Fine art reproduction with digital photography and ink-jet printing

by Brian P. Lawler

This is a revision of a handout that I started eight years ago. It is a product of practice, research, consulting with numerous experts, and a good deal of failure.

I made a deal with my friend Carlen that I would make a reproduction of one of her paintings. The original hangs in my living room, and she wanted a copy for display in her studio.

This is my successful reproduction image of Carlen's roosters painting. I succeeded with this image because it had a reproducible color palette, and I was able to get the lighting to work using cross-polarized filters. Since making this image I have abandoned polarizing filters and adopted the more correct lighting techniques described in this handout.

I took steps to fulfill my promise to make a copy of her painting. In some parts of the industry this is called *Fine Art Reproduction.* In other parts, it goes by the pretentious name "giclée" printing. That word is the French for "squirted" which, I suppose, describes what an ink-jet printer does to ink on its way to the substrate. Ask a native French speaker what "giclée" means, and you'll learn an altogether different definition that is not appropriate in a family publication like this (I find this particularly amusing when talking to art gallery snobs who refer to their art as being reproduced not by ink-jet, but by "giclée printing" which is obviously much better).

My task was to photograph, then print a full-size reproduction of Carlen's painting. One would think that this is an easy task, but I knew better. When I had my business we did a fair amount of reproduction photography for scanning on our Crosfield scanner.

Anything that we couldn't wrap around the drum would be photographed onto 4x5 inch Kodak Ektachrome film, and then the resulting film was scanned.

I was successful in reproducing Carlen's painting, mostly because I was lucky. In subsequent attempts I have not been so lucky. The color has been unacceptable, the lighting has been impossible, or a combination of factors has contributed to various failures.

Fine art photography is a complex task, one requiring tremendous attention to detail and the application of care in the selection and placement of lights and camera, selection of lenses, color management and reproduction on appropriate papers.

It's important to the graphic arts and photography fields because *there is money to be made* in reproducing fine art – whether it's for sale as art, or as an illustration of art to be printed in a publication or used online.

To reproduce artwork successfully, one must build a photographic environment conducive to this work, and develop a work flow that allows for correct lighting, color management of the source image, and then reproduction using color management on an excellent ink-jet printer on an excellent fine art paper.

The first step is to have control over the light in the photo studio – it must be *absolute* control. For our studio work we will be using strobe lights made by Paul C. Buff Company. These lights are not expensive – they cost about $600 each, including the radio transceivers that control them from the camera. Strong light stands are needed, as two strobe lights are mounted on each stand, and that is a significant amount of weight.

I built a wall mount for artwork in our studio. It's a sheet of plywood machined with parallel T-slots on which clamps can be added. The plywood was painted black, then mounted solidly on the wall of our photo studio.

Space is limited in our studio, so I made the plywood panel 50 inches square. This allows us to photograph artwork up to about 36 inches square. Any larger and we would run out of space for the lights, which must be placed at a distance from the art and the wall.

Photographic experts have determined over time that specific angles must be used to illuminate artwork and not create reflections. The best ratio for lighting angles is 2.5 horizontal and 2.0 toward the camera. Distance from the center of the artwork should be adequate to evenly illuminate the work being photographed without hot spots.

For our lighting set-up I have chosen a horizontal radius of 48 inches from the center of the artwork, which results in a 38 inch distance away from the wall for the position of the lights. At 48 inches I get adequate light coverage of the artwork.

Measuring with a tape measure, I marked the wall with the radius, then measured away from the wall to position the lights correctly.

The lights are mounted with Super Clamps and 5/8 inch aluminum bars. These bars allow me to position the two lights on each stand at the same distance from the artwork, but also above and below the art.
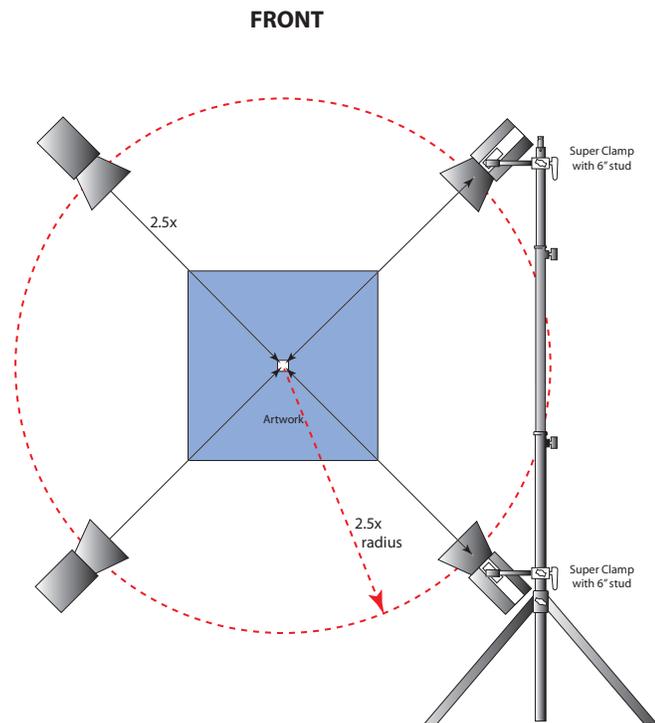
FRONT

This is the front view of the fine art reproduction wall. The strobe lights are mounted on two vertical light stands, each along the radius of the lighting arrangement.

After mounting the lights to the stands, we need to position them the correct distance from the center of the artwork, and the correct distance from the wall.

Once they are positioned correctly, they are aimed at the center of the artwork using a laser mounted to the strobe light body. I work to get the lights to within a centimeter of the center of the art – indicated by the target in the *WhiBAL* card.
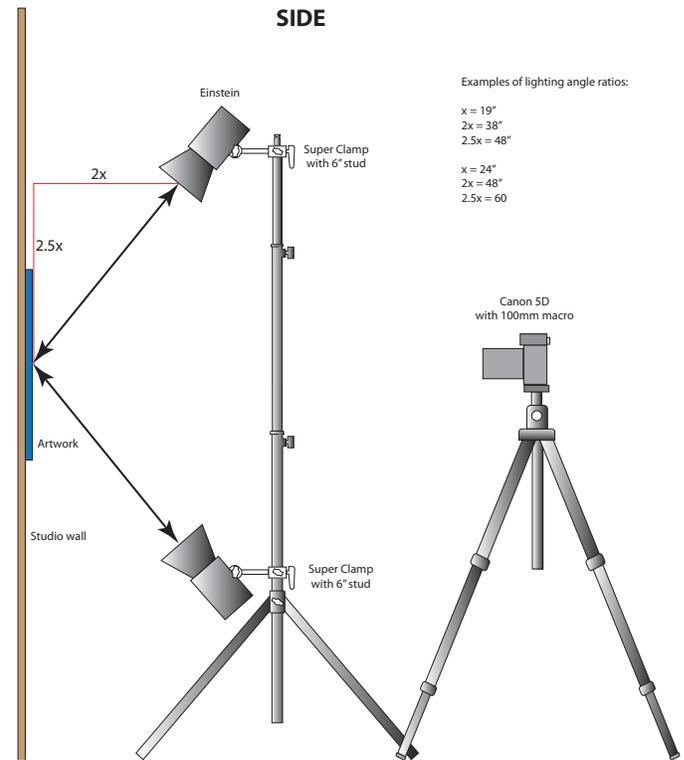
SIDE

This is the side view of the same lighting arrangement.

The camera is positioned so that it is square to the artwork – perfectly square. To do this we use a special photographic mirror and a mirrored filter for the camera with a small hole in the center. We suspend the mirror on the artwork wall, then mount the mirrored filter on the lens, and look through the filter until we see a series of concentric circles in the viewfinder.

When positioned correctly, the camera will be less than 5 arc-seconds off-axis.

The next step is to measure the behavior of the lights and the camera by making an input profile. This is done by photographing a standard camera profile target called the X-Rite *ColorChecker SG*. It has 140 color patches that are used to measure and correct the camera's color with special software.

To make a proper photograph of the ColorChecker target (and eventually the fine art we hope to reproduce) we need to be sure that the exposure is correct, and that

Here, Professor Van Kleeck positions the camera using the Hasselblad photographic mirror and the Zig-Align mirrored filter on the camera. You can also see the Einstein strobe lights mounted on the two parallel light stands. The ColorChecker SG is behind the photographic mirror.

the strobes are equally bright over the entire surface of the reproduction area. To do this we use the incident light meter on the PCB *Cyber Commander* radio trigger device. It measures exposure to 0.1 f-stop. In our initial tests with this lighting arrangement, all the readings were within 0.1 stop of each other (in fact they were all exactly the same).

There will be some differences of opinion of color temperature between Adobe *Camera Raw* and the strobe lights in the studio. To overcome any inaccuracy, it's important to record a *custom white balance* in the camera prior to making the test photo and the final photos. To do this, we photograph a *WhiBAL* gray card (it's actually slightly off-white), and then register that photo in the camera as being the new custom white point. We use a *WhiBAL* card that can be mounted on the wall and photographed to obtain the custom white balance. Once set, on the Canon camera, this custom white balance will remain in effect until changed.

After determining that the exposure and white balance are set, we choose an aperture that allows for a sharp image with some – but not much – depth-of-field. There is a "sweet spot" in every lens where the lens is sharpest. Typically that sweet spot is two f-stops from the largest aperture of any lens. We're using an f2.8 lens for this project, so that sweet spot will be approximately f5.6.

By adjusting the output of the strobe lights (and ensuring that they are set to *constant color output*), we are able to get a good exposure at f5.6. The light output of the strobes turns out to be minus 5 f-stops to get this exposure.

Even with correct exposure, we need to make a bracketed series of exposures to ensure that we capture the artwork in all of its glory. We shoot a range of two stops of exposure in 1/3-stop increments (this is the unit of exposure on the Canon cameras). So, with f5.6 as the nominal exposure, we make the following exposures:
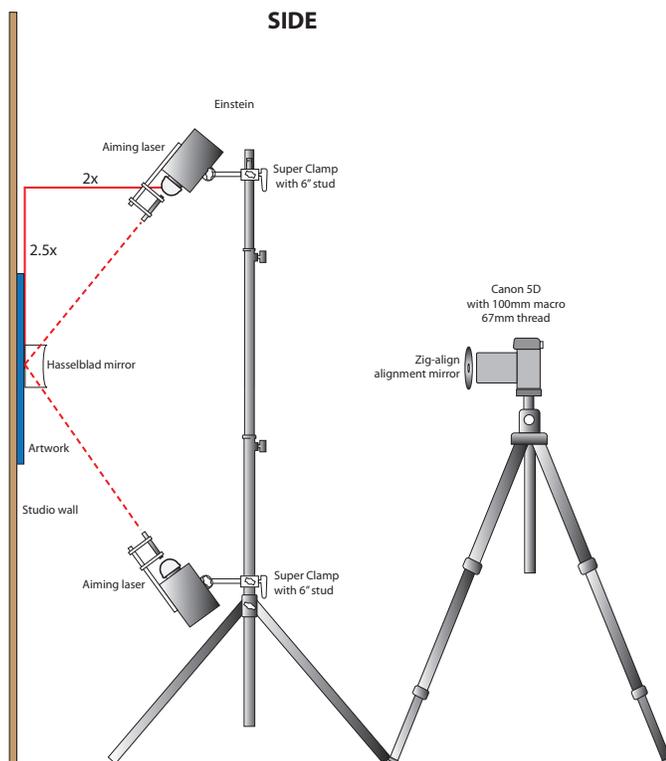
f5.6

+1/3

+2/3

f5.6

−1/3

−2/3

These exposures can be evaluated on the computer after we get into the lab, and where we will choose the best exposure based on the measured CIE-Lab value for *L* in each image. We will pick the one that delivers closest to .95 L value (very near white).

SIDE

This shows the Hasselblad mirror on the artwork, and the Zig-Align mirror filter on the camera lens. This combination of tools allows for the precise alignment of the camera to the artwork, a process that is otherwise very difficult. Also shown are the aiming laser beams used to position the lights correctly.

So far I have discussed only how to photograph the color target, and it is important because we must use that target to build a *Camera Raw profile* with which to import subsequent images into Adobe *Photoshop* (or *Lightroom*). Note that this is not an ICC profile; it is a different kind of profile that works only in *Adobe Camera Raw.*

To build that profile we use an application called *BasicColor Input,* from the German software developer BasicColor. This software is the best on the market, and is known for making the absolute best input profiles for digital cameras.

BasicColor can read many Camera Raw files, and when it encounters one, it makes an appropriate profile and makes that profile available to the Adobe Camera Raw software for *Photoshop* and *Lightroom.*

(BasicColor *Input* can also make an ICC profile, which it will install in the User *Library* for post processing if you prefer to use the ICC version.)

Making note of the exposure that produces the best camera profile, we can return to the studio and shoot a bracketed series of images of the artwork we plan to reproduce (remembering to use the custom white balance setting on the camera).

It's also important to have a standard grayscale mounted in the image with the original art. We need to be able to read white and black in the next processing steps. I use the grayscale on the *Color Checker Passport,* a small target that fits easily along the edge of artwork.

We again take a series of bracketed exposures of the artwork we're reproducing following the same range of exposures we used to make the profile.

Then, using Adobe *Camera Raw,* we process the image that is best into *Photoshop*, applying the profile we built in the previous step.

First, we apply the profile we made earlier in Adobe *Camera Raw.* This will correct the color in the artwork to within less than 5 Delta-E (the profiles we have been making exhibit Delta-E errors of 2.35 average, and no more that 4.5 peak error. That's exceptional.)

Change the *Camera Raw* settings to open images in *16-bit color,* and change the destination color working space to *ProPhoto RGB* – both of these are important because 8-bit color and *Adobe RGB* are slightly inadequate to accommodate the colors in original art.

Two adjustments then need to be made before the image is opened from Camera Raw. In the *Point Curve* control we need to adjust the white value slider until we get a consistent RGB value of 250 units (each channel adjusted separately). Once that is accomplished, we adjust the black end of the curve to get 10 RGB units (all three channels). This will compress the tone scale a

This is the ColorChecker SG target we photograph to build the input profile. It consists of 140 color patches. This target has become the industry standard for building camera and scanner profiles.
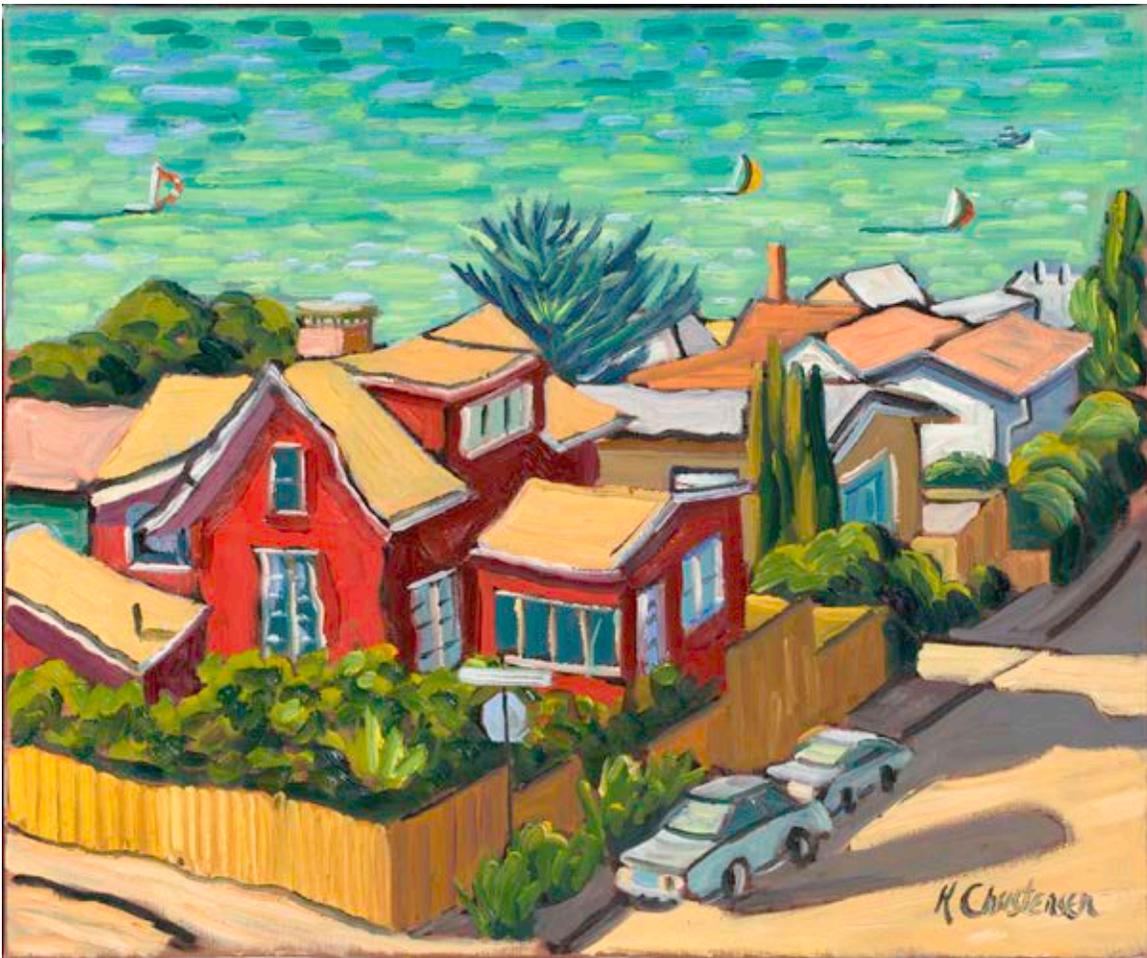
improvement in color reproduction and gray values.

On completion of those adjustments (and nothing else!), we open the image in *Photoshop*.

Once the image is open in Photoshop, we must scale it to the correct size (the same size as the original), and make a print on Epson *Fine Art* paper. This, of course, requires its own ICC profile to make the color come out most accurately.

Experiments with these steps will yield small, but visible changes in the artwork, so be sure to be scientific and make notes about any adjustments you make in the camera, in the studio, and in the software. A 1/3-stop exposure error can ruin the entire process.

And, don't ever rely on your memory – you can't. Bring the original art into the lab to compare to the image on your computer display and to compare with the final prints. Stick to scientific processes and the result will be as successful as your process will allow.

bit, but what we are accomplishing is the customization of tonality to match the artwork we are reproducing. We are forcing the black point and the white point to measured levels that will result in an overall

…and this is the image of the Ken Christensen painting that I photographed in the studio recently. With 16-bit color depth, the ProPhoto RGB working color space applied, and the Camera Raw profile used to convert the image to Photoshop, it is the most accurate fine art reproduction I have ever made.

Fine art reproduction, step-by-step

1. Position the artwork on an easel or other surface appropriate for photography. Depending on the size of the original, estimate the proper distance from the center of the artwork to the lights. I like to use a distance of two to three times the long dimension of the art, but this is variable. Sometimes there are physical limitations on where your lights can be placed.

2. Eliminate all spurious light sources – only one source of light should be used.

3. Determine the light coverage needed to make images in your lighting circumstances. Use this to determine the distance from the center of your artwork area to the lights in the *X* direction (along the artwork plane away from center). Once this distance is determined, calculate the *Z* direction (away from the art plane toward the camera) and move your lights that far away from the artwork plane. Think of the *X* direction as a circle around the artwork at a fixed distance from center. The *X* distance should be 2.5 times the *Z* distance.

4. Install your four lights at the proper *X* and *Z* distance from the artwork plane.

5. Place the *WhiBAL* card in the center of the artwork area with its center target in the middle.

6. Position the lights with laser pointers, using the target in the center of the *WhiBAL* card. Each light should be aimed with the laser so that it is pointed inside the *WhiBAL* center target (about 1.5 cm. diameter).

7. Determine the *sweet spot* of your lens. This is typically an aperture two stops from the largest aperture of the lens. *For example:* For the Canon 100mm f2.8 Macro that is f5.6 (or one-third stop either side of f5.6). The reason for this is that most lenses are not sharp at small apertures, and at the sweet spot you get sharpness and *some* depth-of-field for your artwork. With an aperture of 2.8 there is so little depth-of-field that dabs of paint may be out of focus on the canvas while other dabs of paint are in focus.

8. Fill the camera frame with the *WhiBAL* card. With the *WhiBAL* card in place, determine the *correct exposure* (this might be using the camera's light meter or a hand-held meter). When using strobe flash units, the exposure is set by the intensity of the strobes. I use an incident strobe light meter to get the perfect exposure, and I adjust it very slightly once the fine art is in place.

9. Photograph the *WhiBAL* card. Then, having made an exposure, check the camera's LCD to see if the histogram shows any sign of overexposure (You cannot recover from overexposure). If *correct* exposure is indicated on the histogram, assign this photo as a custom white balance on your camera (the process is similar on all popular cameras). This will define "white" in the camera, and this prevents misinterpretation of "white" in Adobe *Camera Raw* or *Lightroom.*

10. Remove the WhiBAL card and insert the *ColorChecker SG* (CCSG) card in place of the WhiBAL card. Then, using the *correct* exposure you determined in Step 8, shoot a photo of the CCSG. It may be helpful to set the focus of the CCSG slightly soft so that the image is of the colors and not of the paint chips in the target. Once you have made the CCSG photo, remove it, and store it away.

11. Place the artwork in the center of the subject plane. Move your camera so that it frames the artwork with a small amount of extra space outside the frame. Put a grayscale into the shot with the artwork; I use an X-Rite *Color Checker Passport* with the grayscale in the frame. The grayscale will be very important later when adjusting the image in *Adobe Camera Raw* or *Lightroom.*

12. Check square. For this I use two optically flat mirrors, one on the artwork, the other on the lens. It is possible to use small corner marks on tape to accomplish this same task, but the mirrors are more accurate. My subject mirror is a *Hasselblad* mirror (you can find them on eBay). The camera mirror is a *ZigAlign* mirror that attaches to the Canon lens. When using the mirrors, it's possible to get the camera perfectly straight relative to the art; it can be as accurate at 5 arc-seconds. Getting the art square in the camera ensures that you don't have to make any distortions in Photoshop to correct for square.

13. Be sure that the entire surface of the painting is in sharp focus. I use *Live View* on my Canon camera to see critical focus on the camera's LCD screen – *Live View* provides both 5X and 10X magnification of the image.

14. Check exposure at the corners of the artwork. With the *Einstein* lights I use, I can control brightness in 0.1-stop increments. Most of the time the exposure is accurate corner to corner, but I occasionally make 0.1-stop adjustments to get the lighting exactly the same at the four corners.

15. Take a series of exposures of the artwork. Bracket one stop on either side of nominal in third-stop increments.

16. Leave the studio set-up in place if possible, taking only the memory card to your computer for the following steps. This will allow you to return and try again if you need to.

17. On the computer, transfer the images from the memory card. I prefer to convert to DNG *while importing* with *Adobe Bridge* (see the separate handout on this topic). DNG is important in the next step.

18. Run *BasicColor Input* profiling software and set up a workflow that makes a *Camera Raw Profile* from your test image. Name the workflow with a name that describes your camera and lighting and exposure. Drag and drop the properly exposed DNG file onto the BasicColor *Input* software. It will automatically create the profile from that image, and it will install that profile automatically in the *User Library* on the same computer. This profile will become available immediately to Adobe Camera Raw. (This profile is portable; to share it with others, you'll have to go into the User *Library,* then the *Application Support* folder, then *Adobe, Photoshop,* and *Camera Raw Profiles* folders to copy it.)

19. Open the *correctly exposed* image of your fine art into *Adobe Camera Raw* (this should be the photo made at the same exposure as the CCSG). Choose your new *Digital Camera Raw* profile from the list of available profiles on the right side of Adobe Camera Raw (you may have to dig for it). It will correct the color to the greatest degree possible. Do not change the color temperature of the image (that is automatically defined by the *Custom White Balance* you set back in Step 8). Leave the white balance setting as: *As Shot.*

20. Choose the second tab in *Adobe Camera Raw* (Curves), then choose *Point.* Work on individual R,G and B channels while making the followng adjustments. With the *Passport* grayscale in the shot, adjust the top-right of the curve until the white square in the grayscale turns red (you must turn on the highlight exposure alarm in the histogram pane first). Once it turns red, move it slightly to the right (2 RGB units) until the red alarm turns white – just barely.

21. Adjust the lower-left point of the curve (combined channels) to get the blacks to about 10 on the 0-255 scale. This will force blacks to be quite dark, but usually quite accurate.

22. Set the *Workflow Options* in *Camera Raw* to *16-bit color* and set the color space to *ProColor RGB.** Then, without changing any other settings, *Open* the image in *Photoshop*.

23. Crop the image (and straighten it if necessary). The proportions will be correct, but the dimensions will not be. Change the dimensions in *Image>Image Size,* with the *Resample* checkbox *turned off* (very important!). For ink-jet printing the optimal ppi resolution should be about 240. If it's much less, you may have to use a higher-resolution camera, or re-shoot the image as a series of photos and stitch them in Photoshop using *Automerge.* Ink-jet printing is somewhat forgiving of resolution deficits.

24. Print your file to an ink-jet printer that you have profiled for paper and ink (an ICC profile). Without a current and correct ICC profile you will not get the best color reproduction.

25. After following this simple** checklist, your reproduction should look very similar to the original image. If not, it may be a result of choosing an incorrect ICC profile for the printer. You can adjust the color in *Photoshop* or *Lightroom* to make small changes, but big errors are usually a result of inattention to detail or allowing something to change in settings or lighting. Review the process and correct as necessary.

*See the separate handout on *16-bit color* and *ProPhoto RGB.* **Ha!

An additional note on printer profiles and gallery lighting

On one occasion I was very successful in making a fine art reproduction of an oil painting. I was very happy with the result in the viewing booth (D50 color temperature). When I returned the painting and took the reproduction to the artist's residence, it did not look as good. The colors did not match as they had in our viewing booth.

The painter had low voltage incandescent track lighting in his home. I believe the color temperature of those lights to be 2700K, but I am not sure. I know that I could make a custom ICC profile for the gallery lighting in his home. By re-reading the color target I printed on our Epson 9800 printer, and declaring the color temperature of the viewing condition to a more appropriate value (ISO *Illuminant A*), the new ICC profile would make the printer produce art for a lower Kelvin temperature environment. That, I believe, would be more successful.


This is the Jerry Scott painting that I reproduced for the Color Conference. Note the ColorChecker Passport on top of the artwork.
It's there to provide a grayscale in the image. I use that grayscale to adjust exposure in Adobe Photoshop.

A pretty good argument for using ProPhoto RGB as your working color space

Photographers discovered 20 years ago that *sRGB* is a really bad color space for professional photography. So we all changed to *Adobe RGB 1998.* Bravo!

The reasons for doing so are important: Adobe RGB has a larger overall gamut, and conversion to CMYK print gamuts like *FOGRA* and *GRACoL* leave colors largely unchanged. Skin tones are rendered slightly better in Adobe RGB, and cyan-green colors are possible in an image, where they are clipped with the much smaller sRGB color space. It was completely logical.
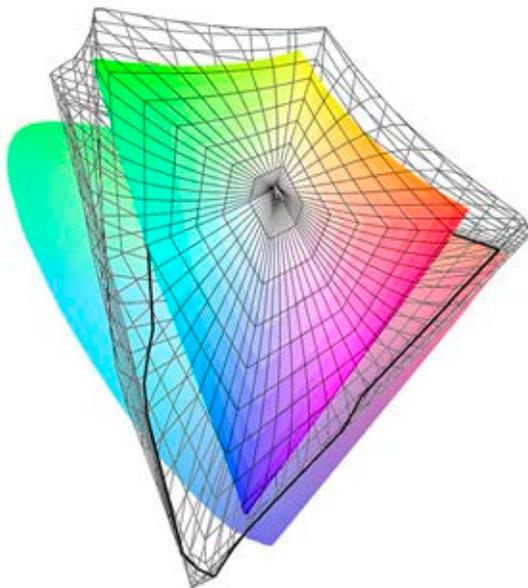
This is a 3D view of the ProPhoto RGB working color space (available in Adobe Photoshop) compared to the Adobe RGB 1998 working color space. The ProPhoto extends beyond the human visual spectrum on the blue axis in order to accommodate a larger range of violet, cyan and green colors. It is also very slightly larger along the red-green axis, which includes the colors described in this essay.

About ten years ago I was counseled by an Adobe trainer to switch to *ProPhoto RGB,* a significantly larger working color space. His argument was strong, but I didn't think it affected me. Someday, he argued, Canon would come out with an ink-jet printer that has such a huge color gamut that I would love it. If I started converting all of my images into *ProPhoto RGB* space (this is done in Adobe *Camera Raw*), I would be able to take advantage of the impressive gamut of that future printer, and I would enjoy the benefits.

I followed his recommendation and I switched to *ProPhoto RGB,* applying it to all of my images. My images did not improve (they were just fine in Adobe RGB), but I felt pretty good about my ability to take advantage of a future printer with much more color than my current printer (an Epson 9800). I never expected *my images* to improve, but I did want to be on board when that new huge-gamut printer came along. To date it has not.

Over the years, probably more a result of staying in-step with other photographers, I switched back to *Adobe RGB 1998.* My photos still look good, and I seldom get any reminders from the *Color Settings* palette reminding me that the color profile I have in my photos is different than the color settings I have established for the Adobe *Creative Cloud.* My work flow just works.

This past week, however, I encountered a situation while photographing an oil painting where the difference between *ProPhoto RGB* and *Adobe RGB* made the difference between success and failure.

I have been working for months (years) to learn a new technique for making reproductions of paintings. This involves considerable discipline: more accurate lighting, precise exposure, perfect camera positioning, building and applying an excellent input profile (applied in Adobe *Camera Raw*), and then adjusting the black-point and the white-point to get the best possible tone range in the resulting images.

I don't want you to think I'm new to fine art reproduction photography. No, I have been doing it rather badly for decades. I have spent countless hours and many dollars building the right set-up, measuring and preparing the lighting, and taking unacceptable photos of paintings and other artwork.

In January, 2018 I attended an inspiring seminar on fine art reproduction by artist/photographer Christopher Campbell and software developer Franz Herbert. The two presented at the annual *Color Conference,* an event hosted by the Printing Industries of America. It was the best seminar I have attended in

years. At the end, Mr. Campbell showed two samples of paintings and reproductions that were indistinguishable. Franz Herbert demonstrated BasicColor *Input,* the software he develops for *BasicColor*, a German firm that makes profiling and profile editing software.
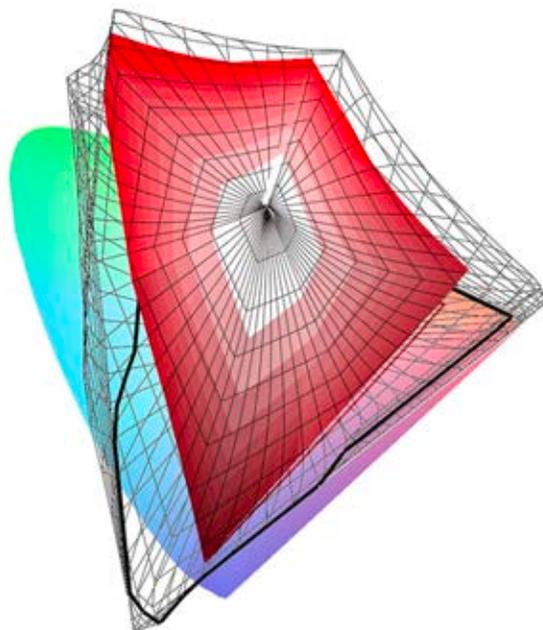
This is a comparison of the ProPhoto RGB working color space (black wireframe) to the image capabilities of a Canon 6D digital camera. The size of ProPhoto is important to capture such a large potential volume of colors captured by that, and similar cameras.

As a result of attending that seminar, and doing considerable reading after, I developed a work flow and apparatus for fine art reproduction photography. I built a special wall mount for paintings; I bought clamps and aluminum bar stock to mount my strobe lights in the correct position for this kind of work. I got a new *ColorChecker SG* target from X-Rite, and bought a pair of lasers to aim my lights.

In February I got a copy of BasicColor *Input,* and began the process of learning how to make and use Camera Raw profiles (I have used *ColorChecker Passport* for years). In late April, I assembled all of this in the studio at my university. I brought my own strobes over (they are arguably better than the lights owned by my department). I set up my lights, measured their positions exactly, and then aimed them using the laser.

I bought a Hasselblad alignment mirror on eBay, and I bought a *Zig-Align* mirror for the Canon macro lens I planned to use for this activity. The two mirrors

are used to square the camera to the artwork: one goes on the artwork wall, one goes on the camera lens during the alignment stage.

Once assembled, I showed my students how the system works. We set up the *ColorChecker* SG and we made exposure calculations to get the images in the camera – a Canon 6D. We then made profiles using the *BasicColor* software, and learned that the errors in color from shooting to profile were too high: my average Delta-E was in double-digits. I photographed the painting and opened it using the profile we made. Printing that image to Epson Somerset paper we could see that the color was too orange. Cream colors in the original were wrong. I worked with the image to make it look better, but it got worse.
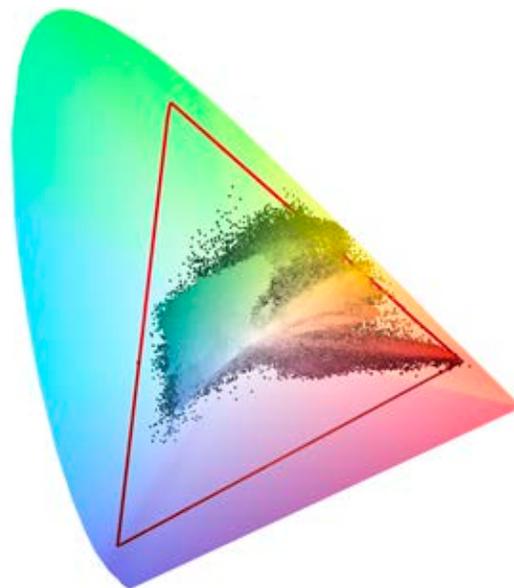

This is a projection in 2D of the colors in a recent fine art reproduction image I made in the studio at my university with the Canon 6D camera. Notice the colors that extend beyond the triangular gamut of Adobe RGB 1998 at the top-right; these are the cream-yellow colors described in this essay. This image was created in ColorThink Pro software, which can plot various color gamuts in 2D and 3D space.

Back in the studio, I recorded a custom white balance in the camera, a step that I had omitted in the first round Then I photographed the *ColorChecker* SG again, and made a new profile. This one turned out much better: average Delta-E of 2.46, peak Delta-E of 5.3.

I photographed the painting again and opened the image in *Camera Raw,* applying the new profile. On printing it, the cream colors were much better, but still visibly wrong.

In Adobe *Camera Raw* I changed the bit depth of the photos from 8-bit data to 16-bit data and tried again. The result was the same: cream colors that were orange. I reconsidered everything that I was doing, attempting to figure out how to make it better. I seized upon the idea of the color space, wondering if *Adobe RGB* is too small for the colors in the painting. I changed the color space to *ProPhoto RGB* and tried again. Bingo! I could tell immediately that the cream colors had been captured and converted to Adobe *Photoshop* correctly.
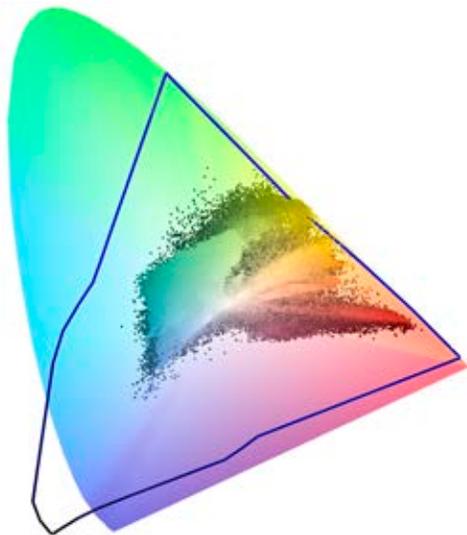

…and this is the same image superimposed on the 2D gamut chart of ProPhoto RGB. You can see that the larger working space accommodates nearly all the colors in the photograph, doing a much better job than its slightly smaller counterpart Adobe RGB 1998.

After analyzing the two gamuts side-by-side, I realized that the most significant difference between the two (in this case) is a small strip of land along the red-green axis, passing through the red-yellow-orange (and cream) areas of the image. *ProPhoto RGB* is slightly larger along this axis (there is not much room to move there), but this was exactly the area where my colors were being clipped/mapped into the smaller *Adobe RGB* color space, and this was pushing the creams into stronger reds. When I used *ProPhoto RGB,* the colors were being recorded and passed correctly to Photoshop, and they were remarkably better.

The resulting image, and the print I made from it, are nearly perfect. It is the most satisfying result that I have ever made.

One more thing to consider when choosing a working color space is whether that space accommodates colors that are impossible to reproduce (a common occurrence). *ProPhoto RGB* "contains" colors outside the human-visible spectrum, and also outside the gamuts of most printer/paper combinations. But in this case, the red-green axis of the Epson ink-jet printer on *Luster* paper closely matches that axis of *ProPhoto RGB* (where I needed the additional colors), while Adobe RGB falls slightly shorter of that margin.
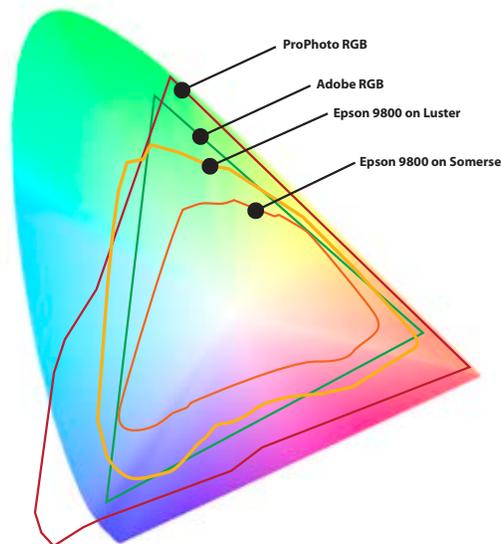
Here are the gamuts of Adobe RGB and ProPhoto RGB color spaces compared to ink-jet gamuts on the Epson 9800 printer. The largest is ProPhoto RGB, followed by Adobe RGB. The yellow line describes semigloss Epson Luster paper; the smallest gamut is Epson Somerset paper, a 100% cotton fine art paper. ProPhoto RGB is large enough to accommodate (almost) all the colors in either gamut. Note that Adobe RGB cannot accommodate all the colors in the Epson-Luster gamut. In fine art reproduction this can be a critical weakness.

Taking advantage of the larger gamut of colors in *ProPhoto RGB* solves a problem. Another painting, perhaps one with a number of saturated green or blue-green colors (areas of weakness on all CMYK printers) might not be served by the *ProColor RGB* working space, but it is not any better with Adobe RGB. I argue that ProColor RGB is the color space to use for maximum color capture and reproduction.

The case for using DNG as your primary file type

I have files created by a Kodak branded, Canon-built digital camera from this century that can no longer be read. This is my second case of photo file obsolescence; the first being Kodak *Photo CD* files that cannot be read by any existing commonly used software (I did find a solution to reading Photo CD discs that involves a UNIX program and using Terminal to control it).

Photos from the old Kodak/Canon camera are not readable with anything I can find.

The threat of file type obsolescence

The idea of photo files becoming obsolete is a scary one, because it points out a great threat to society. Sometime in the future we will no longer be able to access our images with *any* existing software.

A few years ago, while preparing for a show in the local art museum, I scanned a number of five-foot-long strips of Kodak *Cirkut* camera film. Some of these film negatives were more than 100 years old. They still work perfectly; there are clearly visible images on them, and they were transferred to digital files by scanning.

I would like to be confident that photos I take today will still be useful 100 years from now. Current file types including most camera-specific Camera Raw files will probably not be legible beyond a decade or two, and the companies that make the cameras that create proprietary files have no incentive (in fact they have the opposite) to support their files beyond a reasonable period of time – ten years, 20 years?

Innovation drives new camera capabilities

The constant pace of innovation and improvement in camera technology will drive this. Bigger sensors, better color capabilities, greater bit-depth, white point recording, expanded gamuts, and more (perhaps post-processing focus information can be encoded) will force camera manufacturers to move to more capable versions of Camera Raw, and perhaps we'll have new storage technologies that supersede the SD card, and others that we find so handy today. It's inevitable.

At some point Canon, Sony and Nikon will each say, "Enough!" for their current storage schemes and they will move on. Adobe, which now supports hundreds of different Raw formats, will inevitably abandon support for the oldest of them and move on.

And that will be the day that we need to go back to some 30-year-old image and open it anew. But on that day the image will not open. It will be lost to technological obsolescence. That will be a dark day.

That day will come soon.

(*Ironic note:* It's happening right now! As I write this, Canon has announced the Canon *.cr3* file format, which will soon make the common *.cr2* obsolete.)

We need obsolescence-proofing now

Fortunately we have a solution on hand today, one which will prevent obsolescence for some time, and one which we can all adopt immediately to stave-off the possibility of image obsolescence for a while. The idea of any software working in 100 years is unlikely, but not unimaginable.

This file is the DNG – or Digital Negative file. It was created by Adobe in 2004, but has now been made available by that firm to the world community. It has also been offered to the International Standards Organization as an ISO standard, one that can continue to be used in open-source software, and one that may prevent, or at least forestall obsolescence.

Archivists are encouraging everyone to use the DNG file to prevent file type obsolescence.

How do we get to DNG?

The simplest way to put our images into DNG format is to import images using Adobe *Bridge,* and its companion application *Photo Downloader.*

Photo Downloader does not sport the finest user interface (far from it!), but it does several things that no other application can do while *simultaneously* downloading images to a computer. It can:
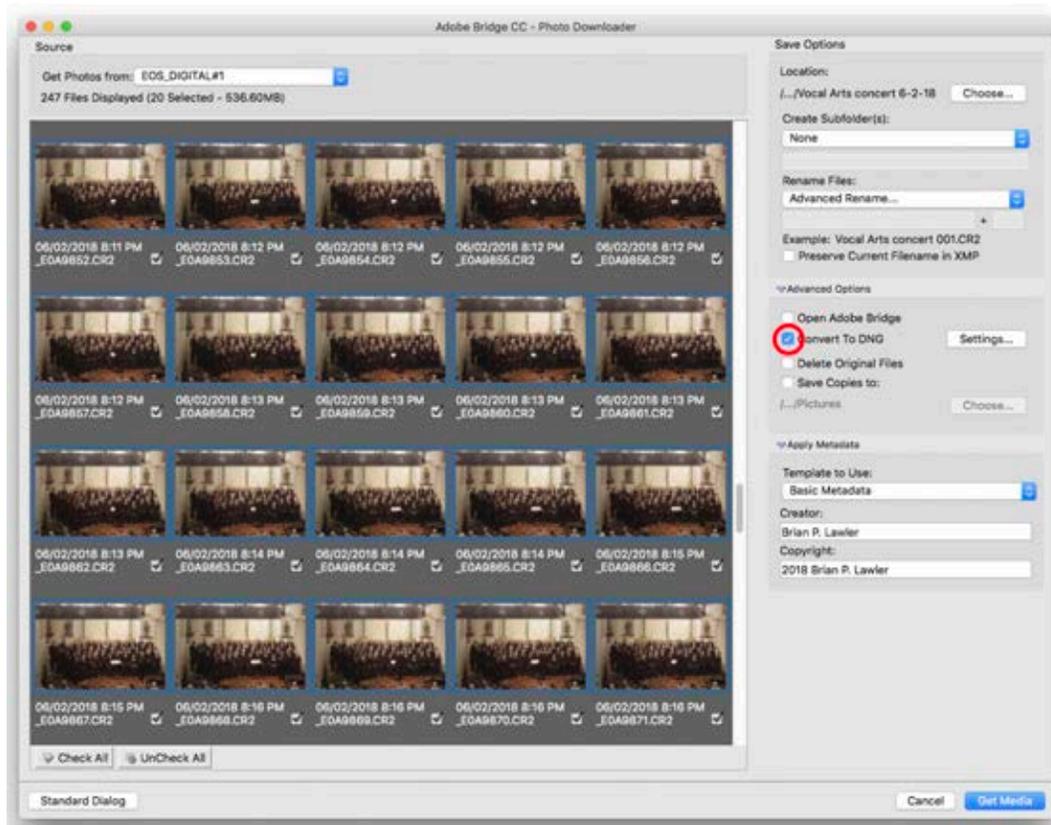
rename
number
sort into date-shot folders
convert to DNG
apply metadata
apply copyright
write copies of the photos to a separate folder
delete the originals after copying them

All but the last of these are features that I use often. I never delete a photo from a camera card until I am confident that the images are safely stored on a local computer. And, even then I don't erase the camera memory card until the next time I use the camera.

This software is *only* available from the *File* menu in Adobe *Bridge,* which is only available to those who have the Adobe *Creative Cloud.*

It is also *only* possible to read photos from a camera memory card, and not from a folder of existing images.

(Bridge can also read images from a camera connected by a USB cable to the computer, but that uses a different application which is not as capable.)

Choose the destination folder in the upper-right corner. Choose whether to subdivide the images into folders, and by which criteria (I seldom do this). Then choose *Advanced Rename,* and choose *Text + Sequence Number* (and other variables that you may want). I always put a space after the text to separate it from the sequence number. Be sure to allow enough digits in the sequence number to accommodate all of your images (and yes, spaces are valid characters in file names).

And, this is the most important part: Check the *Convert to DNG* check box.

You can also add metadata from your own list of prepared metadata, you can add your own copyright claim to all of the images, and you can write copies of the photos to a back-up disk if you wish. Then choose *Get Media.*

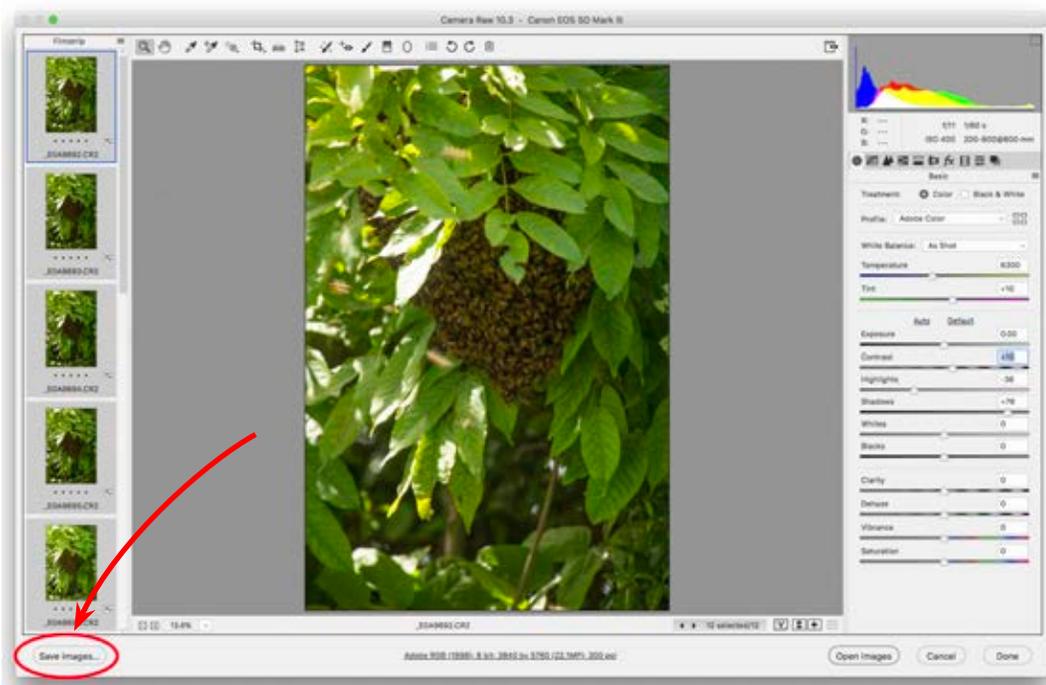### Another scenario: Converting Camera Raw images to DNG

Suppose you have a folder of Camera Raw photos on your hard drive, and you want to convert them to DNG. You would want to do this to create a DNG archive of images from those photos you have already stored on your hard drive.

To convert one or more images from Camera Raw to DNG, chose a batch of images and hit *Command-O* (Open). This will cause the images to open in Adobe Camera Raw. You might get a warning dialog indicating that you have selected a large number of images to open at one time. Click *Continue.*
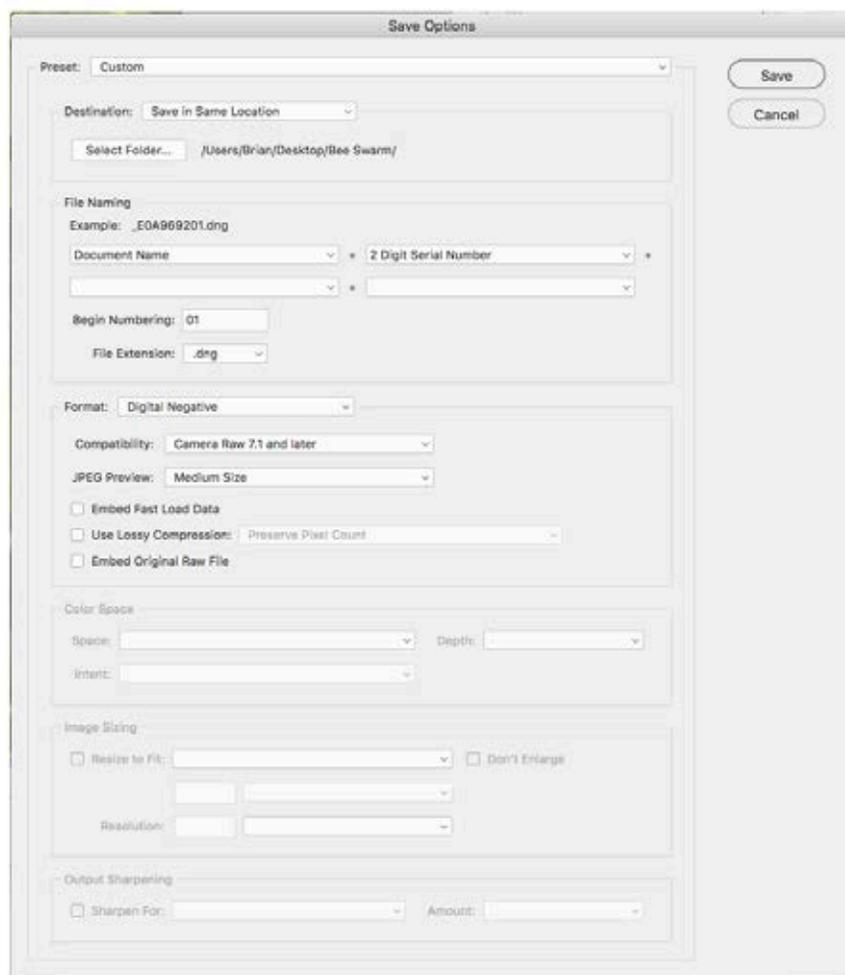
Once they open in Camera Raw, select all (*Command-A*). Then choose the *Save Images* button in the lower-left corner of the window.

A new dialog will open. Choose *Save in Same Location* (or you can save in a new location). Choose *.dng* as the image suffix, which will automatically select

Importing photos from a camera card to DNG

This is easy and effective. You put a memory card into your computer, or to a card reader. Run *Bridge*, choose *File>Get Photos from Camera,* and then choose *Advanced Dialog* from the application that opens (it's called *Photo Downloader*).

Once in that application, choose the images you want to download (start by clicking the *UnCheck All* button). You can click on one image, then shift-click on the end of a range of photos. Non-contiguous selection does not work in this application, alas.

files. You can continue to do other things while this is happening.

Converting with the Adobe DNG Converter

Another technique is to use the free *Adobe DNG Image Converter*. Download this and install it on your computer. It has a logical interface. This application can convert Camera Raw images in any folder into DNG files. It does so quickly and effectively.

Once the conversion is complete, you will have a folder with .dng files in it. Those images are saved in the most obsolescence-proof format currently available.

You can be confident that your photos will work in the future. How long? No one knows, but I assure you it will be longer than if you do nothing with your files.
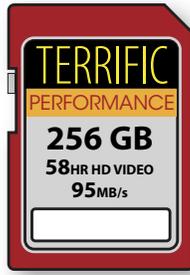
If you take steps to import all new images into your computer in DNG format, and to archive your photos in DNG format, you may be able to avoid the dark day when you will no longer be able to read your photo files.

Note:

DNG will not convert from JPEG images. The file format is limited to Camera Raw files.

I am confident that JPEG images will be legible for many years, due to their ubiquity. But, JPEG is not a good format for archival images because of the damage done to images as they are converted to JPEG.

— Brian P. Lawler, December, 2018

the conversion to DNG (though you can overrule this – don't!).

Click the *Save* button in the upper-right corner.

It will take about one second per image to convert the

Adobe Bridge

Get Photos from Camera…

Rename and add sequence number (Advanced Rename)

(optional) sort into subfolders
according to date

(optional) Add copyright claim

(optional) Append metadata template

(optional) Save copies of the images

Convert to DNG