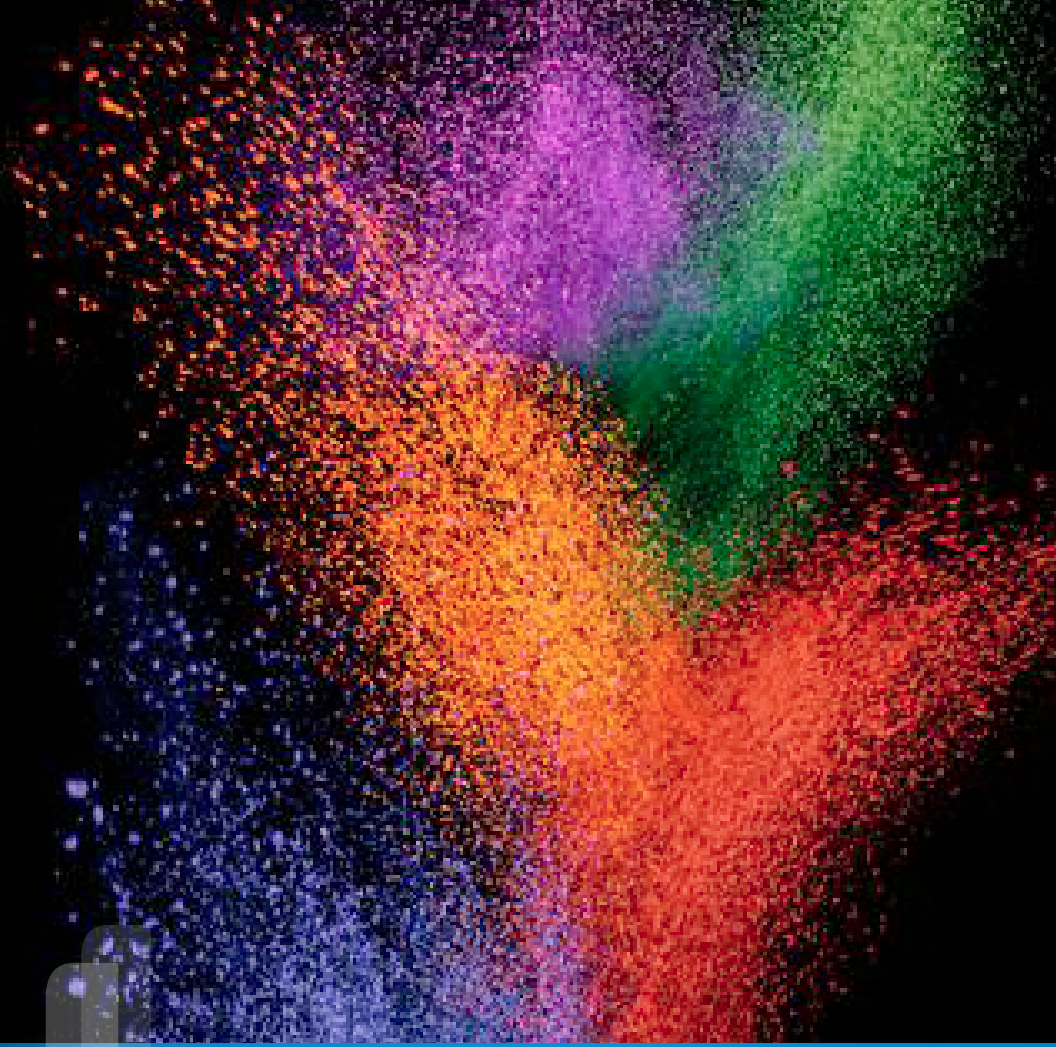


ABC's of Color

Understanding the Color Supply Chain

efi® print to win.

ABC's of Color

Understanding the Color Supply Chain

"The end-to-end process of producing good color from **design**, **production** and **output**"

Introduction

Mystery always has surrounded the art and science of color, but with the right tools and processes, it can be relatively simple to produce consistent, accurate color regardless of the output device being used, as long as the device is capable of producing the color gamut or subset of colors that is required.

What constitutes acceptable color is often subjective. What one person sees and approves may not work for another viewer. The good news is that, while there is an art to color, there is a significant amount of science behind it.

The ABC's of Color will demystify the science of color. It will define color terms and measurements; explain the tools and processes behind good color production, and lay out in easy-to-understand terms all of the elements of the Color Supply Chain — the end-to-end process of producing good color from design, production and output.

The Business of Color

Color is important to businesses based on their specific needs. For instance, many organizations have a corporate or brand color that is a key element of their brand identities. Brand owners are fiercely protective of these colors, demanding their accurate reproduction regardless of whether or not the branded items are printed using offset, digital, gravure or other printing technologies, or produced for electronic distribution.

In the publishing world, high-end magazines such as Cosmopolitan, Fortune, and The Economist require high image quality. Their models, photos, imagery, and fine art prints must be reproduced flawlessly.

As the capabilities of document creation solutions become increasingly sophisticated and a wide range of digital elements — including digital photography — are more easily incorporated into documents for print or electronic viewing, the challenge of producing good color increases. In addition, operator skill levels range widely from expert to inexperienced. This situation means that a variety of software tools and capabilities are required to accommodate varying operator needs in order to meet client demand for precise color.

By understanding how each element in the Color Supply Chain works together to generate accurate and consistent color, many color pitfalls can be avoided, along with the delays and aggravation that color issues cause during the production of marketing and other materials.

01

"Good Enough" Color

Not everything produced in color is "color critical" or needs to be perfect, so an important step in the Color Supply Chain is determining what level of color accuracy and consistency is needed to meet the requirements for a given project or client. For example, materials produced for internal distribution may not need to adhere to strict color standards. The color just needs to look consistent every time that it is produced. Similar materials produced for external distribution may require the highest level of color accuracy and consistency. There is a cost associated with good color, and document originators must weigh that cost as they specify production metrics. Also, color is only one aspect of printing quality, and color management does not apply at all to black and white images and text.

1. Raster Image Processor, the processor that translates between document creation applications and the printer to generate a printed image.

“Good Enough” Color

“Good enough” color is getting better as printers at all levels of the output process, from the office through the workgroup and production environments, incorporate more front-end software that is able to automatically overcome an increasing array of color issues. Rather than leaving color management in the domain of creative applications, sophisticated in-RIP[1] color management can become the arbiter of color inconsistencies, especially when there are document elements from a variety of sources. This approach often means that the operator does not need deep color knowledge in order to produce great color.

Whether or not an application is color-critical or simply requires “good enough” color, a well-managed workflow throughout the Color Supply Chain can ensure that businesses and their customers get what they expect in the final printed output.

02

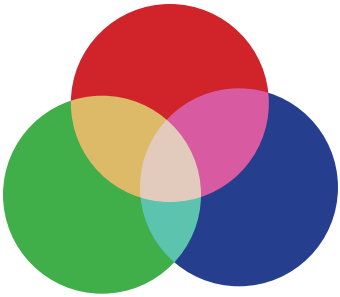
Color Basics

Let's start with some basic color definitions. First, what is color? While this question sounds simple, the answer can be quite complex because color reproduction varies from output device to output device. For example, Cyan toner on one printer may not be the same as Cyan toner on another printer. Compensating for these differences requires standards-compliant technologies and workflows that can translate the color intent specified by the document's creator into the appropriate color output for each device.

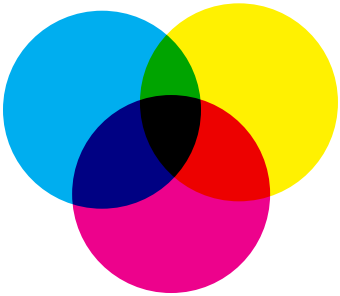
2. http://members.eunet.at/cie/
3. www.Color.org
4. www.ISO.org
5. An easy-to-use how-to guide called Calibrating, Printing and Proofing by the G7 Method is available online at www.gracol.org/resources/
6. www.fogra.org
7. www.bvdm-online.de
8. The American Heritage Dictionary of the English Language, Fourth Edition, Houghton Mifflin Company, 2000.
9. When using a digital press, the proof is often a sheet from the press being used, since digital economics allow affordable production of one or two press sheets as a proof. Additionally, for many digitally printed jobs, a soft proof may be adequate and a hard copy proof may never be needed.

Color Basics

Color is the visual sensation produced in response to selective absorption of wavelengths from visible light. Color is generally described using additive or subtractive models.



Additive Color: An additive color model involves light emitted directly from a source or illuminant of some sort. The additive reproduction process starts with black or the absence of color. Color combinations of red, green and blue (RGB) are then added to achieve the desired color. Computer monitors and televisions are the most common application of additive color.



Subtractive Color: A subtractive color model begins with white or the reflection of all colors. Colorants are then added, shift the reflective values and produce the desired color. This model is used in mixing paints, dyes, inks and natural colorants to create a range of colors.

In an additive or a subtractive model, three primary colors are needed to correlate to the three different types of color receptors (cone cells) in the human eye (trichromatic color vision). The three primary colors in the additive model are red, green and blue (RGB), while the three primary colors in the subtractive model are cyan, magenta and yellow (CMY).

Color Standards

The International Commission on Illumination (CIE) or Commission Internationale de l'Eclairage[2] is devoted to international cooperation on the science of color as it relates to the standards associated with measuring and quantification of color. It also defines the device independent color space in which the transformations from one device to another are performed. Since its inception 90 years ago, the CIE has been accepted as the highest authority on the subject and is recognized by the International Standards Organization (ISO) as an international standards body.

The International Color Consortium[3] or ICC is the official arbiter of color standards as they relate to the technological implementation of color conversions, quantifications and descriptions for the output devices and software used in the graphic arts industry. The ICC was established in 1993 by a group of industry vendors for the purpose of creating, promoting and encouraging the standardization and evolution of an open, vendor-neutral, cross-platform color management system architecture and components. The outcome of this cooperative effort was the ICC profile specification. ICC profiles are used to describe the color capabilities of input and output devices such as monitors, scanners or printers.

ICC profiles provide a cross-platform device profile format that ensures consistent, device-independent color throughout the entire production process. Device profiles can be used to translate color data created on one device into another device's native color space. This addresses the issue mentioned above, where toner or ink colors can vary from device to device. The acceptance of this format by operating system and graphic application vendors allows end users to transparently move profiles and images with embedded profiles among different operating systems and applications.

This acceptance also simplifies the proofing process between designers and printers, since both are working with the same color reference. Designers can achieve accurate color matching by designing with the same color profile that will be used on press. The same is true for commercial printers that have multiple plants. They will be able to reproduce the same color quality at various locations by using well-defined ICC profiles. In other words, ICC profiles allow users to be sure that their images retain color fidelity when moved between systems, locations and applications. ICC profiles also allow a printer manufacturer to create a single profile for multiple operating systems.

As digital cameras become more popular, ICC profiles have become increasingly important, making it easy to reproduce digital photography on digital printers and offset presses. ICC profiles are crucial to this capability because they describe the specific characteristics of the printer, toner, inks and paper to ensure optimal color reproduction for each combination of these elements. Standard profiles provided by the manufacturer are often used; however, custom profiles can also be created to meet specific requirements.

When designating the ICC profile for a given job, it also is important to set the device driver specifications and to consider the ink and paper being used. Good color software supplies standard profiles for all conceivable combinations and automatically loads the matching ICC profile as the user enters ink, proofing medium and print settings into the software interface.

As the graphic arts industry embraces and advances standards development, a range of international printing and proofing standards are being developed that can be used independent of individual manufacturers to produce comparable results. These national, regional and international printing and proofing standards facilitate the exchange of print data and proofs. What's more, print shops can set presses to a standard and be assured that they will work reliably with the proofs supplied by various customers or third parties. These emerging standards also include quality control specifications, which is the future for color management.

The ICC specification is widely used and has been incorporated in many international and other de facto standards. More information on the International Color Consortium and the latest news on new developments in the color management arena can be found on the ICC's Web site: www.color.org.

The International Standards Organization (ISO) is another important organization for world standards. ISO is the world's largest developer and publisher of international standards[4] and is a network of national standards institutes from 157 countries. ISO Standard 12647 specifies a number of process parameters, and their values are to be applied when producing four-color or more offset, digital or gravure printing or for proofing systems.

Regional Standards

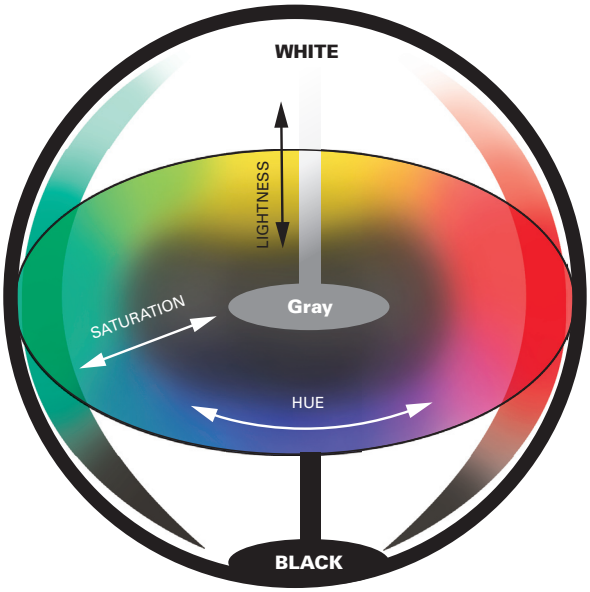
Due to the variability of inks, papers and other elements of the print production process globally and the production differences among heatset web, coldset web (newspaper) and sheetfed printing, a number of regional color standards have emerged. The basic color science underlying these regional standards is based on ICC and CIE work. Graphic creation packages can be configured to produce files compliant with these specifications, depending on where the project will ultimately be produced. These standards include:

- **Specifications for Web Offset Printing (SWOP)**: The North American standard is largely used in newspaper, advertising and magazine production. It ensures color consistency for ads. This standard defines the colors of the ink sets used and the desired densities of the inks on the page. The standard is important to advertisers, who need to ensure brand integrity in their ads and other printed materials. The standard generally assumes that the user is printing on commercial grade glossy paper (see www.swop.org for more detail).
- **SWOP-Uncoated:** This standard is designed for use with the same ink sets but on uncoated paper.
- **Specifications for Non-Heatset Advertising Printing (SNAP):** This standard is for newspaper printing using SWOP ink sets (see www.gain.net for more detail).
- **General Requirements for Applications in Commercial Offset Lithography (GRACoL):** GRACoL describes the tools and standards for sheetfed and web offset developed by the International Digital Enterprise Alliance (IDEAlliance). It is designed to help print buyers, designers, and print specifiers work more effectively with print suppliers. GRACol-compliant ICC profiles are rapidly becoming the standard for digital proofing in North America. SWOP and IDEAlliance have formed an affiliation to address the coordinated development of specifications and guidelines, certification programs, software tools, educational seminars, and peer support networks (see www.gracol.org for more information). In addition, IDEAlliance has been instrumental in creating G7™, a documented and consistent methodology that allows printers to match multiple devices to each other for a consistent and predictable printed outcome.5
- **Japan Standard or DIC:** This standard is characterized by different yellow tones than used by some of the other standards.
- **Eurostandard Ink Set:** This standard is used by printers in Europe. Recently, research institutes such as FOGRA6 and industry associations such as bvdm7 have invested significant effort into colorimetric refinement of those standards, resulting in the Medien standard Druck and a series of FOGRA tolerances that clarify the European color standards.

Color Space

In most cases, device-independent color definitions have three dimensions, and these dimensions make up what we call a color space. The dimensions are:

- **Hue:** According to the American Heritage Dictionary[8] , hue refers to a particular gradation of color such as a shade or tint, like "all the hues of the rainbow."
- **Saturation:** This term refers to the vividness of hue or purity of a color.
- **Brightness or luminance:** The terms refer to the dimension of a color that can range from very dim (dark) to very bright (dazzling).



Conventional four-color offset printing and most color digital printers use four colors – Cyan, Magenta, Yellow and Black – as subtractive primary colors to create a wide range of additional colors in what is known as four-color process. These four colors, referred to as CMYK, with "K" representing black, have long been the primary color space utilized in the world of printing. As mentioned earlier, CMY are the three primary subtractive colors, and when mixed in equal parts, in theory result in black. In reality, a dark color that is not a true black may result from less than ideal colorants. To economize on ink consumption and to produce deeper black tones, unsaturated and dark colors are produced by substituting black ink for the combination of cyan, magenta and yellow.

When an image is captured or created digitally — that is, scanned and captured with a digital camera, or created using desktop publishing software — it is commonly represented using red, green and blue (RGB). These elements are the additive primary colors that are used in displaying images on a screen.

CMYK and RGB represent two different color spaces. With the world's increasing volume of digitally captured files, most of which are in RGB format, printers preparing a file for print must consider the color space in which various elements are created. Having the processes in place to convert these files as appropriate for the intended output device is equally important. To convert values obtained from an input device, such as RGB from a scanner or digital camera, into the device code values needed by an output (rendering) device, such as a CMYK printer, a transformation is needed to modify the data. This role belongs to the ICC profile, which directs the actual color conversion produced by a color management module (CMM). The CMM uses the profiles to convert and match colors on one device's color space to or from another device's color space. When colors on one device's gamut are displayed on a device with a different color gamut, the CMM attempts to minimize the perceived differences in the displayed colors between the two devices.

Spot Colors

Sometimes inks or toners are specially mixed to deliver an exact match to a specific color, rather than using CMYK inks to produce four-color process. These special colors are called spot colors, or sometimes, Pantone colors. Pantone, Inc. developed the first color matching system in 1963. This proprietary system, called the Pantone Matching System (PMS), contains the formulas for creating and reproducing more than a thousand different "spot" colors on a CMYK device. This reason is why spot colors are sometimes referred to as PMS colors. Other color matching systems include HKS, Toyo and RAL.

In 2007, Pantone announced a new color matching system, called Goe, which consists of more than 2,000 colors. While there is some overlap between PMS and Goe, Goe does introduce a large number of new colors to the market.

If CMYK inks can be combined to create colors in a subtractive color system, you might wonder why there is a need for special spot colors. There are three key reasons special inks are used. First, not all colors can be matched using CMYK, so they require a special spot color ink. Secondly, it can be difficult to accurately reproduce certain color gamuts, such as saturated color. Finally, color shifts caused by misregistration and process tolerance can occur when attempting to match a special color with CMYK inks.

If the piece being printed is a full-color piece, additional spot color requires an extra printing unit on the press, or an extra pass through the press to create what would be five-color printing. That is, a four-color press has four printing units, each imaging one ink color (CMYK). To add a spot color, a fifth unit (or a five-color press) is required. Otherwise, the piece must be run through the press again to overlay the spot color. For offset printing, another pass through the press requires drying time (to let the first four colors dry), and complete wash-up of at least one printing unit to allow the addition of the special color. It also introduces the need to assure precise registration of the color being laid down in the second pass as it relates to the four colors that have already been printed. This process can add significant time and cost to a printing job.

For digital printers, which generally print using CMYK toner or inks, spot colors can be effectively matched using sophisticated algorithms within the RIP. For example, the EFI Fiery® RIP offers Spot-On, which helps users manage spot colors and edit the CMYK or RGB values to better match corporate or custom colors. Even so, there are still some colors which are difficult, or even impossible, to match in the CMYK space.

When designing a printed piece, careful consideration should be given to whether or not a spot color should be specified. Quality, color accuracy, cost and the color-critical nature of the piece represent a few of these considerations. In some cases, it makes sense to use an alternative color that is more likely to reproduce accurately with CMYK inks. Pantone PMS and Goe systems provide Bridge Books as well as online software that help designers and printers determine how faithfully a PMS or Goe color can be reproduced, making suggestions about alternative color choices.

Paper and Ink/Toner

How color actually appears when produced on an offset or digital press is affected by several factors, including the printing plate quality produced from the original file or master for offset printing, the press settings, the paper, ink or toner types that are used to produce the job; and even the condition of the press. The press operator has significant influence on the way colors are produced in print. Factors include increasing or decreasing the amount of ink that is applied to the page for offset, and shifting the CMYK balance — that is, increasing the amount of one or more of the primary colors independent of each other — for either offset or digital devices. By taking these actions, the press operator can match the proof – fine tuning the press during print production to produce a printed sheet equivalent to the contract proof that the customer has approved. Operators can match printed sheets to proofs with a visual examination or by using color measurement tools. It is important to understand that color matching between proofs and printed sheets may not always be 100% accurate, even if all of these steps are employed.

This situation is due to the fact that, especially in the offset environment[9], the proofing device uses different inks and may be printing on different paper than is actually used in final production at the offset press. For example, more intense colors can be produced on a high-quality coated paper than on a less expensive, uncoated paper. If a proof is produced on coated stock with the final product produced on uncoated stock, it may be difficult to obtain an accurate color match at press time. For more detailed information about proofing, visit www.efi.com to download the ABC's of Proofing.

The density with which the ink is applied to the paper can be measured with a densitometer, which allows the press operator to deliver consistency, from sheet to sheet, and even job to job, especially if a job is being reprinted. (Further discussion about color measurement tools can be found in Chapter 3.)

While there are consistent standards that apply to offset inks, there are inconsistent standards relative to inkjet inks that are provided by different suppliers. Toner results also vary from manufacturer to manufacturer or from ink batch to ink batch. Additionally, different paper types can result in different ink absorption rates, which in turn, cause color to vary from one paper type to another. The print drivers — or the instructions that bridge the document creation software and the print hardware — for inkjet printers generally have an option that can be selected to specify the paper type. This option reduces that variability. Inkjet printers are relatively stable in their ability to deliver accurate color reproduction. This stability makes it easier to build a reliable color management process across the Color Supply Chain.

As you can see, it is critical to have coordination between the creator of the original file and the various stages of job processing throughout the Color Supply Chain to ensure that the output meets the customer's expectations.

03

Measuring Color

While there is an art to design and selecting the right colors, there is definitely a color science, and that means color can be measured. Scientific measurement of color output enables greater control in the print production process. Translating color into mathematical calculations based on data generated by measuring devices eliminates the need for a press operator to "eyeball" the press sheet to see if it looks approximately right.

10. www.istockphoto.com, search for CMYK printing color bar
11. www.AltonaTestSuite.de
12. www.gwg.org

Measuring Color

There are three different devices used to measure color characteristics, and each has its role during the design and production process. These devices are colorimeters, spectrophotometers and densitometers. Color measurement instruments are able to receive color data in the same way our eyes receive color – by gathering and filtering light that is reflected from an object, whether that object is a flower or a sheet of paper printed with offset inks. The measurement device; however, transforms the color into a numeric value that allows us to scientifically analyze the quality of a specific color object. Below is a brief description of these devices.

Colorimeters

Colorimeters measure colors using filters to determine the nature of the color. In the world of graphic communications, colorimeters are most frequently used to calibrate output devices, including monitors, printers and even LCD projectors. A colorimeter can sometimes be used as an alternative to a spectrophotometer, but it is not as accurate.

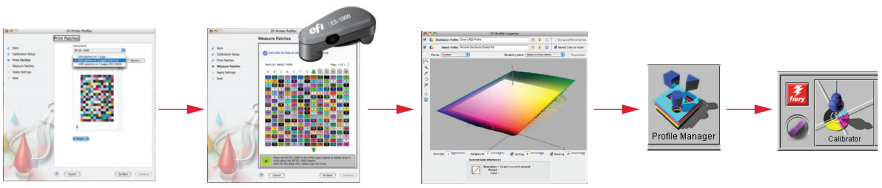
Spectrophotometers

A spectrophotometer measures wavelength reflections. A light source shines through or on the item being measured, such as a printed sheet, and a detector detects how much light has been absorbed by the area of the printed sheet being measured. This absorption is then converted into a number, which can be analyzed by a computer. Spectrophotometers are considered to be the most accurate technology available for measuring color characteristics. An example of a spectrophotometer is the EFI ES-1000 spectrophotometer.

Densitometers

A densitometer measures color density. Densitometers are often used in offset printing. Because inks are known standards, a densitometer helps in controlling the amount of ink on a page and the resulting color. Color standards, such as the standards delivered by Pantone, include ink densities as part of the color specification.

Calibration, Profiling and Measuring



Print Profile Patches to Printer from Color Profiler Suite

Measure Patches with ES1000

Use Profile Inspector to Accept Profile

Upload Profile to the Fiery

Maintain Color by Calibrating at the Fiery

Maintaining a reliable color environment is essential for the production of accurate and consistent color every time. To achieve a reliable color environment, calibration, profiling and measurement of output devices are critical. A number of affordable solutions exist today that combine all the hardware and software essential to these tasks. To be successful, it's important that all of the elements in the Color Supply Chain are speaking the same language or integrated with each other.

What is calibration? It is a process that allows the output device to revert back to a known standard. The frequency of calibration required varies on the print environment and its associated quality standards. In some environments, operators calibrate devices daily or every time that they start a new job or introduce a different paper into the production environment. In other cases, devices may be calibrated on a daily, weekly or even monthly basis.

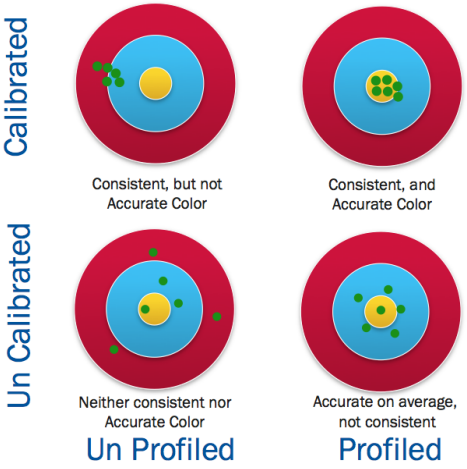
When calibrating, certain output devices, such as those systems using Fiery, you don't need to test it with a profiling solution to achieve consistent and/or accurate color. On other systems without Fiery's capabilities, it is important to use a profiling solution such as Fiery Color Profiler Suite to test the profile patches that go to the printer. Profiling is used to characterize the printer and to ensure optimum color output. Calibration is used to re-set the printer to this optimal desired state.

Profiling solutions then generate ICC profiles that characterize the device, allowing a better understanding of its color capabilities. ICC profiles provide a cross-platform device profile format that ensures consistent, device-independent color throughout the entire Color Supply Chain. Manufacturers typically ship output devices with default profiles, but many operators choose to develop custom profiles to achieve better color results for particular paper characteristics or the characteristics of the printing device.

A color measurement device reads the test pattern/patches. Since spectrophotometers, such as the ES-1000, are the most precise, they typically deliver the best results. The on-screen test pattern/patch results are compared to the numerical values associated with the test pattern. A solution such as Profile Inspector in Fiery Color Profiler then accepts the profile, and it is uploaded to an output device such as Fiery. This process allows accurate color to be maintained by the output device.

Accurate and Consistent Color

When using an integrated color management solution in a digital printing environment, these steps can often be consolidated as shown in the figure to the right. Profile patches are printed, measured and uploaded to the RIP. When profiles are generated, the calibration target is incorporated at the same time, meaning that a single patch serves the purpose of both profiling and ongoing calibration of the device, streamlining the process.



Why is Profiling Important?
Profiles help designers and others early in the Color Supply Chain to better predict the way colors will reproduce at later stages in the process. This color control early in the Color Supply Chain saves time and decreases waste as the job progresses.

In addition to colorimeters, spectrophotometers and densitometers, there are a few other tools, metrics and components that help with profiling. These tools include color bars, test suites, and color tolerances such as Delta-E.

Color Bars
Frequently, a color bar is included as part of a printed sheet. This bar contains small patches of solid color and color gradations and is printed outside the image area, in the trim area. Color bars can serve many purposes. They can be used to determine color accuracy against a given standard or to determine a proof's accuracy against a final print. Color bars also can be used to measure consistency for the duration of a long print run, from job to job when a print job is reprinted, or between two similar printers.

Color bars are available from a variety of sources, including IDEAlliance (at no charge) and iStockPhoto.[10] Many imposition packages also include color bars in their imposition templates. Another option supported by industry standards is the Ugra/FOGRA Media Wedge CMYK, which monitors the quality of digital proofs. It also can serve as a digital control aid to monitor the effect of imaging in CMYK mode and other prepress work. The CMYK tonal values of the Ugra/FOGRA Media Wedge are based on ISO standards. The Ugra/FOGRA Media Wedge is available for purchase from FOGRA.

Test Suites
Once you have a calibrated Color Supply Chain, there is another level of testing that can be undertaken for extremely color critical environments. The Altona Test Suite[11] is one example of a test suite that can be used as a technical check for a job that is being printed. For instance, it can determine if a RIP accurately handles complex PDF/X objects such as transparencies and overprints. This test suite was developed in a cooperative effort by the German Printing and Media Industries Federation (bvdm), the European Color Initiative (ECI), EMPA/Ugra of Switzerland and the FOGRA Graphic Technology Research Association. It is frequently updated and designed for offset, digital, gravure and newspaper printing operations in accordance with ISO standards, as well as a variety of printing devices. The Altona Test Suite Kit, which includes reference samples for several output device types, can be purchased online. By comparing the printed output with the reference sample using a spectrophotometer, users can identify and correct color printing and other issues.

The Ghent Workgroup[12] is another group that publishes test suites. GWG is an international assembly of industry associations and experts whose goal is to establish and share process specifications for best practices in graphic arts workflow. The organization's Web site includes a number of specifications, set-up files (application settings), test suites, white papers and other educational materials to support its mission.

These test suites, and others, which may be available from equipment manufacturers, ensure that printed output conforms to ISO and other standards for color-critical work, as well as consistency across the Color Supply Chain.

Color Tolerances: Delta-E
Measuring color on printed output makes sense, but what do you do with the data collected? Also, how do you know when you have a problem? The term Delta-E, is commonly used in discussing color management and answers these questions. Delta-E is a single number or metric that represents the "distance" between two colors. It helps users identify the limits of their workflows and to work within these expectations. Delta-E can help constituents in the Color Supply Chain measure differences between a proof and the final printed product or to monitor whether or not color produced by a specific printing device has drifted. It also can help users determine how effective a particular profile is for printing or proofing. It should be noted that there are a variety of Delta-E types, including DEab, DE94, DE_CMc and DE2000. It is important to be aware of which Delta-E measurement is being utilized in order to make accurate comparisons.

Delta-E should be used as a relative measurement. Acceptable Delta-E will vary widely depending on the printing environment, how color-critical the job is, and other factors. It should be noted that the human eye cannot detect differences in Delta-E below a measurement of approximately 2. In environments such as laser printers, a Delta-E of 6 to 8 is perfectly satisfactory and is the level that is often achievable on laser based devices. Most commercial printers consider a Delta-E range of 2 to 4 acceptable.

The Color Supply Chain: Bringing it All Together

A functional Color Supply Chain includes more moving parts than might be obvious from a high level review. Understanding all of the moving parts and how they work together is critical to achieving great color. Consider a marketing brochure. The creation process begins with the brand owner, who may create some of the content, provide images and often specifies elements of the brochure, including colors to be used. The project may then be handed off to a creative or advertising agency, and ultimately to a print service provider for production. A prepress specialist also may be involved, although this step occurs less frequently since production workflows are becoming increasingly digital and automated. In the digital world, printers are frequently performing their own prepress activities rather than outsourcing these functions to prepress houses.

Each of these constituents is a critical player in the Color Supply Chain. Color errors at any step in the supply chain affect the overall process quality. This is why device calibration to a common standard, regardless of physical location, plays a huge role in color fidelity throughout the production process. For large or distributed runs, the Color Supply Chain may also include a distributed production platform. Print jobs may be reprinted later by the same printer or a different printer, adding to the complexity of maintaining good color throughout the life of the print project. With a well-managed Color Supply Chain, printed pieces should be identical, regardless of when, where or by whom they are printed.

As stated above, the good news is the Color Supply Chain has become increasingly digital, so it has become easier to ensure consistency across all of these diverse aspects. Digital processes are more amenable to consistent process controls. As long as these process controls, such as calibration, proper use of color bars, measurement of printed output against a standard, etc., are conscientiously and consistently applied, good color should be the end result.

04

The Role of the RIP in Good Color

Raster image processers (RIPs) control proofing and printing devices. They have become increasingly sophisticated and play a significant role in the Color Supply Chain because they process files for printing on digital and offset output devices, including proofing and CTP systems as well as digital printing devices. An effective RIP incorporates such things as ICC-compliant color management and profiles and workflow integration to deliver optimum results. It cannot operate as an isolated application with proprietary tools. Rather, RIPs must be industry-standard citizens of the Color Supply Chain, easily integrating with any production environment and facilitating the exchange of color profiles among the various constituencies of the Color Supply Chain, including designers, agencies, prepress operators and print service providers.

Keep in mind that graphics creation packages allow users to create files that can be very difficult to print. Also, many designers have little in-depth knowledge about the printing process and are not aware that their designs create production issues. At a minimum, an effective RIP accommodates these complex constructs, so the final printed product closely matches the design intent. It also widens the range of file types that can be accepted into the production process. In addition, an effective RIP should be able to handle special or spot colors and correctly process overprints and transparencies.

Device Link Profiles
Profiling software also can generate device link profiles. A device link profile saves and stores a series of profiles corresponding to a specific configuration, saving time in file preparation and processing. They are most useful to people who repeatedly use the same specific configuration. Why might device link profiles be required? One example is when a scanner application does not embed the source profile in the document containing the image it creates. Storing the scanner's profile eliminates the need to request the appropriate source profile each time the user wants to print with a configuration involving that scanner. Perhaps a user also may want to see how a scanned image looks when printed using a specific printer, or may want to look at many images captured on the same scanner at different times before printing the final image. Since the same devices are involved each time, the graphics application displays a list of device link profiles that the user had previously created for various configurations, allowing the user to select the appropriate device link profile for the current activity. An effective RIP supports device link profiles.

Spot or special colors
Accurate production of spot or special colors is a key requirement in the Color Supply Chain. In the proofing or digital printing process, spot or special colors often are simulated using a CMYK match, while special inks may be used in the offset printing process. Some RIPs allow spot or special colors to be stored as a separate value so they can be converted to CMYK values for proofing or printing on a digital printing device. This feature allows for better color matching among disparate systems.

Overprinting
Overprint refers to an object that is printed on top of another object. Overprinting is not straightforward. If the printing process is controlled directly from the layout program for each color separation, individual color separations arrive at the RIP containing all the information required for overprinting. The RIP re-assembles the separations into a file and then uses the color management system to perform the appropriate color space conversion. An effective RIP is able to handle all of these operations to deliver an accurate printed sheet.

Transparency
Designers often create complex images in layers that have some level of transparency. When an object is created or a fill applied, these items appear solid by default – that is they have an opacity of 100%. Most graphics programs allow the variation of opacity for each item (or layer) from 100% (completely opaque) to 0% (completely transparent). Decreasing opacity causes the underlying artwork to become visible through the object's surface. The layers created must be "flattened" in order to print properly, and the RIP must understand how to translate transparency and overlapping objects in a way that renders the colors accurately.

Trapping
When an offset printed document uses more than one ink color on the same page, each color must be perfectly aligned with the other colors that it abuts (comes up against), so there is no gap where the different colors meet. It's impossible to ensure exact registration for every object on every paper sheet running through a printing press, so misregistration of colors can occur, causing unintended gaps. Trapping software allows a slight object expansion, so the object overlaps another object of a different color. This feature removes any inks underneath to prevent unwanted color mixing, while compensating for any potential misregistration that might occur during the printing process.

Trapping can be done manually with trapping software or in an automated workflow during the prepress process. A sophisticated RIP can analyze documents and automatically perform the trapping function without the need for a user to manually specify the trapping rules.

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Tips on Producing Great Color

Now that we've discussed the nature of color and the role of various elements in the Color Supply Chain, on the next page are a few key tips and tricks for producing great color.

Tips on Producing Great Color

1. Good color starts by calibrating all of the devices within the Color Supply Chain. Devices should be calibrated at least monthly to ensure that they have not "drifted."

2. A custom ICC profile should be created for each device within the Color Supply Chain. This process ensures accurate and automatic translation of color values from one device to another, minimizing time and waste during the production process. A Device Link Profile can be established to link devices commonly used in the production process, eliminating the need to specify individual device profiles each time.

3. Paper, inks and toner impact the ultimate color result. Creating individual device profiles for each paper type, ink and/or toner used delivers a more consistent result. For example, if a proof is being generated on a glossy, coated stock, but the final product is being produced on a matte uncoated stock, these custom profiles can produce a more consistent result.

4. Calibrating and profiling monitors is an absolute prerequisite to the effective use of soft (electronic) proofing methods. Without proper preparation, monitors can vary widely in the way that they display color. A proof viewed on a monitor that has not been calibrated for consistency with the rest of the Color Supply Chain surely disappoints the end user. Using a calibrated monitor during the design process results in better alignment of designer expectations with the final project outcome.

5. Spot colors can add time and cost to a printed project. Not all spot colors can be faithfully reproduced with CMYK four-color process. Designers and printers should carefully consider the colors that they are using within the context of the project's budget and desired outcomes. Many tools exist that can help users determine whether or not a special color can be faithfully reproduced using a CMYK match. It is often necessary to use spot colors to consistently match special corporate colors and to ensure absolute color consistency across a distributed printing process.

6. Communication among all constituents in the Color Supply Chain is essential. This communication should include sharing of ICC profiles, discussion about paper and ink types and proofing models, and more. In doing so, good, consistent color can be produced across widely varying geographies and output technology types.

7. Using a good RIP in the production process is a critical element in the Color Supply Chain. It alleviates many color issues and reduces training challenges. Consistency in settings within the RIP is key to delivering repeatable and known color.

8. It is important to incorporate the appropriate color measurement tools to ensure accurate communication among all constituents of the Color Supply Chain.

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EFI Color Solutions, Services and Support

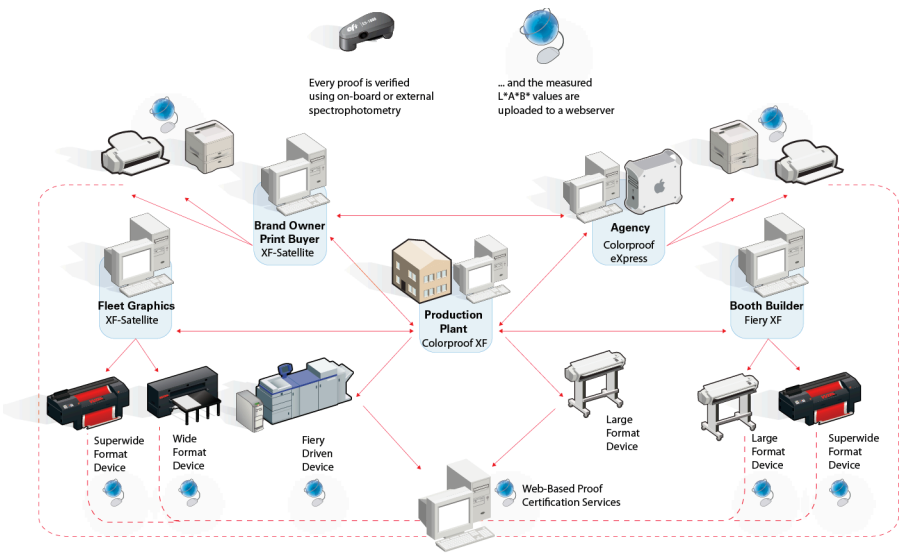
EFI is unique in providing solutions, services and support that touch all aspects of the Color Supply Chain. This one-stop-shop approach ensures consistent, accurate color, every time, anywhere in the world, as shown in the figure on the next page. It also ensures real-time help and a high return on investment.

EFI Color Solutions

Fiery Production and Graphic Arts Solutions
Fiery® Production and Graphic Arts solutions deliver power, performance, and speed to high-end print environments. The products offer unmatched color output, extensive variable data printing support, and superior workflow management. Fiery Production and Graphic Arts solutions cater to mission-critical environments such as high-end graphic arts operations, design firms, commercial printers, and prepress businesses. EFI solutions that are specific to the Color Supply Chain include:

- EFI Fiery ColorWise® is the color management system that provides accurate color across platforms, applications and all media types. ColorWise offers the beginning user great out-of-the-box color, while providing expert users with maximum control over color quality using a suite of advanced and precise tools.
- With Spot-On, users can create accurate color matching for corporate and other spot colors in an automatic, application-independent workflow. Spot-On enables the management of named colors on the Fiery controller, including all PANTONE, HKS, Toyo, and DIC names, in PostScript or PDF documents. In addition to managing "named" colors, Spot-On also creates a list of "substitute" colors. When these colors are specified in a document by their RGB or CMYK values, Spot-On substitutes a different color, or substitute color, from the Spot-On color dictionary that has the CMYK values.
- Fiery's Auto-Trapping feature produces professional-level results without extensive knowledge of trapping rules. It automatically corrects misregistration of Fiery-driven printers for composite or separated documents.
- Fiery servers and controllers include support for ICC profiles.

The Color Supply Chain Synchronized



- EFI's Device Link Profile Support gives advanced users full control over their color conversions between a color space and the Fiery-driven printer. It allows users to dictate the exact color transformation and subsequent output quality that they would like to generate.
- Composite Overprint of CMYK and Spot Colors allows the use of a PDF workflow for documents that include overprint and transparencies. Without support for a PDF workflow, designers are forced to send jobs as native files (i.e., Adobe® InDesign or QuarkXPress) with color separations ON. In a world that is migrating to a PDF workflow, this "workaround" is inconvenient and consumes time and resources at the RIP.
- Fiery is one of the few color servers in the industry that passes the Altona Test Suite, achieves Altona/Ghent Compliance, offers Media Wedge Control Strip Support and supports PDF/X Output Intent.

EFI Fiery XF
For businesses with special printing needs, EFI Fiery XF, a production RIP, provides aqueous, solvent, eco-solvent and UV printers with a way to increase their productivity while still producing high-quality colors that bring their images to life. Powered by Bestcolor® Technology and based on Colorproof™ XF, its fast RIP speed also achieves the best performance in all major printers including: EFI's VUTEk®, HP, Epson, Canon, Mimaki, Mutoh and Roland. Its three configurations and automated workflow allow companies to handle high volume production with tight turnaround schedules, regardless of employee skill levels.

EFI MicroPress
MicroPress is a fast, high-performance raster-based digital document production system for mid-to-high-volume print-on-demand environments that produce complex, short-run, color and black and white documents. The solution provides an intuitive interface, industry-leading architecture, late stage editing tools, workflow automation and other productivity boosting features.

EFI Fiery Central
Fiery Central is a powerful, modular PDF-based production workflow solution for medium to high-volume print-on-demand environments that want to increase their job volume, decrease turnaround times and maximize their equipment investment. The solution comes in three modular components: Fiery Central Focus, Fiery Central Flow and Fiery Central Balance for functions such as job splitting and load balancing to increase production and other features for advanced prepress capabilities.

Fiery Color Profiler Suite
Fiery Color Profiler Suite offers the best profiling solution for any printing environment and is especially suited for printers driven by EFI servers. Its integrated color management tools ensure total color quality control in the color printing workflow. The flexible suite is based on EFI's market-leading color management solutions used by the most demanding color professionals. Its capabilities include:

- Printer Profile Creation.
- Monitor Profile Creation.
- Device Link Profile Creation.
- Profile Inspection.
- Profile Editing.
- Color Verification.

Since these tools reside in a single, integrated color management suite, they eliminate the need to change measurement devices or to open different software packages, ensuring compatibility among applications. The solution also allows customization of printer presets, streamlining operations through the Suite's seamless integration with EFI servers. A demonstration of Color Profiler Suite can be downloaded by visiting http://www.efi.com/products/production/fiery/measurement/color-profiler-suite/demos.asp.

EFI ES-1000 Spectrophotometer
Achieving predictable color every time is a major challenge for any business. The ES-1000 spectrophotometer, a handheld measurement device, solves this dilemma by providing fast, precise and flexible color management. It also produces the highest color quality, saving businesses precious time and money. In addition, the device measures and generates precise values for spot colors for tricky items such as brand logos and letterhead by capturing colors from a physical swatch and including them in the server's spot color library. This process enables fast, easy reproduction of special colors.

EFI Colorproof XF
EFI Colorproof™ XF delivers a versatile solution for proofing, large-format production and photographic printing that combines the latest color technology with industry-standard off-the-shelf hardware. It offers fast, flexible workflow, power, expandability and affordability. The basic package starts with the EFI™ Colorproof XF Server, an unlimited number of Client Options and Printer Option M. By adding extra output and product options, the solution meets growing businesses needs. EFI Colorproof XF caters to digital, commercial and hybrid printers, prepress providers, publishers, creative agencies and photographers.

EFI Colorproof eXpress
The entry-level Proofing to Go™ solution, EFI Colorproof eXpress, is perfect for small businesses with limited budgets and inexperienced operators looking for a fast, easy and effective out-of-the-box solution for validation printing and contract proofing on inkjet, laser and LED printers. Colorproof eXpress supports open market standards, easily integrating into standards-based workflows. EFI Colorproof eXpress manages color based on universally accepted ICC profiles, enabling users to build in color-controlled proofing throughout the prepress and printing process.

XFlow Option for EFI Fiery XF and EFI Colorproof XF
EFI XFlow, an option for Fiery XF and Colorproof XF, helps businesses effectively manage different file formats and job quality levels. It provides a powerful make-ready tool that prepares jobs for printing quickly, easily and accurately, regardless of their format and quality. It also enables print service providers to profit from achieving consistent results automatically with new and repeated jobs. XFlow caters to large and superwide format printers and other digital printing operations. XFlow provides superior color management, guaranteeing accurate color on every print regardless of the complexity involved.

EFI Services

To ensure the highest levels of customer satisfaction, EFI offers educational, professional and proofing services to address companies' special needs and to educate businesses on how to get the most from their EFI hardware and software investments. Below is a brief description of these services.

EFI Educational Services provide worldwide training to our OEM partners and channel to empower the people who use, sell and support our printing technology. For instance, EFI's How-To Site located at http://www.efi.com/support/production/fiery/production/how-to/ offers a wealth of tools on maximizing the Fiery and the many color features described in this guide. EFI Professional Services offer standard and customized courses on deploying and operating EFI technology. These services include optimization, implementation, customization and reporting classes for EFI Print Management solutions.

EFI Proofing Services include the EFI Color Academy's classes, which show businesses how to effectively use and integrate EFI products into their environments using Bestcolor® Technology. It also includes the EFI-fogra·cert, a certification that ensures that specialist dealers and consultants can set up standardized systems using EFI Colorproof™ XF to produce fogra·cert compliant proofs. The services also include the EFI Bestcolor Knowledge Center, a free resource with tips for testing, developing, distributing and supporting EFI's products using Bestcolor Technology. The Knowledge Center is located at http://www.efi.com/services/proofing-services/knowledge-center.asp.

EFI Technical Support

Another key element in ensuring customer satisfaction is the ability to get help quickly. EFI offers a wide range of technical support plans for resellers, distributors and end users, including phone and online support as well as on-site technicians. EFI also provides software maintenance contracts and support service contracts, allowing businesses to automatically receive new updates quickly and easily. In addition, EFI provides online information on system requirements, security, supported printers and downloadable links to ensure protection of our customers' most valuable assets.

Glossary

Additive Color
An additive color model involves light emitted directly from a source or illuminant of some sort. The additive reproduction process usually uses red, green and blue (RGB) light to produce the other colors. Computer monitors and televisions are the most common application of additive color.

Brightness
The dimension of a color that can range from very dim (dark) to very bright (dazzling).

Calibration
It means to check, adjust, or systematically standardize a device's performance.

CIE
The organization offers the ultimate word on color definition.

CMYK
This term means a subtractive color model that includes cyan, magenta, yellow and black (K).

Color Bar
It contains small patches of solid color and color gradations. The color bar is printed outside the image area in the trim area to allow for easy in-line or offline measurement of color on the printed sheet.

Color Gamut
The term is the subset of colors which can be accurately represented in a given circumstance, such as within a given color space or by a certain output device.

Color Management
It is the communication of the associated data required for unambiguous interpretation of color content data, and application of color data conversions as required to produce the intended reproductions.

Color Management Module
A color management module (CMM) does color conversation. It is embedded in graphic arts applications, software, operating system and hardware driver. It uses the profiles to convert and match colors in a given color space on a given device to or from another color space or device.

Color Supply Chain
The term is the end-to-end process of producing good color from design through production.

Colorimeter
Colorimeters are devices that can identify or characterize colors by measuring relative light frequencies.

CTP
This term means computer to plate. It is the generation of a printing plate directly from a digital file, eliminating the need to use film in the plate production process

Delta-E
It is a single number that represents the difference between two colors. A Delta-E of less than two should be indistinguishable to the human eye.

Densitometer
A densitometer is used to measure the relative degree of darkness within selected materials by measuring light reflected from a surface, such as a printed sheet.

Device Link Profile
This term means saving and storing a series of profiles that correspond to a specific configuration.

Ghent Workgroup
The international group consists of an assembly of industry associations and experts whose goal is to establish and share process specifications for best practices in graphic arts workflow.

GRACoL
It is a set of tools and standards for sheetfed and web offset developed by IDEAlliance.

Hue
The term is a particular gradation of color such as a shade or tint.

ICC
This group is the official arbiter of color standards for output devices used in the graphic arts industry.

ICC Profile
ICC profiles are based on scientific standards developed by CIE that define the parameters used to describe all visible colors. An ICC profile provides a cross-platform device profile format that ensures consistent, device-independent color throughout the entire production process.

ISO
This group is the world's largest developer and publisher of international standards.

Pantone Color
It is a custom or spot color as defined by the Pantone Measurement System.

Profile Connection Space
PCS is either CIELAB (L*a*b*) or CIEXYZ.

RGB
RGB is an additive color model that uses red, green and blue.

RIP
The term, Raster image processers (RIP), stands for the hardware and software that converts a file into a raster format for printing. Saturation The term refers to the vividness of hue or color purity.

SNAP
The standard is for newspaper printing using SWOP ink sets.
Spectrophotometer This device measures light intensity by light wavelength and thus color.

Spot Color
It is a custom or special color that can be printed using specially mixed ink or simulated with the four-color process.

Subtractive Color
This model is used in mixing paints, dyes, inks, and natural colorants to create a range of colors, where each such color is created by the mixture absorbing some wavelengths of light and reflecting others.

SWOP
This North American standard is largely used in the production of newspaper and magazine advertising to ensure color consistency for ads, regardless of where they are printed.

Additional Resources

For more in-depth information about color, the following resources are suggested.

Books

Billmeyer and Saltzman's Principles of Color Technology, 3rd Edition (Hardcover), by Roy S. Berns

Measuring Colour. Second Edition, Hunt, R.W.G. 1991

Online Links

Fiery Color and Imaging Forum: http://fieryforums.efi.com/

Fiery Color Profiler Suite Forum: http://proofingforums.efi.com

X-Rite: The Color Guide and Glossary, Free Online Guide: http://www.xrite.com/documents/literature/en/L11-029_color_guide_en.pdf

Why Color Management, Adobe Online Reference: http://www.color.org/whycolormanagement.pdf

IdeaAlliance and the IPA have collaborated to provide a wide range of online resources and educational materials at http://www.printtools.org/bridgs/.

IPA offers a Color Management Professional Certification Program. Details can be found at http://www.ipa.org/knowledge/cmp.

The ABC's of Proofing at http://www.efi.com

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650-357-3500
www.efi.com