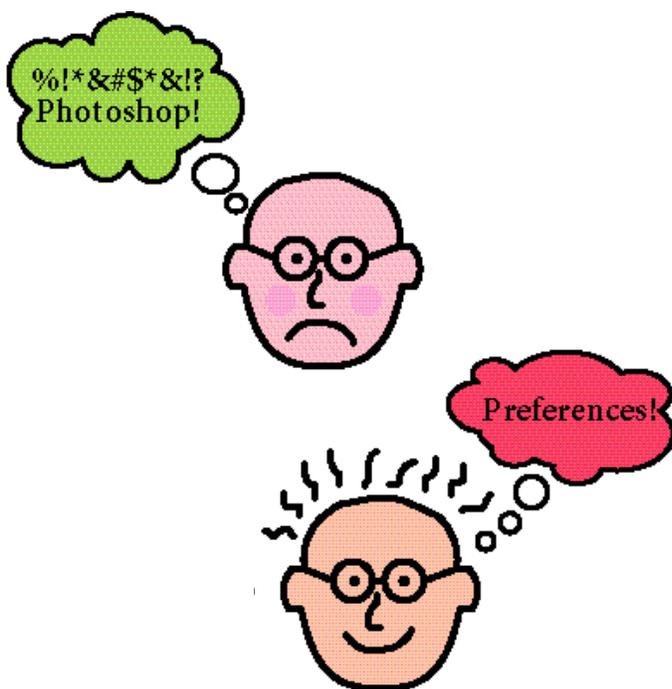


Setting up your desktop computer system and Adobe Photoshop for color separations

by Brian P. Lawler

Making what you see match what you get
Most desktop computer users have reached the plateau of success where most of their work is coming out pretty nicely. The dilemma is that the quality is falling a little bit short of expectations, and that is due at least in part to a lack of system calibration and monitor balance.

Whenever I hear a person criticize Photoshop's color separation quality I want to ask (often I do ask!)



“How do you have your Preferences set-up?”

Sometimes the answer I get is an authoritative, long-winded explanation of how the person did a trial run, and then adjusted their system according to the chromaticity values plotted on a GATF color gamut scale with their spectrophotometer (I let these people fend for themselves).

From most others, though, I usually get a simple answer: “What preferences?”

Most Photoshop users buy the product and install it on their computer system. They scan an image, or acquire one from a Kodak Photo CD, and the color looks OK on-screen, and they convert it to CMYK and then save it in TIFF format. And, later it becomes a part of a publication which when printed is – in a word – disappointing.

Sometimes our printed jobs are disappointing,

and when they are, the cause may be the system itself, or a number of other factors in production including human error (Heaven forbid!). The problems introduced by system set-up can be solved to a tremendous degree, but there are some technological hurdles that cannot be jumped.

One of these is the computer monitor. While the quality and size of the available monitors are impressive, the colors produced by monitors are in the visible (additive) color system, and not in the pigment (subtractive) color system. As a result, the color on a monitor can be made to approximate – but never match exactly – the color on a printed page.

Beyond the fact that computer monitors cannot be balanced precisely to the printed page, monitors are emissive devices – they create light by stimulating mineral phosphors inside the picture tube by flashing a beam of electrons against the inside of the monitor.

The red-green-blue emissive quality of the monitor, combined with the effect of electrons on organic phosphors makes monitors impressive, but highly variable devices. The colors they emit in the morning are different than the colors they emit in afternoon. Monitors also change color over their lifetimes as the phosphors decay.

Color temperature

The white point of a monitor is measured in its color temperature. This measurement is made in degrees Kelvin, where 0° Kelvin is absolute zero (–273° C), where all atomic activity ceases, and the color temperature of the light from the sun is 6,500° Kelvin.

Some people assert that this isn't degrees Kelvin, but just Kelvin (who cares?). The color temperature of common light sources is important in any event:

Incandescent light bulb (100W)	2,800° Kelvin
Incandescent light (Quartz-iodine)	3,200° Kelvin
Printing Industry standard (USA)	5,000° Kelvin
Printing Industry standard (EU)	5,500° Kelvin
Strobe flash (varies)	5,700° Kelvin
Fluorescent (cool white)	6,000° Kelvin
TV monitor (NTSC standard)	6,500° Kelvin
Daylight	6,500° Kelvin

Since most computer monitors are based on television monitors, their color temperature is usually 6,500° Kelvin. This is more blue than the white light used to evaluate printing.

Apple is now making two computer monitors

specifically designed for graphic arts with a color temperature adjustable to 5,000° Kelvin.

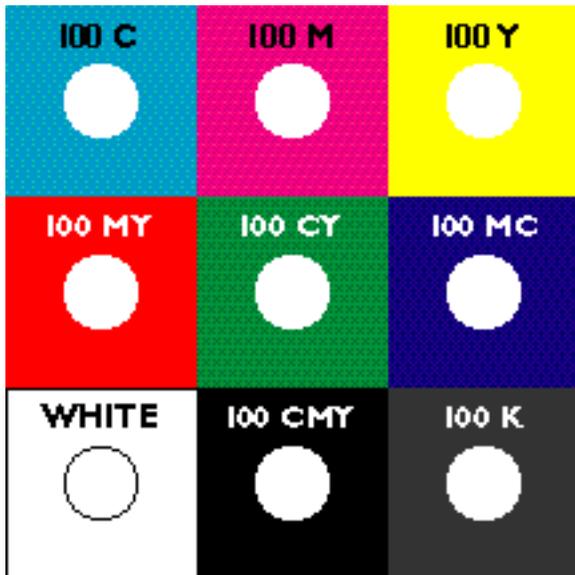
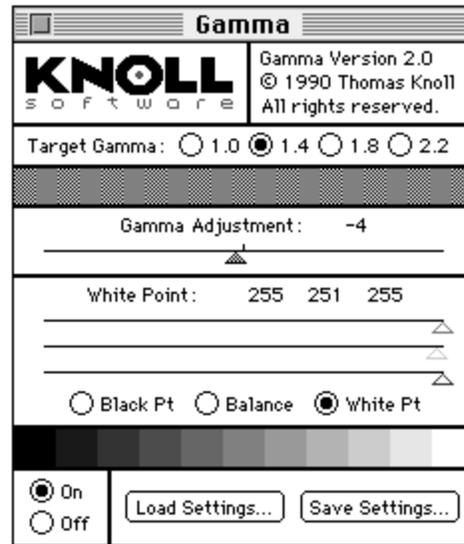
Though this is an important step, the variation in color temperature between 5,000 and 6,500° Kelvin is fairly easily “forgotten” by human viewers. Human eyes are surprisingly good at subtracting the base color temperature from the image we see on a monitor.

Balancing your monitor without instruments

It is also surprisingly easy to “balance” your computer monitor to a color standard that you can create yourself.

Balancing the monitor requires the use of a device called the PPCC*, a device which you make yourself on proofing or printing processes that are standard for your situation.

To build a PPCC, build a file in Adobe Photoshop



(must be in CMYK mode) that looks like this: Each square is made-up of solids, so there is no possibility of translation error in color separation. The balancing tool can be made from a prepress proof or an actual press proof, though it is more valuable to make an actual press proof, as we will see later.

After making the PPCC proof, cut or drill a hole in the center of each color square. Once complete, it is used to balance the color of the monitor using Knoll Software's Gamma software (provided as a part of Adobe Photoshop).

This color balance adjustment is a multi-step process. First we must address the analog elements of the balance adjustment. On every monitor there are controls for brightness and contrast. Regardless of the labels and technology used (buttons or knobs), these are analog controls. Begin by putting the contrast control at its neutral point, then set the brightness all the way up.

Reduce the brightness control setting until there is a good black outside the image area of the monitor

*Poor Person's Color Calibrator

(the area outside the image area is called the mask and it will be grayed when brightness is set too high).

After getting a bright image with a good black mask (subjective isn't it?) adjust the contrast control until the monitor looks best (even more subjective isn't it?). A good looking monitor is bright and “crispy” in contrast. It may not be the right color – we'll come to that in the following instructions.

Some people recommend taping-down the monitor knobs after completing the previous steps – this is good advice.

Then set the gamma button to 1.8 in the Gamma software (on some monitors a setting of 1.4 will work better – you'll have to try to find out). Then slide the gamma slider back and forth until the vertical gray bars in the control panel appear to blend together (squinting helps).

Once the gray bars have been neutralized, the monitor's actual contrast will have been set (factory gamma values are approximate and usually inaccurate); this setting is a response to both the manufacturing qualities of this monitor and to current (analog) brightness and contrast settings.

Three steps remain in the process: first, set white point by clicking on the White Point button, then adjusting the RGB sliders until you have a good white compared to the white of the PPCC proof. Begin with all the sliders pinned at the right end of the scale (values of 255). Then, holding your PPCC up against the monitor, slide one of the sliders to the left and ask yourself if the hue is better or worse than it was when you started. Continue this process until you match the hue to the best degree possible.

Black Pt. is similar. You push all three sliders to zero settings, and then slide each one away from the left until the hue of black (100K, not CMY) matches that of the PPCC best.

After completing the White Pt. and Black Pt. adjustments, tackle the Balance. Here it is a matter of reaching the best compromise between the hue of the

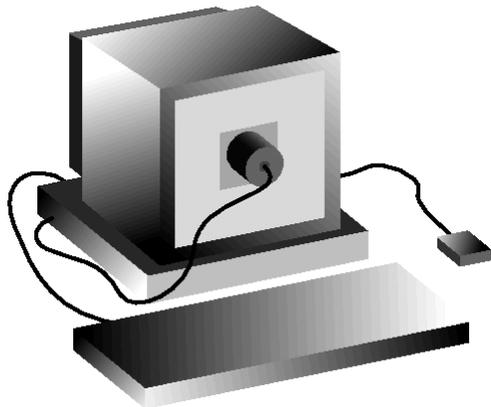
monitor (remember – the monitor’s brightness will always exceed the brightness of a paper proof) best matches the hue of the PPCC. The hardest colors to get are green and red. Compromise!

Once you have completed this, take one final look at the Gamma software control panel with particular emphasis on the grayscale below the control sliders. Look for any hint of color cast, and if one is present, return to the Balance controls to tune it out.

Then save your settings with the button at the bottom, giving the file a name that makes sense like **Gamma 8-13-95**.

Calibrating your monitor with instruments
Calibrating monitors with the PPCC is fine, but it has its pitfalls. First, one can almost certainly not do two monitors equally, and similarly, one cannot do the same balance twice on the same monitor.

The solution to the problem of calibrating multiple monitors (or the same monitor multiple times) is to purchase an instrument for managing your monitor.



Some monitors ship with a calibrator device (illustrated above) which connects to the computer, others must be purchased and connected to the computer for the task.

In either case, monitor calibrators are usually quite effective. They range in price from about \$500 to several thousand dollars – but price is not necessarily an indicator of quality for the low-cost units are pretty good, and any above one thousand dollars is usually a good bet.

On the outside, the calibrator looks like a space-age communications device with a suction cup to hold it on to the forehead of the user.

Inside the device are (usually) three photosensitive CCD chips with red, green and blue filters affixed to their surfaces.

The software that accompanies these calibration devices will typically ask that the calibrator be attached to the face of the monitor and once that is complete, the software will run a series of “ramp” tests to measure the output performance of the monitor. Usually this will be three passes of 256-step color brightness tests, followed by a neutral gray step test.

Once the software has read all the possible output values of the monitor (256 per color for 16,777,216 possible color permutations in 24-bit environments) it will build a corrective curve for the system software that will modify the performance of the monitor until it is changed.

With one of these calibrators – I use the Colortron instrument, pictured on Page X of this article) it is possible to calibrate a monitor extraordinarily well. It is also possible to use the same device on a number of monitors and get to a point where several monitors (almost!) match each other perfectly.

If budget permits, I recommend getting a calibrator. It builds confidence, and makes the process of calibration more scientific and reliable.

How often to check calibration?

Strong opinions exist on this; I find that if I calibrate every time I remember – about once each month – that my monitor is “in” for the short term.

Room lighting and monitor balance

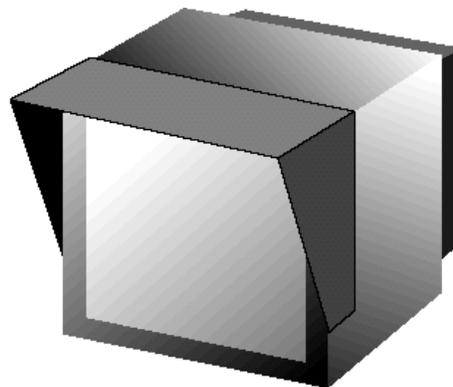
At this point we must address room lighting, for it has incredible importance in the balance equation, and cannot be ignored.

Occasionally we see prepress experts working in rooms where there is no ambient light while their computer monitors glare out into the room displaying colors known by no printing press.

We also see from time to time a designer working under a bright skylight, with diffuse light reflecting off the monitor, and affecting the quality of the image on that monitor.

In both cases, we are not seeing **reasonable** situations. Monitors should be placed in rooms with “normal” lighting. Since we don’t design our work, or view our printed products in caves or tanning salons, we should probably not view our work-in-progress in these odd environments either (exceptions will be made for cave-dwellers and tanning salon employees).

A good suggestion is to construct a glare hood for monitors in bright lighting circumstances, or situate



A glare hood can be constructed easily from stiff flat-black illustration board. Fasten it to the monitor with Velcro hook-and-loop tape or double-sided foam adhesive.

the equipment where lighting is more “normal.”

Room lighting – lighting types

Most technical guides for lighting in the graphic arts suggest that rooms be illuminated with 5000° Kelvin fluorescent tubes throughout. I would argue that this is fine, but that these lamps tend to be significantly more expensive than other tubes, and this may be too costly for smaller design shops.

It is more important to use a **consistent** type of fluorescent tube in the office, and provide a special area for 5,000° Kelvin viewing. There are some great light boxes which can be placed next to a computer workstation which feature 5,000° Kelvin lamps.

Adobe Photoshop’s reference manual stresses that a **mixture** of light sources is a good approach to room lighting – fluorescent tubes **supplemented** by incandescent sources. Since fluorescent illumination is not spectrally complete, the incandescent sources can fill-in the gaps where fluorescent tubes produce no color whatsoever.

I find diffuse lighting superior to directed lamps; it is always nicer to work in a room where the light is bounced off the ceiling or emitted from diffused fixtures than to suffer with the glare of directed lighting.

Your room lighting should be binary

On – or off. No dimmers! Introducing a variable lighting controller in a design studio is unwise, because the lighting cannot be made to be consistent, and consistency is more important than any other factor!

Photoshop preferences – the first frontier

As already mentioned, the problems encountered by Photoshop users in color separation often stem from imprecise set-up of the Preferences.

This all-important step in Photoshop will determine the quality and color of color separations made by the program. Careful set-up, followed by trial-and-error evaluation (or evaluation using electronic instruments) will give your version of Photoshop excellent control over the process.

Preferences are found under the File menu, and consist of individual settings for Monitors, inks, and color separations. As an alternative, the last preferences window may be used to load purchased or created color separation tables which overrule all but the monitors settings.

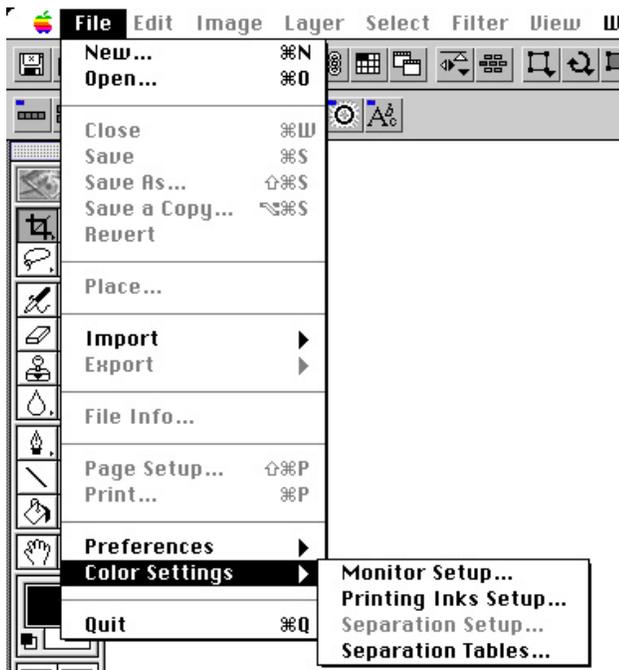
We’ll work on each preference menu in order, to establish our base color separation methods.

Monitor set-up is the first stop on this tour, and is

quite an important step in establishing baseline color balance.

In the monitor set-up window that arrives on-screen first, you are asked to choose your brand and type of monitor. The pull-down list includes a wide variety of monitors, but certainly not all. Usually knowing the **actual manufacturer** of your monitor will assist in this effort, (knowing that you have a Flotsam 19 may not be helpful otherwise).

Most monitors are built by Sony, NEC, Hitachi, Philips, and others – there are probably ten manufacturers in the world whose monitors become other brands with new stickers applied to the front panel. The easy way to determine the manufacturer is to look on the back panel where the UL listing is (we hope!) stamped with the serial number and electrical



standards. Most often the manufacturer will put its own name here. If you don’t find it here, you might call the company that markets the monitor and ask (and ask them for phosphor colors while you are on the phone!).

Radius monitors, for example, are made by Sony and Hitachi (perhaps others). When setting-up for the Radius monitors, I usually check to see if the monitor is a Sony, then choose the Sony 19-inch (or whatever size) from the Photoshop Preferences list.*

The default is the Apple 13-inch RGB Standard, which is probably the most common monitor found in the graphic arts industry. This monitor is a Sony Trinitron 13-inch monitor with a 6,500° Kelvin color

* Interesting political comment: In 1992, Radius started calling its 19-inch monitors “20-inch” monitors. SuperMac – then Radius’ biggest competitor – couldn’t be caught with a “smaller” monitor, so changed its monitors to “20-inch” also.

The entire industry followed, perpetuating the Big Monitor Lie. These monitors are actually smaller than advertised. The glass in the “20-inch” monitor is 19.5 inches diagonally, but the **image** inside the glass is 17.5 inches. The 20-inch monitors are the **very same** devices as the 19-inch, only the labels changed. Pressured by similar market influences, Apple’s 13-inch monitors got bigger – overnight – by one inch to become “14-inch” monitors to compete with all the “14-inch” monitors sold by the PC industry. A year later they miraculously became “15-inch” monitors.

Don’t believe everything you read; 14-inch monitors are 12.5 inches measured diagonally, and have **exactly** the same display as “smaller” monitors.



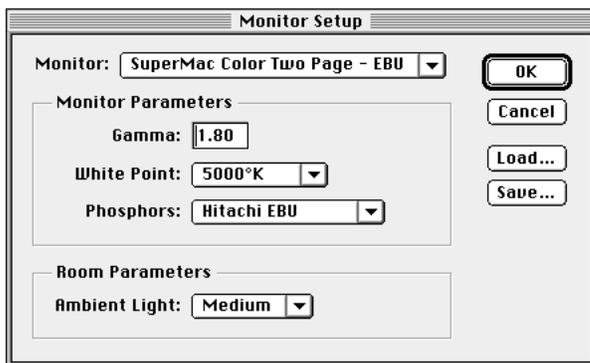
By choosing Monitor: from this set-up window, Photoshop displays a list of popular computer monitors from which to choose. Pick the one that is closest to your monitor.

temperature. The standard may be used for many similar monitors on both Mac and PC computers.

Gamma

The gamma setting here establishes the manufacturer's established value. You can enter any value, but you cannot change the actual gamma by entering a different value here.

Enter 1.8 if you are in doubt (The Gamma control panel (see page 2) can "trim" this gamma setting after



the fact, actually modifying the contrast of the display you see.

White Point

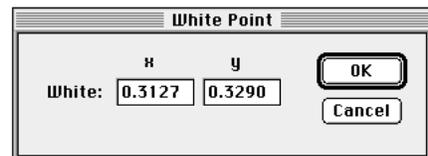
The white point of a monitor is set in manufacture, and generally cannot be changed. Enter the value the manufacturer determined (6,500 if you are in doubt). Again, you cannot change the white point here; you are

simply acknowledging the white point.

Monitors from Sony and others are now available with 5,000° Kelvin color temperature for prepress purposes. This is indicative of a trend by the manufacturers to provide monitors for specialized industries other than television.

Phosphors

Phosphors vary dramatically between manufacturers, and modestly within a run of monitors made by an individual manufacturer. If the phosphors of your brand of monitor are not in the list, you may (probably not) be able to obtain the correct values to enter in the "other" window under Phosphors. This is usually entered automatically when you choose a monitor type.



Your manufacturer may be able to provide an x,y chromaticity value for your particular monitor's white point which can be entered in this window.

Room Parameters

After setting the monitor, gamma and white point, Photoshop wants to know about your room lighting. Its options are "cave" to "tanning salon." Choose appropriately.

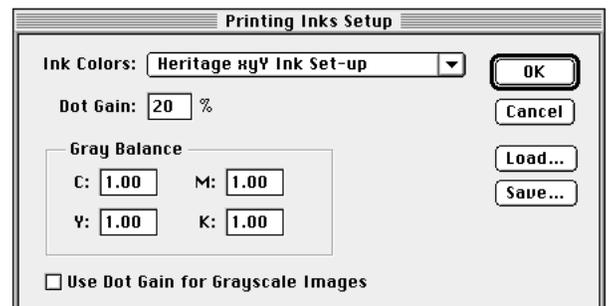


Printing Inks Setup

Once you have jumped all the monitor hurdles, you must jump into the ink quagmire (this can be messy if you don't clean your shoes afterward).

The Inks set-up is critical to success in color separation because it tells Photoshop how to build its all-important color look-up tables where the color separation is actually done.

The default of Photoshop is SWOP (Coated). You cannot fault Adobe for establishing that as the default, as SWOP (Coated) is a good standard, and it usually results in pleasant color separations from Photoshop for both sheet-fed and web-fed printing on gloss papers. SWOP is a printing industry standard for proofing; it stands for Specifications, Web Offset





The method is to print the PPCC (see page 2) and then measure its color from the actual printed proof. ColorTron's software allows the conversion of measurements from RGB, CIELAB, CMYK, spectrophotometry, and others from one value to another, and getting the x,y,Y values is easy.

The result of these measurements can be entered in the custom Ink Colors window in the Ink Setup preferences. Results are entered in CIE x,y,Y chromaticity values (x and y are Cartesian coordinates and Y is a value for the third dimension – upward to describe lightness).

There are formulas for converting CIELAB colors

The Colortron calibrator is an accessory for the Macintosh computer which will read reflective densities, transmission densities, dot areas, and will also behave as a colorimeter and spectrophotometer. It also has an accessory that attaches the calibrator to the computer monitor to allow monitor calibrations. Devices from other manufacturers work equally well.

Printing. Even though it has the words Web Offset in its title, it is a **proofing** standard for commercial printing.

Using SWOP standards, printers can create color separations and proofs that will print correctly on web offset presses.

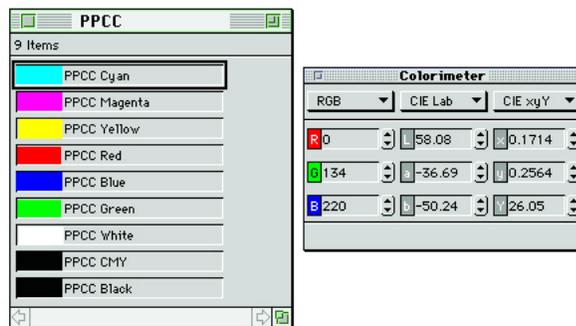
Dot gain, an important factor in any separation process, defaults to 20 percent with SWOP (Coated). This is dot gain measured by what happens to the 50-percent dot, and represents the average in the sheet-fed industry. This may surprise you, but it is a reasonable value.

If you generally print on uncoated papers, or if you print on newsprint, it is critical that you change the set-up to reflect your printing substrate. Change from the Ink Colors pull-down menu to a more appropriate process.

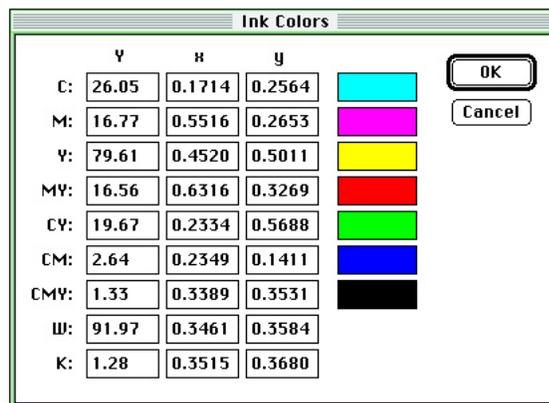
Custom ink colors

It is also possible to build a custom Ink Colors menu from an actual press proof made in your production circumstances. If you have access to a measurement instrument that can read Chromaticity (in x,y,Y values) you can do this yourself. Otherwise, your printer may be able to provide support in gathering this data.

I own a ColorTron instrument (illustrated above) from Lightsource in Larkspur, California. This clever instrument is both a densitometer and colorimeter, and it will deliver the chromaticity values I need for custom ink set-up.



Above, the Colortron instrument's color palette and Colorimeter windows. Below, values from this instrument are entered in the Custom Ink Colors menu in Adobe Photoshop. The values are derived from the PPCC (page 2) and converted into CIE xyY values for this window.



(or others) into x,y,Y, available in Wysecki and Styles' Book *Color Science: Concepts and Methods, Quantitative Data and Formulas, Second Edition* [John Wiley & Sons, NYC, 1982].

Entering the values in the custom ink colors window tells Photoshop exactly how your printing process behaves based on the color progressive charts printed by the PPCC.

If you create a custom Ink Colors set-up for one press, and wish to create another for another press-and-paper combination, this ink colors set-up can be stored by Photoshop (back in the Printing Inks Setup window).

Using defaults

For those without a colorimeter, the defaults provided by Photoshop for SWOP, Toyo, and Eurostandard are adequate as good starting points. Adjustments to their performance can be made by color balance, curves, or other techniques in Photoshop.



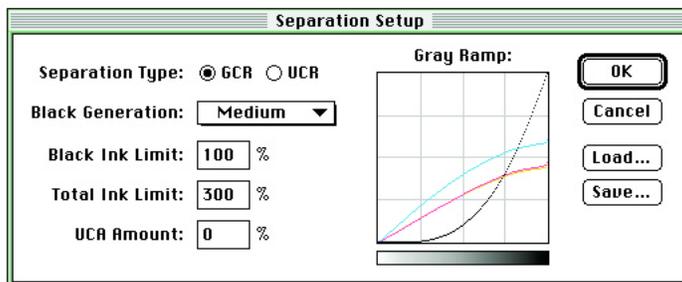
Separation Setup

After establishing monitor and ink set-ups, you'll need to tell Photoshop how to make its color separations.

Whoa! (You might be thinking that you don't do your separations in Photoshop, favoring QuarkXPress or some other page layout program.) The truth is that if you convert from RGB (or any other color space) to CMYK in Photoshop, **the color separation is being made by Photoshop**, so you must be sure that it is right.

Page Make-up programs usually *parse** already-separated files into color separations, but the color separation is already done.

So, we have to tell Photoshop how to make the



color separations! For this we need to know about esoteric things like gray component replacement (GCR) and undercolor removal (UCR) and ink limits, and total ink coverage (TIC) – and the phase of the moon when making separations?

The separation setup window in Photoshop allows us to control these esoteric variables. Interestingly, it defaults to GCR, the process of making color separations by gray component replacement.

Gray Component Replacement

Developed in the 1980s, gray component replacement is a technique with great rewards for a small audience. To most printers it is of little importance. Adobe elevated its status to mythical levels by making it the default in Photoshop.

While it was obscure, using GCR today is a useful option because you certainly won't offend anyone, or cause trouble in any printing process by using it.

To set the controls for GCR there are four elements to address. First is the Black Generation which can be set from none to full. Most successful users set this to "Medium" which will produce what the industry might call a 50-percent GCR separation.

To use more than this would require better understanding of the process, and a rationale for making such a separation.

What is GCR?

GCR (gray component replacement) is a logical algorithm which analyzes colors in a file, and adjusts the cyan, magenta and yellow components in those colors so as to reduce areas where these three color work together to create grays. The reduction is translated into a luminance value which is added to the black ink in the same area. The result of using GCR is that neutral grays in a color image are easier to keep in balance on a fast-moving web press.

Some tout the savings in color ink when using GCR, but this is nonsense – only huge press runs would enjoy such savings. The advantage of GCR is gray balance, and it helps web printers and screen printers. Sheet-fed printers are getting used to the idea, but generally don't care whether a separation uses GCR or not.

Black Ink Limit

If you want to control shadow-area dot gain with this control, enter the point where the shadow dots plug on the printed proof for your average job.† Values of 84 to 96 are typical.

Since the 20 percent value entered in the Inks Setup window affects midtone gain (and on its way all the tones above and below), the gain control for shadows will actually prevent shadow dots from being drawn with values greater than the amount you enter here. You'll have to address highlight losses elsewhere (perhaps Curves?).

Total Ink Limit

This setting is meaningful and important. Total Ink Limit determines the amount of ink that can be laid onto a sheet without smearing. Ask your printer for a value to enter here. Typical values run from about 215 to 330 percent.

*Parsing is the process of "scanning" through the text of a file, and applying only a selective part of that text to a process – in this case color separation. There are four components to a color separated file – CMY and K. When parsed, only one color at a time is forwarded to the imagesetter.
† You might want to consider an alternate – and more thorough – method for controlling dot gain overall; read my essay entitled **Know thy enemy: measuring and controlling dot gain.**

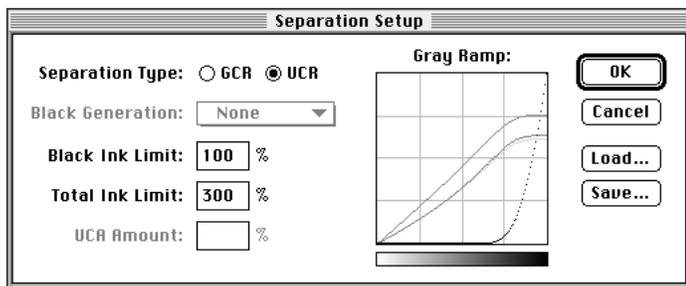
UCA Amount

Undercolor Addition is defined by Adobe (**Photoshop User Guide**, Pg. 221) as a tool that "lets you reduce the amount of undercolor removal in the very dark areas in order to create more saturated blacks."

I have not experimented with UCA, so I do not have an opinion about its effectiveness.

Using UCR instead of GCR

For those who are not absorbed in the concept of Gray Component Replacement, the alternative is Undercolor Removal, a process which in Photoshop is the "opposite" of GCR.



Undercolor removal is similar to GCR, but it more simply reduces the amount of cyan, magenta and yellow which pile-up in heavy multi-color areas of a color separation. UCR is a more "conventional" separation, one that will produce good images and cause little trouble on-press.

When using Undercolor Removal, Black Ink Limit is still adjustable in this window, as is Total Ink Limit. Each must be addressed.

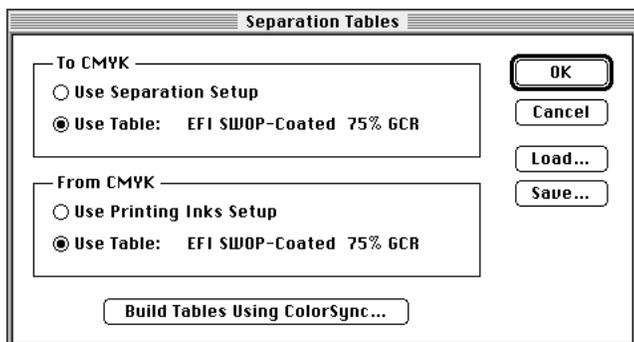
Monitor Setup...
Printing Inks Setup...
Separation Setup...
Separation Tables...

Separation Tables and color management

An option for some users of Photoshop is to create color separation tables which overrule the settings in the other preferences menus.

In Photoshop 4.0, you can build custom Separation Tables from Apple ColorSync 2.0 printer profiles. Though the button was present in earlier versions, it didn't work.

To build a Table, you click the button in the Separation Tables window, and then choose a CMYK profile for a printing press. Photoshop will then build a separation table that mimics the color characteristics



of the printing press.

When Separation Tables are loaded, Separation Setup and Printing Inks Setup are both disabled. Any attempt to change them will result in a dialog box warning that to do so will overrule the Tables that are loaded.

To use the color separation table, just change the mode from RGB (or LAB) to CMYK. Photoshop will then consult the custom table you have built to make its color separation decisions.

I have tried this, and though it seems to work, I am not completely satisfied with the results. I ran the same image through Apple's ColorSync plug-ins for Photoshop, and made a separation in Photoshop by Mode change, and compared the two. The colors were extremely pleasing, but the saturation was slightly different.

By design, an image processed through a profile, and processed by a color table should be the same.

Of the two, the export through the Apple plug-in was the superior image.

The Apple ColorSync plug-ins are available free from Apple Computer and from Adobe Systems. To get a set, just go to apple.com, or to adobe.com on the World Wide Web, and follow the links to the ColorSync plug-ins.

Conclusion

If you take the time and are careful to set up your system and your software correctly, and if you take the time to produce proofs to check your process, your success will be greater.

No process is perfect, but striving for perfection is a great goal, and these settings will bring you closer. This is the eighth in a series of essays I have produced on the graphic arts use of computers and graphics software. Your comments are welcome.

■ This is one of a series of essays on computers in the graphic arts. Others include scanning, dot gain, black and white from color, Photo CD, calibration of desktop systems, and several essays dealing with World Wide Web graphics. Please write, or send an e-mail message to get copies of the others.

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