### Introduction

Color management provides the tools to reconcile the different color capabilities of monitors, scanners, printers and printing presses to ensure consistent color throughout the production process. ICC profiles provide the means to do this. [See What are profiles?] Color management also allows digital proofing, especially important now that more and more presses are run CTP (Computer To Plate) without actually generating film. This change precludes the old way of producing press proofs.

Another application of ICC profiles is to make one device emulate another, so that you can proof your output on a faster, less expensive, more convenient printer rather than having to resort to such proofing devices as Imation MatchPrint<sup>TM</sup> or worse yet, the actual press. PhaserMatch<sup>TM</sup> ICC 7700 provides you the tools to emulate any press or other printer on your Phaser<sup>®</sup> 7700.

For additional information on color management and color workflows, see the section on Color Management below or visit these sites:

- International Color Consortium: They developed and continue to develop the ICC profile specifications. They have introductory articles on and specifications of ICC profiles at www.color.org/
- Adobe Systems: Adobe complements their color software products with some excellent technical guides on color basics, color management, etc. You can find them at www.adobe.com/support/techguides/color/main.html
- Monaco Systems: They provided the core application for PhaserMatch<sup>™</sup> and offer other tools utilizing ICC profiles. You can find them at www.monacosys.com/

# What is color management?

Color management is based on color spaces. The range of colors, or gamut, perceived by the human eye, captured on film, displayed on a computer monitor, or rendered by a printer vary significantly. Each has its own color space, a mathematical means of describing its colors. RGB is an additive color space that combines red, green and blue light to create all other colors. RGB color spaces are used by monitors, digital camera and scanners. CMYK color, on the other hand, is a subtractive color space using cyan, magenta, yellow and black inks on paper to absorb red, green and blue light. The remaining reflected light is the color perceived by the viewer.



Both RGB and CMYK color are device dependent color spaces; the colors they render depends on the device that produces the colors. The colors produced by a scanner vary from a monitor since a scanner uses a CCD (charge coupled device) array to capture colors, while a monitor produces colors from light-emitting phosphors. Additionally, converting an image from RGB to CMYK generally compresses the colors into a smaller gamut. To complicate matters more, the CMYK color space of one printer can vary significantly from the CMYK color space of another printer. As the graphic below shows, the colors reproducible by different mediums varies significantly.



In the last few years, the publishing industry has settled on a system of color management developed by the International Color Consortium (ICC). ICC-based color management relies on two things: device profiles, which characterize how individual devices produce color, and a color engine (also called a color matching module or CMM), which reads those profiles and translates and corrects colors between devices. ICC-based color management relies on a color space, called CIELab (or LAB), to arbitrate between the color spaces of different devices. LAB color space is based on the way the human eye perceives color and is device-independent. A LAB color engine translates RGB, CMYK and other color spaces to and from LAB, which acts as an interpreter between those color spaces. ColorSync, the Macintosh's operating system's color-management software, currently supports CMM color engines from Heidelberg, Agfa and Kodak, each of which uses a different algorithm to perform its color conversions. Image Color Management (ICM), Microsoft<sup>®</sup> Window's color management software, currently supports the CMM LinoColor color engine from LinoType-Hell AG.

When you create an image using an application that uses ColorSync or ICM, an input profile is either embedded in the image file or stored in the system's color folder. This profile contains information about the color capabilities of the equipment you are using to create your image, such as a scanner or digital camera.



A monitor profile identifies the colors that your monitor can reproduce. ColorSync or ICM compares the monitor's capabilities with the information provided in the input profile and picks the appropriate matching colors to display. When you print an image, ColorSync or ICM compares the capabilities of the monitor with the capabilities described in the printer's profile and picks printed colors that most closely match what you see on your monitor.

#### What are profiles?

An ICC profile is a computer file that describes the color capabilities and the color space of a monitor, a scanner, a printer, a printing press or a color proofing device. PhaserMatch<sup>TM</sup> ICC generates the following types of profiles:

**Link Profiles.** These are profiles that describe the color behavior of two CMYK devices (your Xerox printer and a target device such as a printing press or a proofing device) combined together into a single file. Creating link profiles or editing existing link profiles lets you alter the colors printed by your Xerox printer so they more closely match the colors produced by the output device of your choice.

A link profile is added to the choices in the Color Correction field of the Macintosh printer driver. Using the Xerox-supplied Phaser printer driver on the PC, a link profile is added to the Press Match list under the TekColor<sup>TM</sup> tab in the printer driver dialog box.

**PhaserMatch<sup>™</sup> ICC printer profiles.** These are standard ICC printer profiles. A printer profile is a file describing to the computer operating system's color management software how the printer describes the colors it prints. These files are used by PhaserMatch<sup>™</sup> to create link profiles.

**Target Device Profiles** These are standard ICC printer profiles that describe the color capabilities of devices such as printing presses or proofing device. These files are used by PhaserMatch<sup>TM</sup> to create link profiles.

Many printers include ICC profiles you can select using the Macintosh ColorSync Control Panel, Microsoft<sup>®</sup> Windows PC Printers Control Panel, as well as other applications. PhaserMatch<sup>TM</sup> ICC lets you create new profiles for printers that do not have printer profiles as well as create custom printer profiles for a printer using a particular brand or grade of paper.



**TekColor<sup>™</sup> profiles.** TekColor<sup>™</sup> profiles are color correction tables built into a Xerox printer. A TekColor<sup>™</sup> profile gives you color-altering choices in the Color Correction field of the Macintosh printer driver or the TekColor<sup>™</sup> tab of the Window's Adobe<sup>®</sup> 4.3 printer driver with DLL. By default, the Color Correction pull-down field gives you options such as SWOP Press, Euroscale Press, Commercial Press, and Fuji Press, as well as others.

#### What is PhaserMatch™ ICC?

PhaserMatch<sup>™</sup> ICC is a color-management application for PC and Macintosh computers. Its primary function is to create link profiles. When you print, a link profile lets you adjust the colors produced by your Xerox Phaser Color printer to more closely match the colors produced by other printing devices, such as a high-end printing press or a proofing device. This gives you a means of inexpensive, color pre-press proofing.

Another major function of PhaserMatch<sup>TM</sup> ICC allows you to edit a link profile, which lets you fine-tune the link profile's color corrections.

As intermediate steps to creating a link profile, PhaserMatch<sup>TM</sup> ICC creates ICC printer profiles and target device profiles. A PhaserMatch<sup>TM</sup> ICC printer profile contains color information about the colors your Xerox Phaser Color Printer will print on a specific media type you load in it. A target device profile accurately describes, in a standard ICC-compatible format, the color capabilities of a printing device, such as a printing press or another printer. Later in the process, you combine the PhaserMatch<sup>TM</sup> ICC printer profile with the target device profile to create a link profile. Printing with the link profile, the images you print on the Phaser 7700 printer will match the colors printed on the target device (printing press or other printer).

PhaserMatch<sup>™</sup> ICC gives you the editing tools to fine-tune the colors of a link profile.

PhaserMatch<sup>™</sup> ICC is scanner-based and provides color matching capabilities suitable for creative professionals who require fairly precise color and for users who want reliable, predictable color. Pre-press and printing professionals will probably require more sophisticated software tools and color measuring instruments.



### What are the Steps in Using PhaserMatch™?

The three major steps in creating a PhaserMatch<sup>™</sup> link profile are:

- 1. Create an ICC printer profile for the Phaser 7700.
- 2. Create an ICC printer profile for the target device.
- 3. Combine two printer profiles into a device link profile.
- 4. Edit a device link profile, if needed.

If you already have the first two printer profiles, you can use them and skip steps 1 and 2.

# First: Create an ICC printer profile for the Phaser 7700



To create a profile for your Phaser 7700, print the IT-8 page — shown in the figure to the left — to your Phaser 7700 using whichever print quality mode and TekColor<sup>TM</sup> correction you need.<sup>1</sup> You will then attach the actual IT8 Target, included with the PhaserMatch<sup>TM</sup> ICC software package, to this print target. Now the PhaserMatch<sup>TM</sup> application will scan the combined image into your computer and create a printer profile for the Phaser 7700 using this combination of media, print quality and TekColor<sup>TM</sup> correction.

In more detail, the sequence of steps is as follows:

- Print the target IT-8 page to the Phaser 7700, using the media and print quality you want to profile. This can be done either from the PhaserMatch<sup>TM</sup> ICC application itself or by print the image using the included TIFF file, *CMYK PrinterTarget.tif*, using what ever printing application you wish.
- Attach the provided IT-8 target at the bottom of this printed page.
- Scan the combined image into PhaserMatch<sup>™</sup> ICC. You may do this directly from PhaserMatch<sup>™</sup> using a TWAIN interface or you may scan the image in via some other scanning application, perhaps on a different computer, and import that scanned image in PhaserMatch<sup>™</sup>. In either case, scan the target at 150 dpi (dots-per-inch) with automatic color correction or color management features turned off. Scans between 72 to 300 dpi are acceptable but 150 dpi gives the best results.<sup>2</sup> Also ensure that mirror-imaging and other scan manipulating features are not selected.

<sup>1</sup> Usually, you will want to use the TekColor<sup>TM</sup> mode of 'None' to not introduce additional color corrections into the combination, but it is possible to generate profiles with these additional modes included. Note that the Phaser 7700 driver when it downloads the link profile you build from this printer profile will set the printer to 'None' mode automatically.

<sup>2</sup>*NOTE*: If you are unable to create a scan at 150 dpi but instead must use a higher resolution setting, you can use an image editing program, such as Adobe Photoshop, to "de-res" or lower the image resolution to 150 dpi. Be sure to use the "nearest neighbor" setting when you lower the resolution.



 Provide PhaserMatch<sup>™</sup> with the reference file for the IT-8 target you are using. Since there is some slight variation in colors between different batches of the IT-8 target, this file accurately describes the color of your particular IT8 Target to PhaserMatch<sup>™</sup> ICC. The reference files are included on the CD, are installed automatically and will appear in a file selection window when PhaserMatch<sup>™</sup> needs the reference file. If you should have a newer IT-8 target than the ones whose reference files are included on the CD, you may get the corresponding reference file from the Xerox web site at www.xerox.com/officeprinting/



• Once PhaserMatch<sup>TM</sup> has the scanned image, you will be asked to mark the corners of both the printed target and IT-8 target so that PhaserMatch<sup>TM</sup> can find the color swatches to read their color values.

• After you have marked all the corners, PhaserMatch<sup>TM</sup> ICC will build the ICC printer profile and then you give it a file name and the application will save it as ICC profile file in the appropriate system folder.

**About the IT8 Target.** Scanners are generally calibrated and profiled using a standard color target called the IT8 target. For the purposes of PhaserMatch" ICC the target comes in the form of a 5 x 7-inch print, and is included in the software package. The target is accompanied with a reference file which mathematically describes the color value of each patch of color on the target. When you scan the IT8 target, PhaserMatch" ICC correlates the actual colors of the target (as described in the reference file) with the values generated by the scanner and creates a temporary scanner profile.

The IT8 Target is carefully color-calibrated; data stored in an accompanying file tells PhaserMatch" ICC the values of the colors on this particular IT8 Target. By scanning the IT8 Target and the Printer Target together, PhaserMatch" ICC can correlate the colors and create a profile to match the tar get colors without any color changes caused by the scanner itself.



# Second: Create an ICC printer profile for the target

In this procedure you create an ICC profile for a Target Device such as a printing press, a non-Xerox printer, or a proofing device. The ICC profiles you create are selectable using the ColorSync Control Panel in the Macintosh and the Color Management tab of the Display Control Panel in Microsoft<sup>®</sup> Windows 98, Windows ME or Windows 2000. You create the ICC printer profile for the target device, usually a press, in the same way you did the Phaser 7700 profile in the first step. The one difference is that you do not have the opportunity to print the target page directly from the PhaserMatch<sup>TM</sup> application, since one rarely has a press connected directly to your PC or Mac. Instead, you will print the included TIFF file, *CMYK PrinterTarget.tif*, using what ever printing application you wish.

In more detail, the sequence of steps is as follows:

- Print the target IT-8 page using the included TIFF file, *CMYK PrinterTarget.tif* — to the target device from whatever application you can. Ensure that the paper and print driver settings of your target device are set to the values you wish the Phaser printer to simulate.
- Attach the provided IT-8 target at the bottom of this printed page.
- Scan the combined image into PhaserMatch<sup>TM</sup> ICC. You may do this directly from PhaserMatch<sup>TM</sup> using a TWAIN interface or you may scan the image in via some other scanning application, perhaps on a different computer, and import that scanned image in PhaserMatch<sup>TM</sup>. In either case, scan the target at 150 dpi (dots-per-inch) with automatic color correction or color management features turned off. Scans between 72 to 300 dpi are acceptable but 150 dpi gives the best results.<sup>3</sup> Also ensure that mirror-imaging and other scan manipulating features are not selected.
- Provide PhaserMatch<sup>TM</sup> with the reference file for the IT-8 target you are using. Since there is some slight variation in colors between different batches of the IT-8 target, this file accurately describes the color of your particular IT8 Target to PhaserMatch<sup>TM</sup> ICC. The reference files are included on the CD, are installed automatically and will appear in a file selection window when PhaserMatch<sup>TM</sup> needs the reference file. If you should have a newer IT-8 target than the ones whose reference files are included on the CD, you may get the corresponding reference file from the Xerox web site at www.xerox.com/officeprinting/

<sup>3</sup>*NOTE*: If you are unable to create a scan at 150 dpi but instead must use a higher resolution setting, you can use an image editing program, such as Adobe Photoshop, to "de-res" or lower the image resolution to 150 dpi. Be sure to use the "nearest neighbor" setting when you lower the resolution.





Once PhaserMatch<sup>TM</sup> has the scanned image, you will be • asked to mark the corners of both the printed target and IT-8 target so that PhaserMatch<sup>TM</sup> can find the color swatches to read their color values.

After you have marked all the corners, PhaserMatch<sup>TM</sup> ICC will build the ICC printer profile for the target device and then you give it a file name and the application will save it as ICC profile file in the appropriate system folder.

#### Third: Create a Link Profile

Link profiles describe the color behavior of two CMYK devices (your Phaser Color Printer and a target device, such as a printing press or a proofing device) combined together into a single file. Creating link profiles lets you alter the colors printed by your Phaser Color printer so they more closely match the colors produced by the output device of your choice.

This process allows you to combine a PhaserMatch<sup>™</sup> ICC printer profile for a Phaser Color Printer with the ICC profile of another target press or proofing device to create a Link Profile. This link profile then allows the Phaser Color Printer to emulate the color behavior of the target printer or device. You select this newly-created profile with your Phaser Color Printer driver. The link profile is added to the choices in the Color Correction field of the Macintosh printer driver. Using the Xerox-supplied Phaser printer driver on the PC, a link profile is added to the Press Match list under the TekColor<sup>TM</sup> tab in the printer driver dialog box.

To create a Link Profile between a Target Device and your Phaser Color Printer, you perform the following Steps:

- **Choose Target Device Profile** •
- Choose Xerox Printer Profile
- Choose Target Printer Options
- Save Link Profile



When choosing the profiles to combine — one for the Phaser 7700 printer and one for the target device — you will be able to select from the appropriate ICC profiles in the system's color folder. For the target device, you will see any printer profiles available whether created in PhaserMatch<sup>TM</sup> or not. The profile selections for the Phaser 7700 printer will be restricted to those that are for the Phaser 7700, i.e., you will not see other printer profiles.

In the next step, you select how you wish the colors black and white to be reconciled between the Xerox printer profile and the target printer profile.

- Selecting **Text Enhancement** prevents 100% black text from being defined as a combination of cyan, magenta, and yellow colors but instead defaults to the printer's true black. Generally, this improves the sharpness of black fine lines and text.
- Selecting **Preserve Paper Colors** defines the color white as the color of the media on which the target printer prints. For example, the Xerox printer will print yellow to simulate the yellow paper that could be used on a printing press.

The next step is to provide a file name for the to-be-created link profile. You can also change the description that is embedded in the profile. By default this is set to a concatenation of the descriptions of the two printer profiles.

Click 'Next' and the link profile will be built and saved.

#### Fourth: Edit a Link Profile

The **Edit a Link Profile** function lets you modify the color behavior of a Link Profile. If there are big differences between the target printer and the output produced by the **Xerox** printer using your Link Profile, you probably need to create a new profile. The editing tools are for fine-tuning profiles, not for making major changes.

In the first step you select a Link Profile to edit. Pull down menus narrow the selection criteria of profiles available for editing. Once you have chosen a profile to edit, the editing window shown below will appear.

Only edit the Link Profile to correct a problem that is affecting all your images. Use your image-editing software, such as Adobe Photoshop, to correct individual images. When editing a Link Profile, keep in mind that you should be making very few changes to the profile. If you make several changes to a profile, you can find the changes you make will introduce other problems.





### Edit Profile – Image

This window provides you with a sample image and the tools to edit the Link Profile. See Tips on Editing Link Profiles.

The editing window is made up of a **Tool Bar** which you use to select editing functions and manipulate the image preview itself, with controls such as zoom and the Color Selection tool. The remainder of the display is an image screen which shows an **Original Link Profile** window displaying the image you began with. This screen can be split into two halves with the second half containing an **Edited Link Profile** window displaying your image as it is altered by any adjustments you make to the profile. When you open a previously edited Link Profile, the original image is automatically displayed in the left screen and the edited version in the right screen.

#### Tool Bar Controls

**Select Preview Image**. This item allows you to select a new preview image. The image must be a CMYK TIFF file.

**Print Sample Image.** Clicking this icon allows you to print the preview image to a Xerox printer to verify the effects of the profile editing. The Print Quality and media settings are overridden with the applied data values contained in the profile being edited so they match the conditions for which the profile is intended.

Help Button. Clicking this button displays the on-line help files.

**Zoom Controls.** These controls let you zoom in and out of the displayed sample image.

**Color Picker**. When you select the Color Picker tool, the cursor changes to an eyedropper. You use the eyedropper to select colors from your sample image.

**Split.** Clicking on this icon toggles the display between one-image mode (which shows "after editing image") and two-image mode which shows a "before editing image" and an "after editing image" revealing the effects of the edit(s) you make.

**Target Printer Global Edit** icon opens the **Target Printer Global Edit** window, allowing you to alter the input curves of the target printer color space.



**Xerox Printer Global Edit** icon opens the **Xerox Printer Global Edit** window, allowing you to alter the output curves of the Xerox printer color space.

**Selective** opens the **Color Editing** window, allowing you to selectively edit individual color regions in the profile without affecting other colors.

**Color Information.** Pressing this button pops up a window giving dynamic CMYK, HSB or LAB color values of the Color Picker.

Your primary choices are the three buttons in the upper right-hand corner: **Target Printer Global Edit**, **Selective Edit** and **Xerox Printer Global Edit**.

# Target Device Global Edit

The **Target Device Global Edit** window allows you to alter the CMYK color map of the printing press or device that you wish your Xerox Phaser Color printer to emulate.

Generally, it is best to use the **Target Printer Global Edit** function to adjust all four primary color curves. The color curves for the Xerox printer are more likely to have non-linear color components, especially in very light and very dark colors; therefore, even a linear change to the Xerox printer curves can have some non-linear color effects.

Click any of the four **Cyan**, **Magenta**, **Yellow** and **Black** buttons at the top of the screen to select which primary color you wish to modify.

The graph displays tone curves for each of the primary colors you selected. The color of the line indicates which primary color you are changing. Click on a curve to select a tone, and then use your mouse, by dragging the handle, to alter the curve's shape to change the amount of output color printed for any input color.

When you edit one of the four primary colors, any color composed with the selected color will change. For example, if you change cyan, you will change the blues and greens of the entire image, as well as the cyans.

The **Input Level** indicates the percentage-of-color point on the tone curve you have selected. You can also type in a value.

The **Output Level** indicates the amount of color that will be printed for any particular input color. You can also type in a value. In the graph display, as you bend a primary color's curve upward more primary color will be used to print that color. Likewise, as you bend a curve downward less color will be used during printing.



The **Reset** button returns the checked tone curves to the linear defaults of the original file *before you made any edits*.

The **Apply** button updates and saves the Link Profile with the changes you just made.

*NOTE:* Changes will not be saved if you close or exit the window, you must select **Apply** before exiting to save your edits.

# Selective Edit

The **Selective Edit** function allows you to make fine adjustments to the profile's range of color. Using these controls you can make selective edits to individual color regions in the profile, such as flesh tones, without affecting other colors. Only link profiles created with PhaserMatch<sup>TM</sup> ICC 7700 can be edited using the **Selective Edit** tool.

At the top of the display is a running list of each edit you make and apply. To make a new edit, click the **New** button. To edit a previously made color edit, such as "Edit 1" or "Edit 2," select it from the pull-down list.

The **Current Color** control shows the hue, saturation and brightness (HSB) levels of the color currently select by the eyedropper. It will also show the HSB values of a color edit when you select it from the pull-down list. Slider knobs let you alter the selected color by hue, saturation or brightness.

The **Printed Color** control lets you alter the printed color that is mapped to the selected Current Color. Slider knobs let you alter the selected color by hue, saturation or brightness.

A screen in the lower-left corner of the display provides a representation color map. A point on the graphic shows selected Current Color in relation to the total color map. The tip of the arrow displays how the new printed color will shift. A slider bar just to the right of the graphic lets you scroll up and down through the brightness axis of the color space. To the right of the color map graphic are two other slider knobs. The **Lightness range** knob lets you expand or reduce the range of Lightness affected by the color edit. The **Color range** knob lets you expand or reduce the adjacent hues affected by the color edit. An expanding (or contracting) circle on the color map graphically indicates the affected area.

Controls at the bottom of the display let you zoom in and out of the color map and re-center it. An eyedropper lets you pick colors off of the color map. A grabber lets you grab and move the color map.



## Save your Edited Link Profile

This screen lets you save the Link Profile you just edited.

Enter a file name for the Edited Profile. Give the profile a descriptive name that reveals its function.

Change the default description, if desired.

Click **Finish** to save your profile and return to the Task Bar window. PhaserMatch<sup>™</sup> ICC will save the file to the appropriate location on your computer's hard drive.

# Tips on Editing Link Profiles

If the problem is with a primary color and all the colors that contain the primary colors, use the **Xerox Printer Global Edit** function. If only a primary color is not quite correct, use the **Selective Edit** tools to correct it. Only link profiles created with PhaserMatch<sup>TM</sup> ICC 7700 can be edited using the Selective Edit tool.

Generally, you use the global edit functions to correct color differences in the profile that involve the entire image such as a hue shift or images that are too light or dark. If the primary colors (cyan, magenta, yellow and black) have the same color cast difference as all the other colors, then use the **Xerox Printer Global Edit** function.

If the primary colors are correct, but the secondary colors (red, green, and blue) and any other colors are incorrect, correct them using the **Target Printer Global Edit** function.



To solve light/dark problems you can use either global edit functions, however it is generally best to use the **Target Printer Global Edit** function. Make the adjustment using all four primary color curves so the ratio between the curves remains the same. (If the ratio does not remain the same, the color balance is altered and a color cast is introduced.) The color curves for the **Xerox** printer are more likely to have non-linear color components, especially in very light and very dark colors; therefore, even a linear change to the **Xerox** printer curves can have some non-linear color effects.

In this example, the cyan curve is adjusted to lighten all cyanbased colors.



Use the **Selective Edit** function when the overall contrast and color balance is correct, but certain colors, such as flesh tones or blue sky are incorrect, for example, but nearby rose colors and blue water are correct.

In this example, a sample of green is selected and altered to a different shade of



green by the arrow. The effect of the change is limited by the circle despite the arrow extending past the circle.

Edit the target device curves if image detail is lost in the highlight, mid-tones or shadows.

For highlight detail loss, use the **Target Printer Global Edit** function to decrease contrast in the light areas (low CMYK values) of the target printer curves. Decrease contrast in the middle areas to reduce detail loss in the midtones. Likewise, decrease contrast in the dark areas (high CMYK values) to reduce detail lost in the shadows. If the image looks flat, increase the contrast. The changes you make to the curves together should alter the curves into an S-shape (to increase the contrast) or a backwards S-shape (to decrease contrast).



In this example, the cyan color curve is selected and the curve is altered to increase contrast by lightening the light cyans (lower end of curve) and darkening the dark cyans (upper end of curve).

