMe file that explains, "For accurate color, choose to preserve embedded RGB profile when opening this (these) file(s)." But keep in mind there is less color variation between different CMYK profiles than different RGB profiles. Hence, if the printer assigns the wrong CMYK profile it will likely look better than assigning the wrong RGB profile. The printer also has the option to convert from a general CMYK profile, such as US Web Coated (SWOP) v2 to a more specific CMYK profile, – using either Photoshop>Edit>Convert to Profile, or more ideally, a device-link profile that can convert from one CMYK profile to another without having to go through the three-channel Lab color space used by Photoshop's conversion engine.

g. ***Inkjet and dye-sub printers:*** Choose a wide-gamut color space, such as Adobe RGB (1998) or ProPhoto RGB, for the source space. These printers have internal RGB-to-CMYK conversion algorithms, so they should be profiled in RGB and you should *not* convert images to CMYK before printing with them. Although manufacturer-supplied profiles have greatly improved, using custom RGB profiles for the printer-paper combinations in the print space will provide the best quality and the best match to a profiled monitor.

   NOTE: You can 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.

Converting Images to CMYK:

We strongly recommend 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 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 sources. It is increasingly likely 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 embedded RGB profiles to ensure accurate color when they are converted to each printer's specific CMYK profile.

Send RGB image files (especially Adobe RGB [1998]) 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 (1998), or possibly, the narrower-gamut ColorMatch RGB. European printers may prefer ECI-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 image file.

4. Resolution

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 printers recite 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 of lower-than-optimum resolution will not deliver as much image detail and crispness as the output device can reproduce. 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, requiring a third value: of pixels per inch. (Outside the U.S., dimensions are stated in

centimeters or millimeters, and resolutions expressed 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 printers normally work best with resolutions of 180 ppi to 360 (some say up to 480) ppi, such as 8×10 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 most commonly quoted offset-printing standard is 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 as 150-lpi halftones (common for magazine printing), the appropriate image file resolution range would be 195 ppi to 300 ppi. Newspapers print with coarse screens. A common newsprint resolution is 85 lpi, which works best with an image resolution of 170 ppi.

- Screen-display and electronic-projection image resolutions will vary substantially, depending on the native resolution of the projection device. It's important to obtain information about the native resolution of the screen or projector before delivering "screen resolution" images.

- The resolution of digital images intended for screen display and electronic projection is best described by absolute pixel dimensions: width and height in pixels. Example: 1024x768 pixels.

- Images should be cropped to the correct aspect ratio for intended use. Examples: 1024x768 is a 4:3 (1.33 to 1) aspect ratio, while widescreen 1920x1080 is a 16:9 (1.77 to 1) aspect ratio. Where cropping is undesirable because it will change the composition of the image, you should set the image size along the longest dimension. You can either accept that two borders (either the top and bottom or the left and right) will have bands of the background color, or you can add bands of black or another color to the image to fill out the screen.

- Determine whether the intended use of an image involves zooming or panning. If it does, deliver enough resolution to accommodate this intended use.

- The size of the image on a computer monitor is based on the physical size of the screen and the setting of the screen resolution. When sizing images for use on multiple computers, consider that a 600 x 400-pixel image will almost fill an old 15-inch display set at 640x480 and will be very small on a 30-inch display set to 2560x1600.

- Size images delivered for projection specifically for the intended use whenever possible. Sizing images for the exact native resolution of the projector produces the best results. Undesirable effects, such as stretching, shrinking, pixelation and loss of sharpness can be caused by software and hardware rendering of unsized images. Besides these drawbacks, it's not useful to make the image larger (in terms of pixels) than the screen size, since it will take much longer to redraw. Size it too small, and the image quality will deteriorate.

Common Resolutions:

- o VGA (640x480) — Once the standard, now only used on small devices, such as graphics tablets.
- o SVGA (800x600).
- o XGA (1024x768) — By far the most common resolution for PowerPoint and projection video.
- o SXGA (1280x1024).
- o SXGA+ (1400x1050) — Newer projectors.
- o Widescreen (1920x1080) — HDTV 1080i and 1080p.

A Guide to File Dimensions for Print:

Uncompressed file size requirements for print	
	RGB TIFF at 300 ppi (default for 150-line screen)
Double page (A3)	50 MB
Full page (A4)	25 MB
Half page (A5)	12 MB
Quarter page	6 MB
Eighth page	3 MB
Billboard	48 MB **at 600 ppi** (but 300 ppi is acceptable, *i.e.* 24 MB)

Digital Capture Quality Parameters: Sensor Size and File Dimensions

Sensor size and file dimensions offer only a rough guide to final printed quality. You can enlarge or reduce digital image files by interpolation in imaging software, which adds or removes pixels. RIP software and hardware can also interpolate during printing. Properly handled, interpolation can increase digital image files in size by as much as 400 percent. However, success depends on the qualities of the original file and the final output required. Note that increasing resolution through interpolation cannot add detail to a file. It may, however, prevent obvious pixilation, offering a smoother look.

Sensor Size (megapixels)	Pixel Dimensions	Approximate Doc. Size at 300 ppi	8-bit File Size
21.1 MP	5616X3744	12X19 inches	60 MB
17.5 MP	3413 x 5120	11x17 inches	50 MB
11.2 MP	2731 x 4096	9x13 inches	32 MB
6.3 MP	2048 x 3072	7x10 inches	18 MB

Stock-image distributors, magazine publishers or others requesting files may specify a certain minimum size for camera sensors used to generate image files. However, pixel quality trumps pixel numbers, so that a high-quality 6-MP sensor will often be sufficient for 95 percent of intended uses, while pictures from a 10-MP sensor in a point-and-shoot camera may not look good beyond 8x10 inches at 300 ppi, especially if used at an ISO exposure setting above 200. Although many publishers have standardized on 300 ppi for 150-line screens, the actual requirement is 1.3 to 2.0 times the line-screen resolution, so as a practical matter, smaller files can successfully work for a given final size.

5. File Formats

File formats vary widely. They include "lossless" compression types, such as LZW-compressed GIF and TIFF, PSD and most raw file formats, and uncompressed types, such as standard TIFFs. Some formats, such as JPEG2000 and HD Photo (JPEG XR), offer both lossy and lossless compressions. Although lossy compression at high compression rates can create visible artifacts, many call lower compression rates "visually lossless." For the web, use JPEG. For printing, uncompressed TIFF is often preferred, although high-quality JPEGs are usually visually indistinguishable from TIFFs, and some prefer them due to file delivery and/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 there are some caveats to consider when 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.)

Leave RGB master files unsharpened or sharpen only on a removable layer, since resizing for future uses is likely. Archive master files along with the raw files for a project.

Raw File Formats: Although you should capture images at the highest quality your workflow requires, the best quality clearly comes from capturing in a raw file format. The advantages of raw file formats include:

- The photographer can choose a different color space each time the file is processed.

- The file offers greater bit depth.

- The file captures the maximum dynamic range.

- The processing operation can adjust white balance, saturation, exposure (to a degree), tonal characteristics, highlight recovery, noise reduction and lens corrections, all in a non-destructive way.

- Many raw processors have sizing algorithms some say are superior to interpolation in Photoshop, since they are working with the actual pixel data captured by the camera's imaging sensor.

- You can process raw files 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 capturing raw format images whenever your workflow supports it, there are several potentially negative issues with raw file formats as opposed to capturing JPEGs or TIFFs. Most serious is the issue of proprietary, undocumented raw file formats becoming obsolete, unsupported, and eventually, inaccessible. (Luminous Landscape offers good analysis of this problem.) In addition, there are workflow problems associated with raw file formats. Proprietary raw files must be converted to another format or 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 their ability to be non-destructively edited. If they are paired to sidecar files, they are harder to manage. And no cataloging software can read any color adjustment information contained in the sidecar files. Even proof-printing 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 possibilities for solving this problem:

- *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 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. One reason is DNG's unique 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 they can be copied 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 all-in-one solutions, 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 will depend on how they develop and how universally they are adopted.

6.Naming Files

To avoid problems with files transferred across computing platforms, request file names that use only the letters of the Latin alphabet (A-Z, a-z), the numerals 0-9, hyphens and underscores. Avoid other punctuation marks, accented letters, non-Latin letters, and other non-standard

characters, such as \:/*<> or brackets. On a local network or with rewritable media, limit the file name to 31 characters or less (including the three-letter file extension). Limit file names to 11 characters or less (including the three-letter file extension) when burning to optical media, since some computers don't support long file names. Use a single period (.) between the file name and extension.

Specify unique file names. Multiple files with the same name will cause problems for computers and people alike, and a newer file might automatically overwrite an older with the same name, or vice-versa. You may want to specify including the numeric date and/or the photographers name as part of the file name as a way to avoid duplicate names.

For a complete guide to file-naming protocol, see the Controlled Vocabulary web site.

7. Sharpening

Why Sharpen? To get the best quality out of any digital image, whether scanned from film or captured with a digital camera, you must compensate for the mathematically unavoidable loss of perceived sharpness that results from digitization. Likewise, whenever reproducing an image in a medium that relies on dots (whether the halftone dots of offset printing or the pixels of a computer monitor), there is additional, process-specific softening to anticipate and neutralize. 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 should be the sharpest, clearest image for a client to view or use. If you are capturing in JPEG format and trying to minimize post-production time, you might try different in-camera sharpening settings. If you put quality ahead of speed – and especially if you may want large prints later – it is best to perform 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. 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 whether the raw sharpening adds to the problem.

Noise: All digital capture involves some level of noise. There are three situations that require noise removal as part of the workflow:

a. When capturing at high ISO settings.

b. When capturing images where the highest possible quality is required, such as for stock or large prints (even at lowest ISOs).

c. When making long exposures with early-generation digital cameras that do not have built-in noise removal.

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

Process Sharpening: Perform process sharpening at the end of whatever post-processing (editing, retouching, resizing, etc.) you apply to an image. Process sharpening corrects for the ways changes in size, color, tone and color space can affect sharpness. It also may involve the photographer's creative decisions about how sharp the image *should* appear, including

sharpening selected areas 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, computer monitor, digital projection, etc.). Apply it 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. When creating a master file, you should save an unsharpened version, or save the sharpening on a layer, to allow new sharpening when repurposing and/or resizing an image file. You don't want to guess whether a master file has been previously sharpened for output.

Who Should Sharpen? In principle, all sharpening should wait for final output. In practice, there are drawbacks to this approach: 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 lead to soft reproduction. If an image capture is sharp, you should show and deliver it sharp. Using three stages of sharpening is ideal, but it's not always practical. Photographers should deliver images with at least capture sharpening applied. If a photographer is editing or retouching images, he or she should also apply process sharpening. Photographers should only deliver images with output sharpening when doing the final pre-press work. If the client or printer will resize or repurpose the images, then the client or printer should be responsible for output sharpening. Clearly communicate this when delivering files with an included 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.

Practical Considerations: It's important not to over-sharpen at any stage. An 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.

Which Sharpening Tool? Photoshop CS2 and CS3 each have a Smart Sharpen filter. These filters offer more control than Unsharp Mask because they can reduce sharpening amounts in highlight and shadow areas. Third-party plug-ins – such as Nik Sharpener Pro, Pixel Genius Photokit Sharpener, Focal Blade and others – allow you to fine-tune and automate the process. If possible, use a specialized sharpening plug-in, since the amount and method of sharpening depends on the final intended output, whether it is for web, continuous tone print, ink jet print, or offset printing. Set the image display at 50 percent for most print output, and at 100 percent for images intended for on-screen display. Other pixel magnifications – such as 33 percent, 66 percent or 200 percent – don't offer a true representation of the image, since Photoshop is interpolating the pixels to create these views. It's also important to remember the effects of sharpening appear different on your monitor than they will when ink hits paper, so make test prints – ideally on the same type of device that will be used for final printing.

Side Note: Accurately soft proofing of sharpening on a display is difficult. A sized print is the best way to proof sharpening. Truly accurate soft proofing can only be accomplished by matching screen resolution which is likely between 72ppi-117ppi with the image resolution. Only then is sharpening accurately displayed on screen at 100% size. Photoshop's preferences must also be set to the actual screen resolution. The soft proofed sharpening radius must then be multiplied by a factor which is determined by the actual printing resolution. A screen resolution of 100PPI and print resolution of 360 would yield a 3.6 times factor. Therefore a soft proofed sharpening radius of 1 pixel would need to be set to 3.6 pixels at print resolutions. This method of soft proofing sharpening is accurate, but not very practical in a high volume workflow.
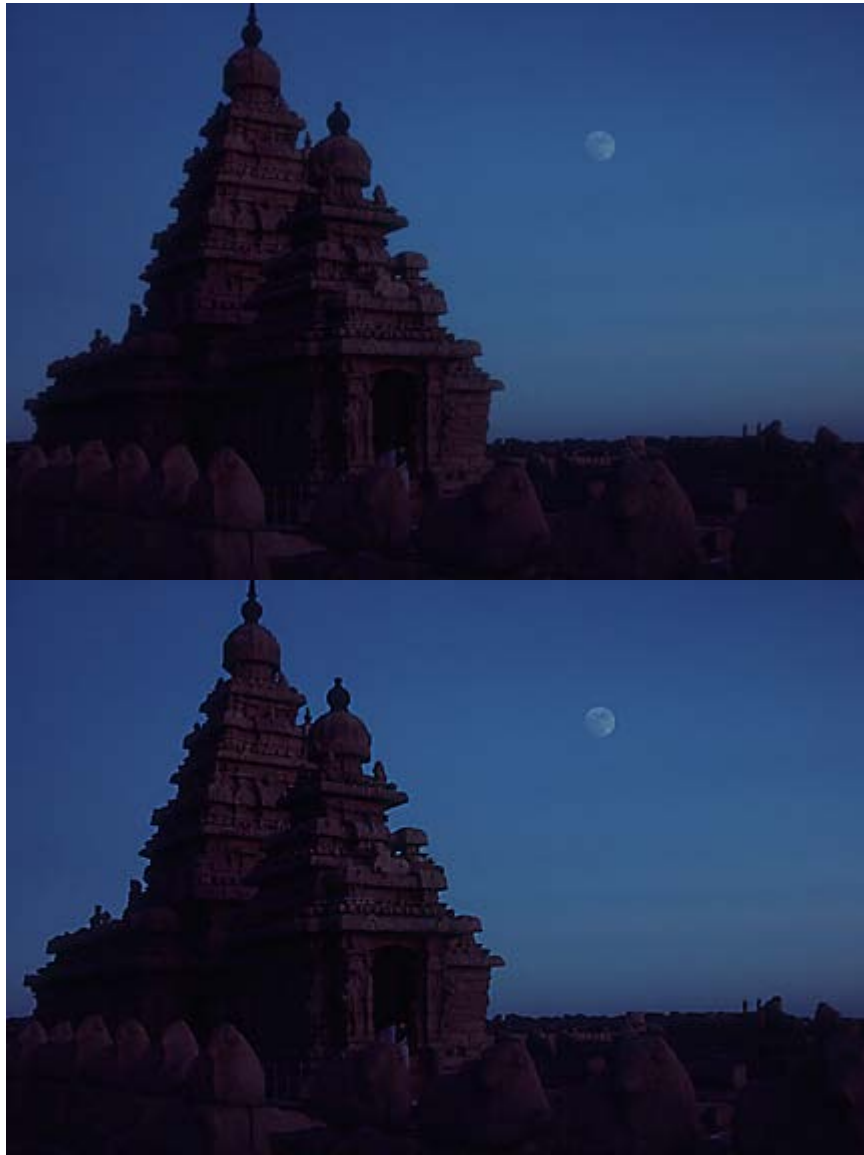
The Shore Temple of the Seven Pagodas; photo © 1985 by David Riecks, www.riecks.com.

In the sharpening example above, the first image is correctly sharpened for its size, the intended display medium (your screen) and the subject matter. The second image is over-sharpened, haloing the roof line with pale blue.

8.Metadata

Overview

Most digital image metadata is textual information embedded in an image file. Metadata has become an increasingly important attribute of a digital file, valuable for both creators and users of digital images. It offers a tool that can describe an image's technical characteristics, color profile, content, context, licensing terms, and perhaps most importantly, the identity and contact information for the rights holder.

The ability to readily identify and contact the rights holder for an image will likely become critically important if (when) proposed "Orphan Works" copyright exemptions become law. Bills introduced in the U.S. Congress, if passed, would affect all photographers by allowing anyone possessing an image to copy, modify, distribute, publish and otherwise use it for any purpose,

after a reasonably diligent search fails to identify the rights holder. All images previously distributed without rights metadata may soon be vulnerable to unlicensed use as "orphaned" images. Embedding complete, accurate rights metadata will help protect images from unlicensed use. Many other countries are considering similar legislation.

Metadata can be embedded in standard file formats, such as TIFF and JPEG. You can also embed metadata in raw files, although this is only recommended for the Adobe DNG file format, since proprietary raw formats are neither standardized nor publicly documented. For now, with proprietary formats, it's best to attach metadata in a sidecar file. You can also save metadata in an image database, making sure the image file and its metadata reside in the same volume, folder or program, in order for the metadata to connect to the image file.

A variety of programs can read and write metadata. Programs like PhotoMechanic and ImageIngester can add metadata as files transfer from camera card to computer. Image editing programs (such as Adobe Photoshop), Image browsers, (such as Adobe Bridge), cataloging programs (such as Microsoft Expression Media (iView Media Pro), Extensis Portfolio and Canto Cumulus), and all-in-one programs (such as Adobe Lightroom and Apple's Aperture) can read, write and edit metadata. Some camera makers' processing software, such as Nikon's Capture NX, provide some basic (usually only legacy IPTC and not IPTC Core) metadata writing, as do some raw processors, such as Capture One.

Types of Metadata

EXIF: All digital cameras include technical metadata, called EXIF data. This provides a host of information, such as the camera make and model, its serial number, the date and time of image capture, the shutter speed, lens used, the ISO speed setting, and often, other technical details, such as white balance and distance to the subject. Raw file processing software can use this information to more accurately render images.

ICC Color Profile Tags: Without a color profile tag, the person receiving an image file can only guess the color space used to create and edit it. Always embed an ICC profile in digital images.

IPTC: This includes user-supplied information. The earliest schema was the IPTC IIM (Information Interchange Module) model created by the newspaper industry in 1991 and incorporated into Photoshop in 1995. While considered a legacy format, it remains widely used and readable by most software that accesses metadata. The IIM format stores information separately but shares many fields with the XMP format. Referred to as the IPTC Core, or IPTC Core Schema for XMP, it includes the Description, IPTC Contact, Image, Content and Status panels that appear under the *File > File Info* menu in Photoshop.

XMP. The Extensible Metadata Platform or XMP is a specific type of extensible markup language used in PDF, photography and photo editing applications. Adobe introduced XMP in 1991. Adobe, IPTC and IDEAlliance collaborated to introduce in 2005 the IPTC Core Schema for XMP, which transfers metadata values from IPTC headers to the more modern and flexible XMP. Stock image distributors and other organizations have since created custom metadata panels that enhance metadata usefulness.

PLUS. The Picture Licensing Universal System is an integrated set of standards for communicating rights metadata associated with commissioned and stock images. The PLUS standards are developed, approved and maintained by the PLUS Coalition, an international, non-profit umbrella association that includes publishers, designers, advertising agencies, photographers, illustrators, stock image distributors, artist representatives, museums, libraries, and standards bodies, such as UPDIG, IPTC, IDEAlliance and others.

Metadata in Use

The type and amount of metadata photographers should embed in their images depends on who will receive the image files.

Stock image distributors can't function without metadata. They depend particularly on keywords. But photographers need to communicate with their stock distributors to know whether they should do all of the keywording, provide only limited keywording or perform no keywording. If the stock distributor prefers photographers do the keywording, ask for guidance. Captions, which are titles or explanations of images, should be foundations for the keywords that follow. Good keywords explain the *who, what, where, when* and *how* of a picture – important tools for finding specific image files.

You'll find an excellent guide to keywording on the Controlled Vocabulary web site.

In addition to the standard IPTC templates, stock image distributors may elect to create their own custom metadata panels – not only to capture additional data but also to organize it differently from the IPTC defaults. It's easy to install these XMP-based panels in Photoshop (see http://www.adobe.com/products/xmp/custompanel.html), and they offer a good way for stock image distributors to insert custom metadata into image files. Although often handled separately, photo releases can be stored in metadata by using a custom template. However, this custom metadata is not yet easily available or interoperable with most image database or cataloging software.

Magazines and publishers also depend on metadata, particularly caption, headline, author, contact information and usage rights. Image files with complete information can save magazines valuable time on deadline. Picture metadata can even provide additional reporting information, especially details such as GPS data and capture time.

Many publishers have rights-tracking software to verify they have all necessary licenses, have made all necessary payments, and conversely, can track licenses to others for using images they own. Good metadata reduces the cost of operating such systems.

Publishers who lack such software still may need to contact rights holders, perhaps for many years to come. They may need to defend themselves from lawsuits (libel, invasion of privacy, plagiarism, etc.) or undertake a regulatory compliance audit. If a publisher is sold, part of the buyer's "due diligence" includes ensuring its assets are untainted by legal clouds. Metadata reduces the need to rely on paper records.

For all of these reasons, photographers should determine magazine and publisher metadata needs, and when appropriate, install and populate custom metadata templates.

Publication designers can improve their workflow by organizing and categorizing pictures for metadata searches in browsers such as Bridge and digital asset management software such as Microsoft Expression Media/iView, Extensis Portfolio or Canto Cumulus. For example, if a design firm commissions a series of portraits, it is often critical to include the portrait subject's name in the Description and/or Headline fields. Other fields, such as Origin, can be equally important to a designer assembling a printed piece. The photographer should ascertain these metadata needs, or make the designer aware of how this custom metadata can improve the designer's workflow.

Web designers often have the same organizational and search needs as publications designers. But they have an additional responsibility to prevent metadata stripping. It is important for photographers to alert their web design clients to the importance of, and methods for, preserving metadata in images destined for the web. Unfortunately, in the initial release of Adobe Photoshop CS3, *Save For Web* (called *Save For Web & Devices* in CS3) strips most metadata.

Although it saves the file description and the creator's copyright notice by default, the feature changes the copyright status to *Unknown.* Beginning with the first CS3 update (Photoshop 10.0.1) it has become easier to discover how to include XMP metadata when using Save For Web. In the updated version, the *Save for Web and Devices* command includes the option to "Include XMP" in the main Save for Web dialog, where users will more likely find it. (In the first CS3 release, the option was buried in a sub-sub-menu.) When this option is enabled, all XMP data – including the creator copyright and contact info – is included in the optimized file, and the copyright status is preserved.

Regrettably, while easier to find than before, the option is not enabled by default. Users must discover it by clicking on a tiny triangle to open a fly-out menu (see illustration), and set it. Once set, however, it stays set.
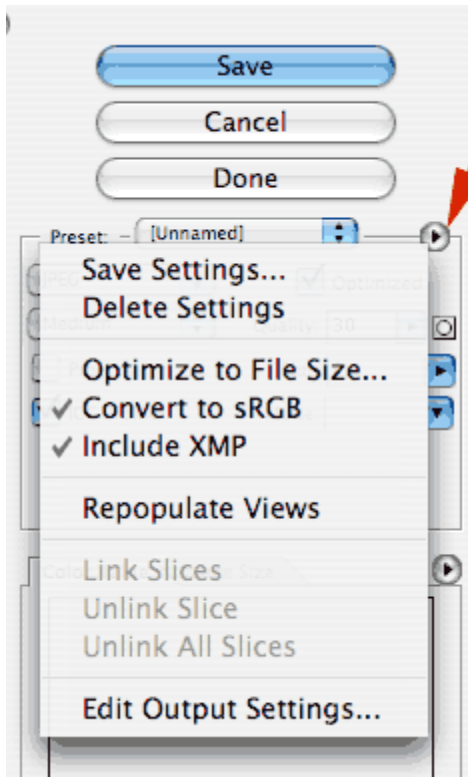
For most users, Photoshop CS3 will automatically request the upgrade from the Adobe web site and install it. If not, you can download the updater:
For Macintosh:
http://www.adobe.com/support/downloads/detail.jsp?ftpID=3774
For Windows:
http://www.adobe.com/support/downloads/detail.jsp?ftpID=3775

Please note "include XMP" means just that. The new file will not include Legacy IPTC-format metadata. Although many programs that read metadata recognize XMP, there are exceptions, including Apple Preview. This means web designers may still want to use "Save As" instead of "Save For Web & Devices," particularly if their clients are photographers, since some magazine editors review photos in the Preview.

Photographers maintaining their own collections of commercial and personal work are realizing the workflow advantages of annotating archived files with descriptive metadata. In addition, rating, labeling and adding private metadata to pictures can help when categorizing, organizing and searching image file archives. Many photographers realize, after accumulating hard drives filled with image files, that relying on directory structure, dates and file names can lead to long, even fruitless, searches.

9. File Delivery

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 delivering files on CD-R, the recommended disc format 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 several 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 requires 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 (see next section), so always include a disclaimer that states, "Accurate viewing and reproduction depend on the recipient properly applying ICC color management."

It is important to provide a *ReadMe* file in PDF, HTML or TXT format with all files delivered for output. The accompanying file should specify image size(s), color space(s), the copyright owner's contact information, any licenses granted (or PLUS code), and for a limited license, the words "other uses, reproduction or distribution are specifically prohibited." The ReadMe file should also include disclaimers noting recipients are responsible for following an ICC-based color management workflow.

10. CMYK Guide Prints and Verifiable Proofs

Cross-rendered *CMYK guide prints* can serve as a valuable visual reference for digital files, especially if the recipient is unknown or the output profile generic. *CMYK guide prints* can be generated in two ways:

1) via the inkjet printer's own software driver

2) via a third-party software RIP

When printing via the printer driver, it is recommended that a custom ICC output profile be built for the inkjet printer. Though many printer manufacturers' profiles are very good for their own papers, a custom profile will help provide a more accurate *CMYK guide print*. When using a third-party proofing paper, a custom profile must be built.

When printing via a RIP, use a custom profile for the ink/paper combination used to create the *CMYK guide print*.

Verifiable proofs differ from *CMYK guide prints* in two important ways:

1) They are printed via a certified proofing system (SWOP, Fogra, etc.) Certified proofing systems combine RIP software, inkjet printers, inksets, and proofing paper. More information on SWOP-certified systems is available.

2) They contain an industry-standard target such as the 12647-7 Control Strip or the Fogra Media Wedge. By reading the target with a spectrophotometer, the recipient can verify the validity of the proof by confirming that the readings are within a certain tolerance.

A verifiable proof provides additional precision when indicating the color of digital files delivered to an offset printer.

Unless supplying a *verifiable proof*, photographers should include disclaimers stating that what they are supplying is a *CMYK guide print* for color reference only. Don't confuse *CMYK guide prints* or *verifiable proofs* with *contract proofs*. A *contract proof* is a guarantee by the offset printer that he will match the proof color on press.

Since inkjet prints made from RGB editing spaces will have wider color gamuts than available from an offset press, CMYK guide prints must be "cross rendered" to more accurately predict the final CMYK printing. Cross rendering involves printing to the inkjet proofer using the final CMYK press profile as an intermediate space, thereby limiting the inkjet proofer's color gamut to the gamut of the final CMYK output space. If you use Absolute Colorimetric (or check the "simulate paper color" box in Photoshop CS3), you may more closely simulate the actual press sheet, since the whites will more closely match the duller white of the actual press stock.

Use a proofing paper that simulates the actual printing stock. Viewing conditions for guide prints and proofs should be consistent and ideally match the standards commercial printers use for viewing. A 5000K light booth or [Solux](#) low-voltage system is recommended. The current ANSI standard for brightness is 2200 lux, which is roughly equivalent to f16 at ¼-second at ISO 100.

It's possible to create CMYK guide prints or even SWOP-certified proofs with inkjet printers. Photoshop's print dialog can be set to create a guide print. But more accurate SWOP proofs require a RIP. Epson offers professional printers with SWOP-certified ColorBurst RIPs.
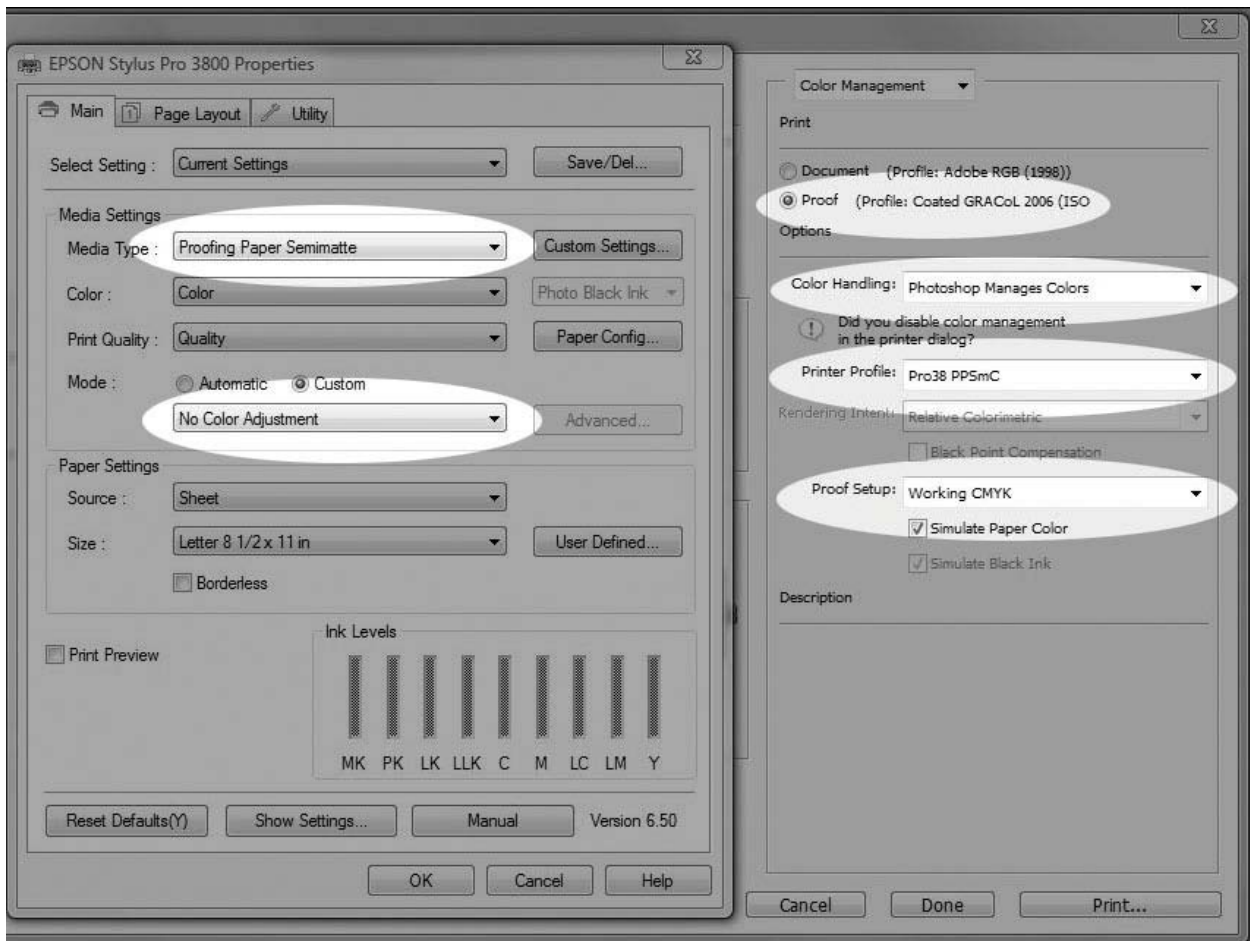
Epson Properties and Photoshop CS3 Print Dialog for making a cross rendered CMYK guide print.

11. Archiving

It is important to address the issue of who will archive digital image files. Basic decisions include what kinds of files to archive, how to protect the archive from format obsolescence and media failure, and the choice of metadata scheme to facilitate searches.

Without careful filing, it can be hard to find a specific image. However, most image file formats (including all we recommend here) include space for metadata that facilitate cataloging and searching with a digital asset management programs (such as Extensis Portfolio or Expression Media). 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 may corrupt the backup.

Over time, as operating systems change and new storage media emerge, you will likely need 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.

Archival Image Formats: Archiving raw image files from Digital SLR cameras will likely be a key challenge in the long-term maintenance of a digital archive. Because each camera model creates a unique file type, it's likely some files will become unreadable in the future. Photographers should develop a comprehensive strategy to confront this issue, accounting for the probable obsolescence of file formats and for the need for file format migration.

File format migration refers to the practice of converting image files to a different (newer) storage format. This might mean conversion to TIFF files, conversion to DNG files, or conversion to some future format not yet invented. Each choice holds certain advantages and disadvantages for image quality, storage needs, and workflow requirements.

Conversion to TIFF Files: By converting images to TIFF format, the photographer stores them in the most accessible file format. And because TIFF is an open standard, it should 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 they will be 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 DNGs. This clearly increases the cost of file storage (assuming other costs stay the same). Although TIFF files have several compression options (LZW, ZIP, and JPEG), none is recommended due to the lack of universal support for a compressed TIFF format. This is especially important if you do not know exactly who will receive the file. Another downside to

TIFF conversion is that it precludes the use of better raw converters surely coming in the future. Just as Photoshop CS3 converts raw files better than Photoshop CS2, it is likely the file conversion programs available several years from now will do an even better job.

Archiving JPEG Files: Conventional wisdom suggests the TIFF format holds a quality advantage over the JPEG format. This holds true only if the JPEG file is saved at less than 10 quality, using the Photoshop standard. Artifacts are either non-existent or insignificant at JPEG quality 10 or 12. Higher bit-depth is really the only advantage of using TIFF over JPEG 10 or 12 (in terms of image quality). Some have argued that JPEG, because of the way it encodes data, compromises color. This is a misconception. When using the highest quality settings, there is no loss of color fidelity. Therefore, if JPEG files are saved at 10 to 12 quality, and if they do not require much pixel editing before use, archiving JPEG files is not a bad concept. And it can save a lot of space. For many picture archives, the economics of storing large numbers of files dominates all other considerations, and JPEG offers a feasible solution to the problem.

Archiving Raw Files: A photographer who chooses to archive raw files preserves the largest number of options for future file conversions. As software improves, new conversions of the image file might offer better color fidelity, better noise reduction or better upsizing interpolation.

This, too, has its downside. Raw files will likely require conversion to a more universal file format at some time in the future. For a single photographer, this may involve converting and re-cataloging 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 may not be safe to alter these files. This means any work on these files, such as adding metadata or tonal adjustments to the image, should not be stored in the file itself. Instead, use either "sidecar" files or store these adjustments in a database. But the added files can become a file-management challenge that may present a serious roadblock in the future, as you try to include such 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 by another program. Always test a backed-up image for anomalies before adding metadata to proprietary raw files.

Archiving DNG files: A raw file can also convert to DNG format, a documented, TIFF-based format created by Adobe. DNG 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. Photoshop opens DNG in Adobe Camera Raw just as it does raw files, offering the full range of conversion options available with the original. Cataloging applications such as Expression Media and Extensis Portfolio can see metadata changes and image adjustments made in Camera Raw.

DNG will likely be readable long after most original raw formats become obsolete, simply because there will be so many more DNG images than those in any proprietary raw format. DNG also offers a lossless compression that can reduce the file size up to a third. In addition, DNG allows embedding the raw file itself, so it can be re-converted later if desired – although since this doubles the file size, embedding the original file may not be desirable.

There is, however, a downside to DNG: Conversion requires an extra step at the time of raw file processing. While this does not take terribly long, it is an extra process. Moreover, 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 not be acceptable.

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 for converting the file at a later date (such as "dust reference" information, or information helpful in correcting chromatic aberration). By converting to DNG today, you may lose this data, since it is currently undocumented and it may not copy correctly.

Archiving JPEG2000 (.jp2, .jpx, .jpf)

Created by the Joint Photographic Experts Group committee in 2000, JPEG2000 is a wavelet-based, image-compression standard. JPEG2000 offers a compression performance gain of around 20 percent compared to the standard JPEG. For lower or higher compression rates, the improvement can be somewhat greater. It has, however, notably higher computational and memory demands, which for most photographers means opening and closing JPEG2000 files takes more time. Unlike the standard, baseline JPEG, JPEG2000 does offer a fully lossless option. Improved compression options and performance, however, are not the main benefit of JPEG2000. The real achievement of JPEG2000 is "smart decoding." This feature enables a decoding application (or plug-in) to access and decode only the required portion of the code stream. This means a single JPEG2000 image can supply multiple, reduced-resolution versions of the original. These might include specific file sizes, and/or a high-quality, high-resolution view of a specific portion of the image. This makes JPEG2000 an excellent format if you require the ability to smoothly zoom, pan and rotate images. Creating compressed images that contain different quality levels allows master images in an archive to supply multiple derivatives, saving time and bandwidth. This makes an image archive much more efficient. In addition to this array of output options, JPEG2000 can handle very large images, at least up to a terabyte. JPEG2000, unlike standard, baseline JPEG, supports high-bit-depth (up to 16 bits per channel vs. 8 for standard JPEG) and high-dynamic-range images. JPEG2000 also underpins the MJ2 and JPM formats for motion images (each frame is a JPEG2000-compressed image) and compound images (images, graphics and text). These additional features make the JPEG2000 format a potentially valuable option for archiving film, video and historical materials.

JPEG2000 has not been widely adopted by photographers. Raw and DNG are viewed as better solutions for their specific needs. And JPEG2000 is not a good candidate to replace standard JPEG as a digital capture format, since the former requires far greater compression time. Still, photographers may want to become more familiar with JPEG2000 and be prepared to deliver in one of its variants, since many cultural heritage and digital preservation communities use it as the basis for their collections. Unlike photographers, these institutions are less concerned with improved rendering options over time. Their focus is preserving a specific rendering intent in the best way possible, with the most efficient storage and delivery options. JPEG2000 does these things well. The unanswered question is whether this "niche" adoption of JPEG2000 will ensure its long-term viability as an archival format. Some of the cultural institutions finding JPEG2000 to be the best current solution for their archiving needs include The Library of Congress, the Harvard University Library, Library and Archives Canada, Chronicling America website and the Google Library Project. For more information, see the Digital Preservation Coalition Technology Watch Report.

Archiving HD Photo/JPEG XR

Microsoft has thrown its hat in the ring of digital formats. Its technology was originally called Windows Media Photo, then renamed HD Photo, Microsoft is now working with the Joint Photographic Experts Group to make the format a JPEG standard, JPEG XR (for extended dynamic range). HD Photo has shown no compelling advantages over JPEG2000 for archival purposes. But HD Photo does have a faster compression algorithm compared to standard JPEG, and this offers some potential advantages as a digital

capture format. Since the main drawbacks to the standard JPEG format are the 8-bit tonal depth limit and limited dynamic range, JPEG XR could provide a welcome step. Covered by Microsoft's Open Specification Promise, JPEG XR avoids problems associated with proprietary raw formats. The future of JPEG XR depends on camera makers offering it as a capture format. If and when this happens, then JPEG XR would become a potential archival format as well.

HD Photo is also the basis for the Microsoft Seadragon project and the related Photosynth photo viewing technology. These new technologies could also drive the adoption of HD Photo, since they both use HD Photo's ability to decode only the needed portions of an image, allowing for rapid screen draws as images are combined, zoomed, and panned. The latest Windows operating systems include full support for HD Photo.

> NOTE: The archiving JPEG section is based on research and analysis by Ken Fleisher. Peter Krogh prepared the rest of this analysis of archival image formats. Peter offers a more in-depth discussion of these issues, as well as details related to the creation and maintenance of a digital archive, in *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.

Archiving 32Bit HDR Images

HDR Imaging is a rapidly evolving field with very few set standards at this point. HDR image formats include: Radiance HDR, OpenEXR, JPEG-HDR, Windows WDP, TIFF LogLuv 24/32, Cineon DPX, TIFF float, PFM, and TGA. Radiance HDR and OpenEXR currently offer the most application support.

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 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, 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; 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 replacing traditional 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 delivered with 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 its distraction. Others embrace file preparation, 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 calibrated monitors, those who embrace file preparation can deliver to printers files that will

reliably (if not precisely) reproduce on paper the optimized images 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* queried 800 offset printers and found only four accepted RGB files in their workflow. When you send an RGB file to an offset printer, the biggest risk is 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 there has been neither communication with the printer nor the inclusion of a ReadMe file that indicates the file's color space, prepress will probably open the file in the shop's default RGB space. This 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, 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.
- High volume, moderately quick turnaround workflow.
- Low volume, high quality workflow.
- High volume, high quality workflow.

High Volume, Quick Turnaround Workflow:
Examples: Most photojournalism, sports for newspapers and magazines, events and most public relations.

The focus is on speed, with tradeoffs in ultimate quality. 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.
- News organizations and printers are expected to have staff trained to receive transmitted photos and prepare them for print, broadcast or web use.
- Software such as PhotoMechanic allows embedding IPTC data on the fly as image files transfer from memory card to computer, saving time and ensuring file recipients have all necessary captioning, cataloging and crediting information.

- Increasing processing power, falling storage costs and growing bandwidth allow more photojournalists to consider raw workflows. New editing and batch processing software facilitates ingesting, optimizing and converting raw image files with ease and speed to meet most deadlines, while preserving all capture data for additional, higher-quality uses.

High Volume, Moderately Quick Turnaround Workflow:

Examples: Monthly magazines, institutional brochures, annual reports, web sites, 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. Using a DNG workflow, you can include an sRGB JPEG preview in the DNG file, which can be used for creating HTML proofs, eliminating the need to run a separate batch conversion for proofing.

- *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 makes corrections for color, exposure, etc., and then created DNG files with the full size JPEG preview option enabled, the recipient of the file will have the flexibility of a raw file *and* the intentions of the photographer. Until more raw processing software supports the DNG format, this limits conversion options primarily to Adobe Camera Raw and a few other programs, such as [DXO Optics Pro](#) and [Silkypix Developer Studio](#). Other raw converter manufacturers, such as [BibbleLabs](#), and [Phase One](#), are adding support to read and write a DNG file. The same requirements as for proprietary raw files – high-end computers, current software, color-managed workflow –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. All should clearly understand the tradeoffs between cost and quality, along with the client's responsibility for adjusting final output. 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 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 more resizing options.

    - Whether, how much and when to compress images as JPEGs. JPEG files are handy when delivering many images or when delivery takes 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 an 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 [CMYK Guide Prints and Verifiable Proofs](#).

    NOTE: RGB master files are Photoshop (PSD) or TIFF files, optimized in a wide-gamut color space (such as Adobe RGB, ECI-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. Leave them

unsharpened, or sharpen only on a removable layer, since resizing for future uses is likely. Archive master files along with the raw files for a project.

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 (see footnote). 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.

NOTE: 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.

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, may benefit from a JPEG workflow.

Workflow Tools and the UPDIG Guidelines: Digital capture proved revolutionary in the sense that it provided options beyond film. Now that digital capture is such a large factor in creating photographs, a second revolution is occurring: 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 depends on 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 unprocessed camera sensor data and do not become image files until decoded according to a set of instructions created by raw processing software in conjunction with user input.

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 they are separate files and can 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 sidecar files. This hides the rendering intent from those programs. Even if other applications could read a variety of sidecar files, rendering intent would still very much depend on the rendering engine in use. 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. All other raw file formats created so far operate in closed, proprietary systems, so fixed rendering requires conversion to another file format for proofing, cataloging and/or delivery.

Preserving Metadata: "Digital images should have metadata embedded that conform 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. The lack of standards among proprietary raw file formats raises questions of where to store this metadata, along with how other applications can discover and use it. Some proprietary raw processing software actually removes such metadata, creating a workflow problem and requiring reinsertion of this information 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 need to store their metadata in sidecar files or database libraries. They must be mindful of the need to arrange their workflow so 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 from those who seldom capture 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 you can make the correct compromises between perceived rendering quality, processing speed and ease of adding metadata.

Confusion surrounds 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 these all-in-one programs unify and improve their workflow, while others complain they are slow, unstable, or unable to handle batch processing. Much of this conflicting information concerns whether a program is being used on dozens or thousands of files, and whether it is running on the fastest multi-core processors with 4+ GB of memory or on older hardware. It's no wonder a favorite phrase on digital photography forums is "your mileage may vary."

Appendix

ICC Color Management

ICC International Color Consortium ICC White Papers
X-rite color measurement and color management, offering hardware, software and services for measuring, formulating and matching color including Color Checkers
Chromix Color Services, Color Think Software
SWOP Specifications Web Offset Publications
SWOP-certified systems This page lists the SWOP certified proofing systems
GRACoL General Requirements for Applications in Commercial Offset Lithography
FOGRA Graphic Technology Research Association
IFRA Global research and service organization for the news publishing industry.
ECI European Color Initiative
ISO International Organization for Standardization
Dry Creek Photo Digital Imaging Resources for Photographers by Photographers
Colorremedies Color Management Essential Training

Metadata

EXIF.org - EXIF and related resources
Orphan Works Orphan works are basically works whose copyright owners cannot be located.
EXIF The specification uses the existing JPEG, TIFF Rev. 6.0, and RIFF WAV file formats, with the addition of specific metadata tags. It is not supported in JPEG 2000, PNG, or GIF.
IPTC IIM the first multi-media news exchange format
IPTC Core This page is about IPTC metadata to be used within Adobe's Extensible Metadata Platform framework.
XMP (Extensible Metadata Platform) a standard for metadata, created by Adobe Systems Inc.
PLUS standards An international non-profit initiative on a mission to *simplify and facilitate the communication and management of image rights.*
Controlled Vocabulary web site Recommendations for Limitations on Image Filenaming
http://www.adobe.com/products/xmp/custompanel.html The custom File Info panel for XMP metadata allows you to define, create, and manage custom metadata properties using standard Adobe applications

Software

Bibble Professional Workflow and raw Conversion software for Windows, Mac OS X, and Linux
Capture NX Nikon's software for simpler, more intuitive full-scale digital image processing and editing
Capture One Raw workflow software from Phase One
Aperture Import, manage, and enhance your photos in one simple, integrated workflow
Microsoft Expression Media 2 is an extremely powerful and customizable image management software application for importing, annotating, organizing, archiving, searching and distributing your ever-growing collection of digital files.
HindSight Software for Professional Photographers including MetaMachine
PhotoMechanic Photo Mechanic is designed to work with groups of photos together in order to manage them.
ImageIngester double backup; naming; moving to folders; applying bulk metadata and Camera

Raw/Lightroom settings; GPS tagging; converting to DNG; verifying; correlating multi-camera shoots.

BreezeBrowser Used to download, browse, select, organize and post process their images, create web galleries and control cameras from a Windows PC.

Cumulus Digital Asset Management software and hardware

Portfolio Digital Asset Management software and hardware

DXO Optics Pro is a multi-award winning program running on Windows or Macintosh to automatically improve image quality.

Silkypix Developer Studio adjust the color, tone, and the white balance of the image can truly help you express your feelings through the photography.

DAM Useful Digital Asset Management and Workflow Software

Adobe Software

ACR (Adobe Camera Raw) Digital camera raw file support.

AcrCalibrator Tom Fors' calibration script for ACR. Visual Vacations ACR calibration tutorial

Lightroom Lightroom® software is the professional photographer's essential toolbox, providing one easy application for managing, adjusting, and presenting large volumes of digital photographs so you can spend less time in front of the computer and more time behind the lens.

Monitor Calibration

PDF manual how to calibrate and profile both CRT and LCD monitors

Gretag-MacBeth Eye-One Colorimeter

Color Vision Spyder 3 Elite Colorimeter

ColorEyes Display Color profiling software and hardware

Profile Verification Kit by Pixl Ltd.

Black Point Check

Grayscale Test

W cathode ray tube

W liquid crystal display

W white point

W color temperature

W color look up table

W gamma correction

W luminance

File Formats

DNG file format (Digital Negative) The public, archival format for digital camera raw data

Luminous Landscape site A good analysis of the raw Flaw

OpenRAW Organization hoping to persuade camera makers to provide open documentation of their proprietary raw formats.

OpenRAW survey The 2006 raw Survey – A Report on the Experiences, Requirements, Belifs, and Preferences of Photographers and Imaging Professionals regarding raw Imaging Technology

File Delivery

YouSendIt Web file delivery service

SmugMug Online gallery and image sharing service

Web Color

http://www.northlight-images.co.uk/article_pages/web-browser-color-management.html* web browser color management

http://regex.info/blog/photo-tech/color-spaces-page2/* web browser color management

Books

The DAM Book: Digital Asset Management for Photographers, By Peter Krogh

Practical Color Management: Eddie Tapp

Real World Camera RAW: Broce Fraser and Jeff Schewe

Real World Color Management: Bruce Fraser, Chris Murphy, Fred Bunting

O'Reilly O'Reilly Media spreads the knowledge of innovators through its books, online services, magazine, and conferences

Peach Pit Essential resources for the creative community

Blogs and Forums

The Dam Forum

John Nack on Adobe

The Lightroom Journal

Photoshop News

Consultants

Peter Krogh- Digital Asset Management

Andrew Rodney- Color Management

Neil Barstow- Color Management

Chris Murphy- Color Management

David Riecks- Photo Metadata