# Offset printing v2.0

On completion of this module, you will have an introductory understanding of:

**Offset printing and how standards are applied to offset printing to obtain reliable quality printing; and**

**Where Konica Minolta printers are used in the production workflow of offset printing, as proofing machines.**

# Module training overview

Target audience will be:

Any technician who completed "Basic Color 2" module at Professional level, or technicians who will service Konica Minolta customers in the commercial offset printing market. This module helps to develop an understanding of color printing workflow processes within the commercial printing industry.

Attainment Targets:

- To gain a basic knowledge of offset printing
- To understand terminology used in commercial offset printing
- To understand how reliable quality is achieved in offset printing
- To understand how quality is controlled in offset printing by the use of standards and profiles
- To understand how the standards and profiles have to be applied in proofing
- To understand where Konica Minolta printers fit in the production work-flow for proofing devices in offset printing.

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# 1 Outline

## 1.1 Purpose of this study

### 1.1.1 What is offset printing?

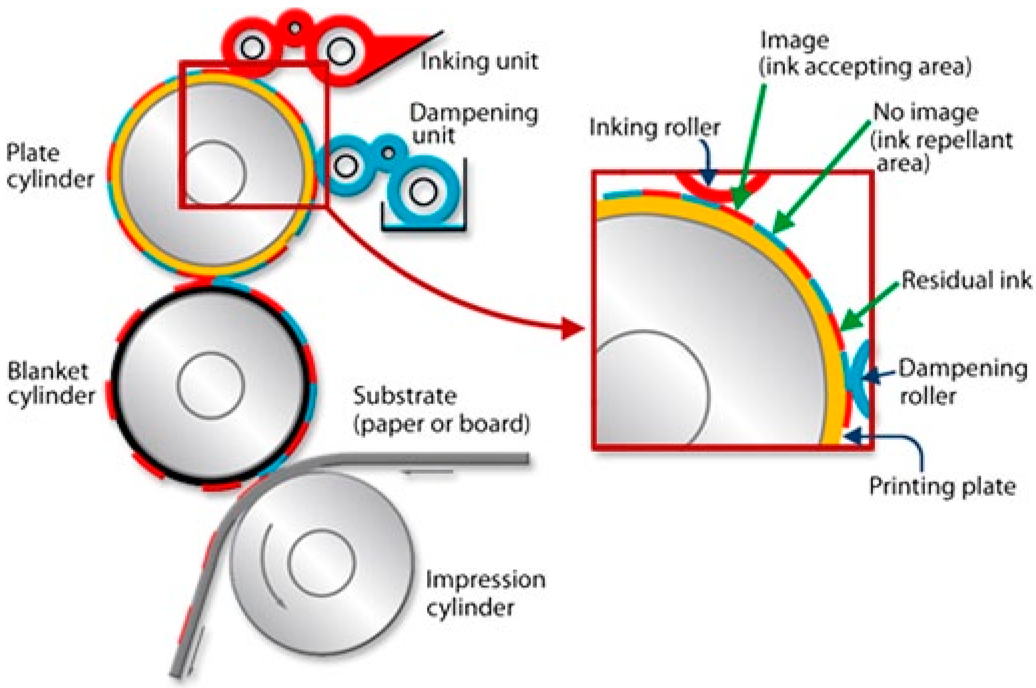
The proper name for the process of offset printing is *offset lithography*, though it is usually called *offset printing*; or just *offset*.

Offset printing is the method most widely used for commercial printing, with runs of about 1,000 to 100,000. Typically, the speed of printing is much faster than office copiers, and high quality can be achieved. Examples of offset printings include: catalogues, brochures, books, magazines, newspapers, maps, cards, and stationery.

Usually, artwork files that are prepared on a computer are used to produce printing plates. The plates are fitted to an offset printing press where ink is applied to the image on the plate. As the press rotates, the ink *offsets* to a rubber blanket on another cylinder. The ink is again *offset* from the blanket to paper or other material.

Offset printing works because oil and water repel each other. Ink is oily, and sticks to the images on the printing plate. The ink doesn’t stick to the non-printing areas of the plate, because they hold water that is applied by the press.

Offset printing accounts for about 60% of the printing market. Other printing processes include: digital printing, gravure, letterpress, flexographic, intaglio, and silk screening.



A diagrammatic layout of the main printing parts of a rotary offset printing press. The substrate (the paper or board) may be fed in individual sheets, or in a continuous sheet (web) from a roll. A web is cut and/or folded as the substrate leaves the press.

### 1.1.2 Where do Konica Minolta products fit?

There is a well-defined workflow before printing begins on an offset press. Before printing plates are made, the artwork computer files are *proofed* (checked). These proofs are produced on *proofers* and checked visually for accuracy.

Ideally, proofs should be produced on the offset press. However this is impractical because of time and cost. So, the final offset printing result is simulated in the proof.

Konica Minolta products are used in commercial printing as layout proofers for a large range of work. It is important that technicians understand offset printing method to be able to set and adjust color at a customer's site. There are limitations to all proofers (*see* **1.1.3 Limitations of proofers**).

There are usually three types of proofs.

- **Layout proofs** are used to check that copy and images are correct, and that colors are accurately applied in the correct places. Spelling and other checks are also made at this time. The machine used for these proofs is called a *layout proofer*.

  More than one layout proof may be required before the final OK is given for offset printing to start.

- **Validation print** which is the color reference proof at the design stage, and reflects a high quality validation of the proposed job content. It refers to ISO 12647-8. Konica Minolta bizhub PRO C6501 has been certified as a 'Validation printing system' (Details: http://fogracert.fogra.org). The Validation printer may also be referred to as a layout proofer.

  More than one Validation print may be required before the final OK is given for offset printing to start.

- **Contract proofs** are the final proofs. They form the basis of the printing contract, and the model from which the printer visually monitors work as it comes off the offset press.

### 1.1.3 Limitations of proofers

All printing machines use some form of ink (or toner) to apply color. The range of colors that can be reproduced by various printing machines is called the gamut. The gamut may vary according to the type of inks or stock used, (*see* the illustration in **3.1.6 Characterizing**). The gamut of all ink systems is always smaller than the range of colors visible in nature.

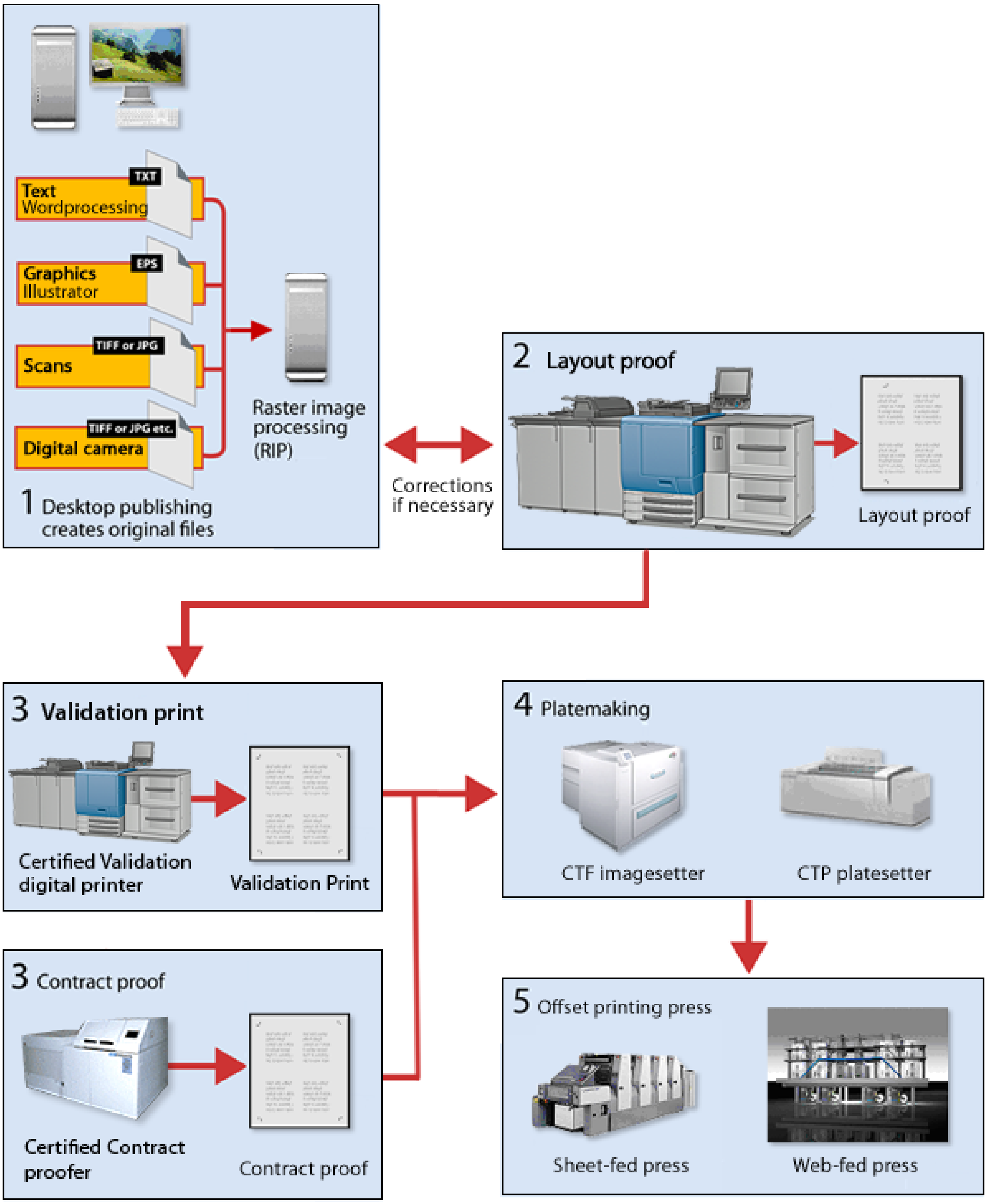
The gamut of toner is generally smaller than the inks used on an offset press. For this reason, caution must be exercised in assessing colors that are displayed on proofs, especially where high color-fidelity is required in the final offset printed work.

### 1.1.4 Why understand offset printing?

A proofer machine is not an offset press and can't reach the standards achievable by an offset press. A proofer can only *simulate* the final output from the offset press. It is therefore important to understand the offset process, and to understand the advantages and shortcomings of proofing devices.

# 2 Offset printing: Basics

## 2.1 Workflow for offset printing




There are five basic steps in the workflow for offset printing: desktop publishing, layout proofing, contract proofing, platemaking, and printing.

Workflow in offset printing starts with desktop publishing, where the copy and images for the design are created. The middle steps are necessary for proofing the design and to check on color accuracy. Proofing is important because the final steps of platemaking and printing are costly. In large operations, the workflow is managed by proprietary digital systems that use a *job ticket* carrying processing instructions.

## 2.2 Platemaking

There are two common methods that are used to produce offset printing plates.

### 2.2.1 Computer to film (CTF)

In the CTF process, a photographic film is exposed in an *image setter*. The image is supplied electronically from the original artwork files that have been processed by a computer program that is called a raster image processor (referred as a *RIP)*.

Light-sensitive plates are then exposed to light through the film. Plates sensitive to ultra-violet light can be handled in daylight and don't require a darkroom.

CTF has a higher initial cost than CTP. The advantage of CTF is that film can be kept for additional runs (providing no significant changes are required). Film which is kept for future use is called *standing film*.

A small picture of a CTF image setter is in the workflow diagram in section **2.1 Workflow for offset printing**.

### 2.2.2 Computer to plate (CTP)

In the CTP process, digital data is transferred from a computer directly onto printing plates without the use of intermediary film. These plates can be either light-sensitive or heat-sensitive (thermal). Thermal plates are gaining popularity because they don't require a darkroom.

CTP has become more popular and is being widely used. It has a lower initial cost than CTF and is faster. The results tend to be sharper. Plates that are made by this process are not always stored for additional runs.

A small picture of a CTP plate setter is in the workflow diagram in section **2.1 Workflow for offset printing**.

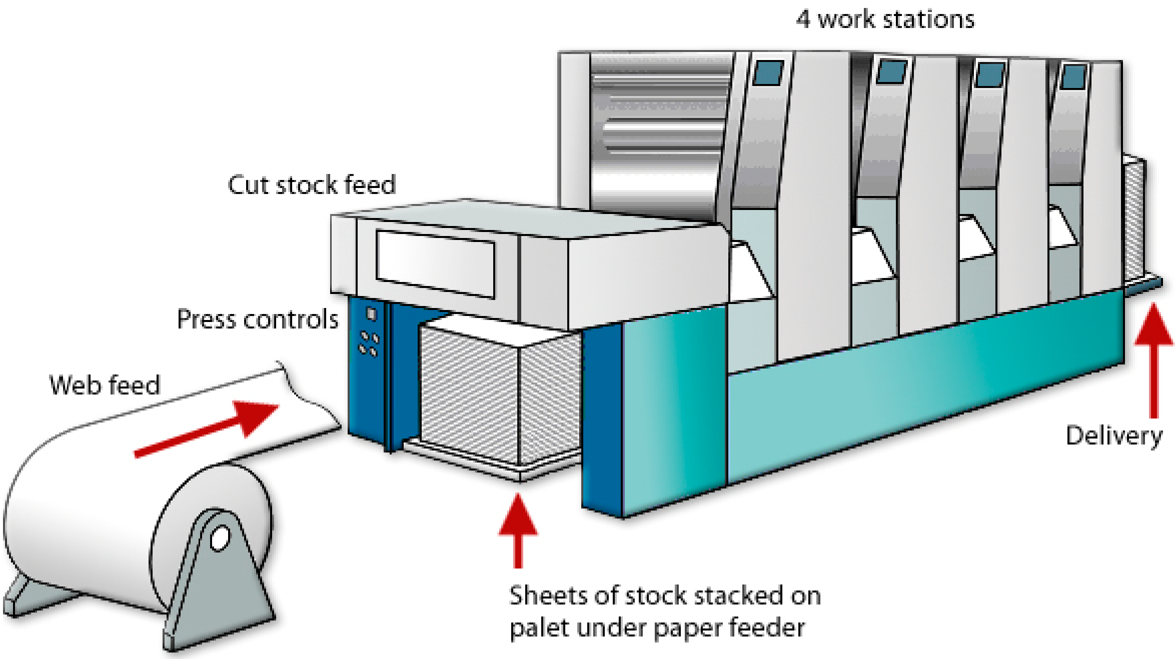
## 2.3 Offset printing presses

Offset presses use a *rotary* method, which rely on thin printing plates affixed to cylinders rather than being fitted to a flat bed.  Some offset presses can print on two sides of the stock at once (called *perfecting*). Sequential numbers can be printed on forms like in receipt books, and perforating can also done on-press. Other processes that are done on separate machines include: folding, stitching, trimming, die cutting, and bookbinding.

Stock is fed to offset presses either as cut sheets, or from a roll of paper (called a *web*). A web is cut or folded as the substrate leaves the press.

Presses have a number of parts:

- stock feed – either sheet feed, or web feed.
- *work-stations* (also called a *head)*. The head contains the cylinders, the dampening unit (also called water fountain), and the inking unit. A station prints only one color, so a four-color job is run on a press that has at least four stations. Presses are built with one or two stations, or as many as 12.
- stock delivery that includes a guillotine or a folder on a web-fed press.
- Controls.



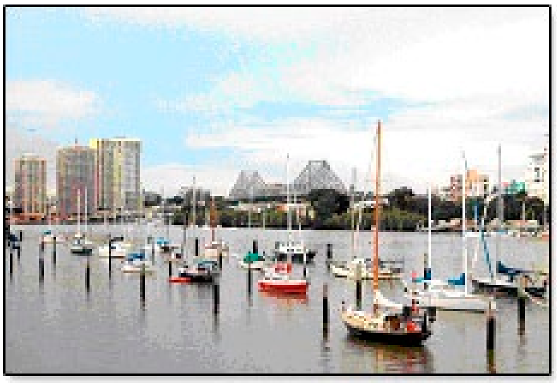

A FOUR-COLOR OFFSET PRESS. A sheet-fed press is fed from a stack of cut sheets. A web-fed press is fed from rolls.

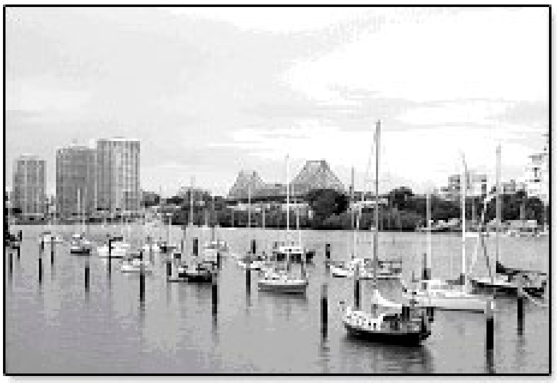
## 2.4 Some image terms

To help better understand some of the information that appears later, you need to have a brief understanding of a few terms used in printing.

### 2.4.1 Continuous tone art (photographs)

In an original photograph (black and white or color), you see shades of black, gray and color that blend together smoothly. This is called *continuous tone art* (or *contones* for short).





Continuous tone photographs can be prints, transparencies, or negatives; color or black and white.

Photographs usually originate from a digital camera. However, photographs that come from film cameras will need the film scanned to become digital images. Traditionally, a drum scanner was used with transparency film, however it is common for a flatbed scanner to be used for both transparencies and reflective originals.

Good results can be obtained from inexpensive scanners, which usually output in the RGB color-space. More expensive scanners can output in RGB or CMYK color-spaces.

Color images scanned in the RGB mode will need to be converted to CMYK for the printing process. Red, Green and Blue (RGB) colors are displayed on computer monitors, where Cyan, Magenta, Yellow and Black (CMYK) are used as color printing inks (*see* **2.4.6 Process color**).

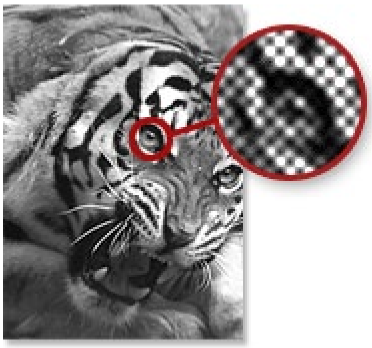
Conversion of RGB images to CMYK images can be done in two ways:

- image processing software like Adobe Photoshop; or
- RIP software (refer to *Color printing workflow for DTP*).

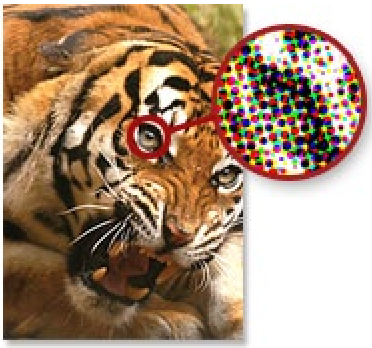
### 2.4.2 Halftone screens

Photographic reproduction requires an image to be broken into a series of dots of various size and color – black (for black and white photographs), or *process colors* (*see* **2.4.6 Process color**). This reproduction is called a halftone. The dots are not seen on a computer monitor.

Small dots produce light tonal areas, and large dots create darker areas. Instead of a regular pattern of dots of different sizes, there is also a process called stochastic screening which uses a random placement of same-sized pixels.



Halftone screen
black and white



Halftone screen
color

Magnification of ink
dots called rosettes

Two halftones: color and black and white. The enlarged circles show screened dots. On the color circle the pattern of dots is arranged in a rosette.

### 2.4.3 Screen frequency

The word screen, in this section, does not refer to a computer monitor.  The traditional process of creating a halftone involved laying a piece of clear film (on which were opaque dots) over a photograph. The image was captured on light sensitive film which generated a second photographic image. This image appeared to have a continuous tone when viewed from a reading distance, but under magnification could be seen the screened image. The density of the screen was measured in lines per inch (lpi). These terms still exist in the digital world.

The number of rows or lines of dots in a halftone image determines the quality of reproduction. The screen frequency (also called *screen ruling*) is the number of halftone dots in a linear inch or centimeter. This is expressed as lpi (lines per inch) or lpc (lines per centimeter). The higher the screen frequency, the more detail the printed picture will have. Typical line frequencies are in the table below.

## Resolutions

It would be nice to print everything at the highest resolution possible. However computer files become larger as the resolution increases, so the time and cost may increase using high resolution. The resolution should be high enough to achieve the required final quality that is wanted.

Be aware there are various measures of resolution that often may sound confusing.

**DPI (dots per inch)** is used for printers (more dots gives higher resolution).

| Printer | Typical dpi |
|---|---|
| Office laser printers | 600 |
| Inkjet printers | Up to 6,000 |
| Offset CTF image setter | 1,200 to 4,800 |

**PPI (pixels per inch)** is used for computer monitors, scanned images, and *raster* outputs from software like Adobe Photoshop (more pixels gives higher resolution).

| Printer | ppi |
|---|---|
| Website pictures | 72 |
| Halftones for offset printing | 300 or 350 |

It is common rule of thumb to use a PPI value twice the value of LPI.

**LPI (lines per inch)** is used for screen frequency (more lines gives higher resolution).

| Publication type | Screen frequency lpi |
|---|---|
| Newspapers and newsletters | 90 to 100 |
| Brochures and magazines | 133 to 175 |
| Fine art books and magazines | 150-200 |

## 2.4.4 Line art

Line art refers to page objects that a constructed from vectors that describe paths. These paths may be open ended such as a simple line or closed such as a circle. The described path can be painted a particular color in a given thickness or have no color. In the case of a closed path it can either be transparent or be filled with a color, gradient or pattern.

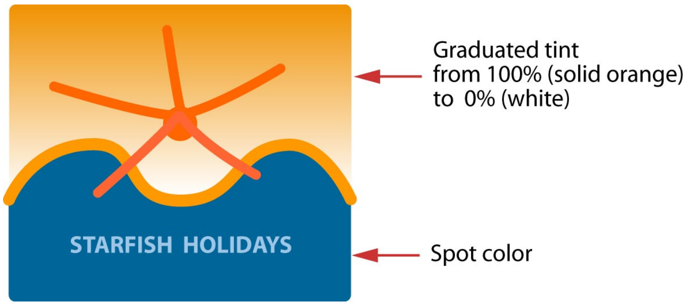
Type is classified as line art.

## 2.4.5 Spot colors and tints

Spot colors are printed with premixed inks, and are used for achieving precise color. The colors can be specified accurately, which is desirable for work that requires exact matching (for example, company logos).

The range of colors available is limited to the number of workstations available (up to about eight), however each additional color incurs a cost to the job.

A tint is a lightened spot color expressed in percentages: 10% tint is faint, and 100% is no tint at all.



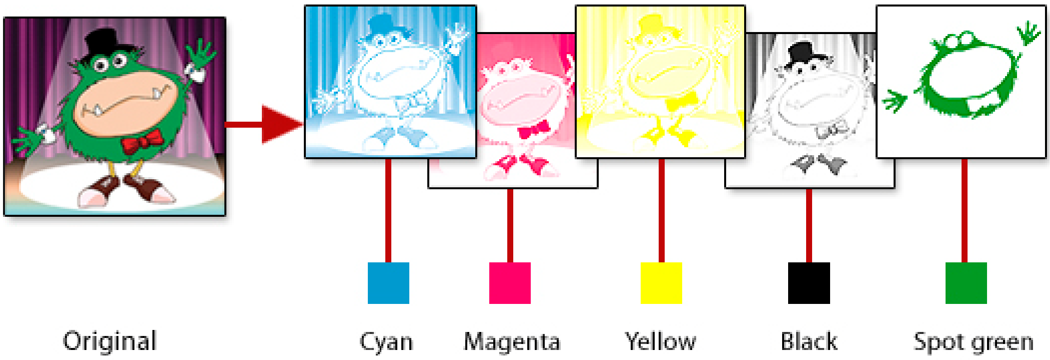

Spot colors and tints applied to line art.

## 2.4.6 Process color

Process color is printed with translucent inks: cyan, magenta, and yellow; and is known as *four-color process printing*.

If cyan, magenta and yellow were applied together in the one spot, they could theoretically create black. However, in practice this black lacks density. Thus, color halftone printing uses four ink colors – the three process colors plus black. Using this method, the eye can be tricked into seeing millions of colors. The letters CMYK stand for the four colors: cyan, magenta, yellow, and black.

Process color can be used to simulate spot colors.




Breakdown of original into four process colors, plus a green spot color.

### 2.4.7 Separations

To print halftone color on a printing press, the color images are separated (electronically or photographically) into the four process colors of CMYK. A separate printing plate is made from each of these separations.

If a spot color is to be printed, an additional plate is made for each spot color.


Five separation films: spot color brown, and four process colors CMYK.

## 2.5 Materials

### 2.5.1 Inks

Inks used in offset printing are specifically made for that process. It has a consistency like thick margarine, and the colors appear dense. Characteristics include: body (degree of softness), length (ability to flow), tack (stickiness), and drying.

Inks dry in a number of ways such as: absorption, oxidation, polymerization, evaporation of solvent and heat setting.

Offset inks may be either opaque or translucent. There may be varnishes and glues which are run on the press but are not actually ink.

**Process colors (CMYK)** These are the four process inks that are used for reproduction of full-color photographs. They are translucent and discussed in **2.4.6 Process color**.

**Premixed (spot) colors** are translucent (except for the metallic and fluorescent inks). Spot Colors are any color that is produced using a single ink/plate. When used in offset printing the term spot color refers to any color generated by a non-standard offset ink; such as metallic, fluorescent, spot varnish, or custom hand-mixed inks. A spot color ink is pre-mixed from a base of primary colors using a formula, like a cooking recipe.

Spot colors are standardized through a number of color specification systems. Each system will have a small set of primary colors which can be mixed to create 1000's of different colors. A well-known system is the Pantone Matching System which uses 13 base colors plus black and white inks that when mixed in the ratios given by Pantone produce up to 1114 universally defined colors. The printed colors can differ depending on the paper stock used so that color specification includes suffixes to describe if it is an uncoated or coated stock e.g. Pantone 485 C or Pantone 485 U. (*see* **2.4.5 Spot colors and tints**).

The CMYK four-color process can simulate spot colors.

**Varnish and glue** Clear varnish and glue can also be printed, even though they are not strictly inks. Varnish is used on limp covers of books to protect them from scuffing, and to add brilliance.

### 2.5.2 Substrates (Stock)

Offset printing is usually done on paper or light cardboard, though other materials can be printed. The generic term that covers all these materials is *substrate*, though the word *stock* is more commonly used. Here we will only refer to paper and board, using the simple term *stock* to cover both. Stock is a big subject, so we will only outline it sufficient for purposes of this module.

There are numerous types, qualities and brands of stock. Most are white because the halftone process relies on white stock for accurate color reproduction. Colored stocks are mostly used for stationary or presentation reports. Broadly there are coated and uncoated stocks. Some of the types are as follows.

**Coated stock** can reproduce much finer detail in photographs, and sharper definition; and the feel of coated stock can give an impression of quality. The coating is often white clay, and it may be applied to one or both sides of the paper. Some surface finishes are: gloss, dull, matt, and castcoat. Paper weights are typically 80 gsm to 200 gsm. Boards can be as much as 400 gsm.

**Uncoated stocks** have a rougher and dull surface compared with coated stocks. Types are:

**Bond stock** is commonly used in office copiers, but can be used in offset printing for forms and letters. Stock weights may be 60 gsm to 100 gsm.

**Offset stocks** are commonly used for forms, booklets and other jobs that might not be of a high presentation standard. They generally have higher moisture content than copier (or digital) style stocks. This higher moisture content can make them unsuitable for toner/fuser based systems. Stock weights of 80gsm to 150gsm

**Book stocks** are intended for trade and textbooks.

**Index and system boards** are a light to heavy board, often in pastel colors, that is used for index cards.

**Stationery:** There is a wide range of specialty papers that are used for letterhead, envelopes and special presentations. Some surface finishes are smooth, laid, wove, linen, and embossed.

**Newsprint:** as the name implies, is used for newspapers. The traditional rough-surfaced paper is now replaced with better quality stock.

**Other specialty stocks** include labels, ledger paper, and bible paper.

**Stock weights** are expressed in grams per square meter (gsm). Office copiers usually use 80 gsm. Most general offset stocks are 90 gsm to 200 gsm. Limp book covers (board) may be 200 gsm to 400 gsm.

**Stock color** is a key factor in the printed outcome. There are many different white stocks. Whiteness depends on the ability of a stock to reflect all colors that make up white light. The whiteness of a stock and the color of the light that is used to view it, influence the matching of printed colors.

**Ink trapping** is the way ink sticks to a particular stock, especially to how the second or successive layers of ink stick to previous layer(s). Stock with good ink trapping is where the same amount of ink transfers to previously printed ink. It has no relation to the term image trapping (see **2.6.3 Image trapping**).

## 2.6 Controlling print quality

There are many factors that significantly influence the quality of a printed job, especially the sharpness and color-accuracy. Controls exist to ensure quality when plates are made, and when the press is run. Monitoring at the proofing stage is important.

Dot-gain and solid-density are factors that specifically apply to four-color process printing.

### 2.6.1 Dot-gain

Images which have varying tone or shades are referred to as having *continuous tone* (or contones). These may be printed in one color – usually black (referred to as grayscale), or multiple colors. Contones are simulated in printing by separating the images into *halftones* – tiny dots of process ink (*see* **2.5.1 Inks**).

Dot-gain is the unwanted result of halftone dots growing in size from the ink spreading around the dots. Factors contributing to dot-gain include:

- faults in platemaking, especially if film is wrongly exposed;
- ink absorbing into, or spreading onto, the stock;
- faults on the printing press, especially when rosettes are not properly aligned.

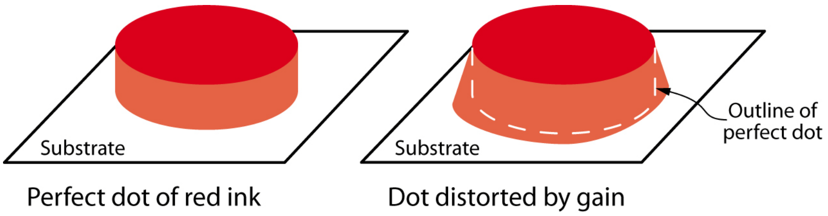
Dot-gain can be monitored at the proofing stage. To do this, the halftone dots must be made visible with a loupe (magnifier). Coated stocks suffer less from dot-gain than uncoated stocks, by absorbing less ink.

Inkjet printers reproduce dots differently from an offset press. Settings to control dot-gain on an inkjet printer may need different settings.

Dot-gain is controlled by:

- dots are made smaller at platemaking to allow for the expected gain;

- careful running of the printing press where ink density and pressures of the rollers are adjusted.




Highly exaggerated view of a dot to demonstrate dot-gain. Dot-gain is the unwanted result of halftone dots growing in area, either on the plate or on the stock. Dot-gain is an important item for quality control.

### 2.6.2 Solid-density

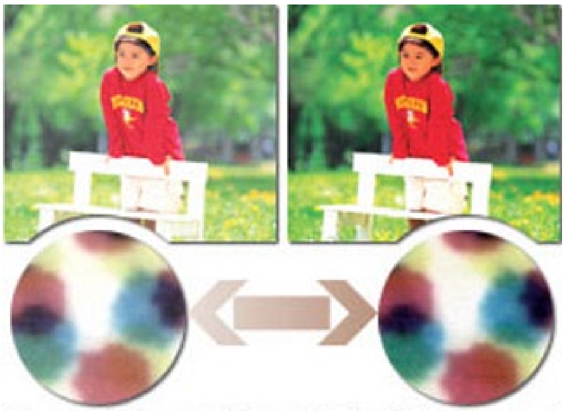
The density of ink applied in halftone printing will affect the color, sharpness and visual crispness of the final printed image. It is an important factor in print quality.

Ink reflects more of its color when it is applied with more density. Solid density is the thickness of ink measured on color patches printed along the edge of the job (see **3.1.2 Managing solid ink-density**).

National printing standards set the solid-density for colors and their tolerances.

CTP plates have less dot-gain than CTF plates because there is no film in the middle of the process. The small increase in sharpness can result in less solid-density, which needs to be monitored at the proofing stage before the job is printed.

Solid-density is controlled by the amount of ink which is applied to the stock on the printing press.



The left picture lacks density in the reproduction of the dots. In the right picture the colors are richer, especially skin-tone of the child and the red shirt. Note the density of the dots in the enlarged circles. Solid-density is an important factor for quality control.

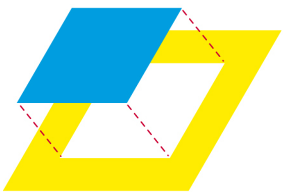
### 2.6.3 Image trapping

Image trapping has no relation to the term ink trapping which refers to a feature of paper (see 2.5.2 Substrates (Stock)).

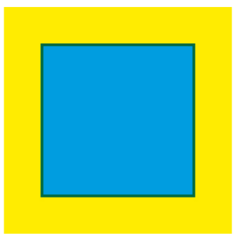
When solid colors overlap or lay beside CMYK images, there can be two problems:

- color distortion caused by two (or more) inks mixing to produce a different and unwanted color;
- unwanted build-up of ink.

To reduce the problems, the first part of trapping is to **knockout** (not print) some color. Which color to knockout depends on which color needs to overlap the other, and the order in which the inks are to be printed (the first ink always prints easier and usually looks better than other colors).



1
Knockout: where the yellow background is not printed



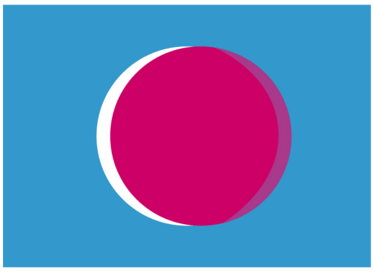
2
Printed image: where the slight border of overlap (darker color) is the trap

Trapping first involves knocking-out (not printing) some of the color. The knockout has to print under or over the background depending on the colors.

**Image trapping** fixes some problems, but introduces others. Different colors are printed by separate printing plates, which are fitted to different workstations on the press. When a sheet of stock enters a workstation to receive a color, the stock needs to be registered (aligned) accurately or the colors become misaligned. This may cause the image to become less sharp.

The second part of trapping compensates for potential gaps between colors on the printed work. This is achieved by creating a small amount of overlap (called a trap) between adjoining colors. There are two types of trap: spreads and chokes.

Traps are created at the desktop publishing stage. This is where most control can be exercised – though good registration is still required on the press.



Spot colors misregistered
Visible gap and overlap
between adjacent objects

Process colors misregistered
Visible gaps and color shifts

COLOR MISREGISTRATION AND DISTORTION For quality printing, trapping compensates for errors that must be prevented, and checked, before making the plates. Trapping is an important item for quality control. In the left-hand diagram, notice the tiny purple crescent that occurs where the red ink overlaps the blue.

### 2.6.4 Black reproduction in process printing

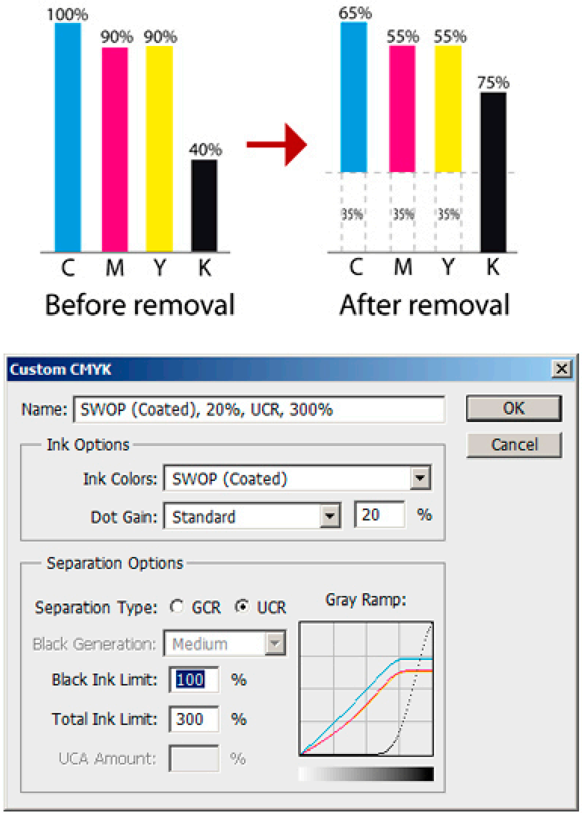
The offset printing process will have a maximum ink level which describes the total amount of ink that can be used in one area (or halftone cell). It is possible to mix 100% of all 4 colors to produce a very strong black. However, this is not desirable as it is not possible for the ink to dry faster enough to avoid smudging or transferring to other sheets of paper. Also, it is possible to reduce the use of CMY inks by using black ink which will translate in cost savings, as colored inks are generally more expensive that black. There are two standard ways this reduction in ink coverage is performed.

**Undercolor removal** (UCR) is a technique for reducing the cyan, magenta, and yellow content in neutral gray shadow areas of a reproduction.

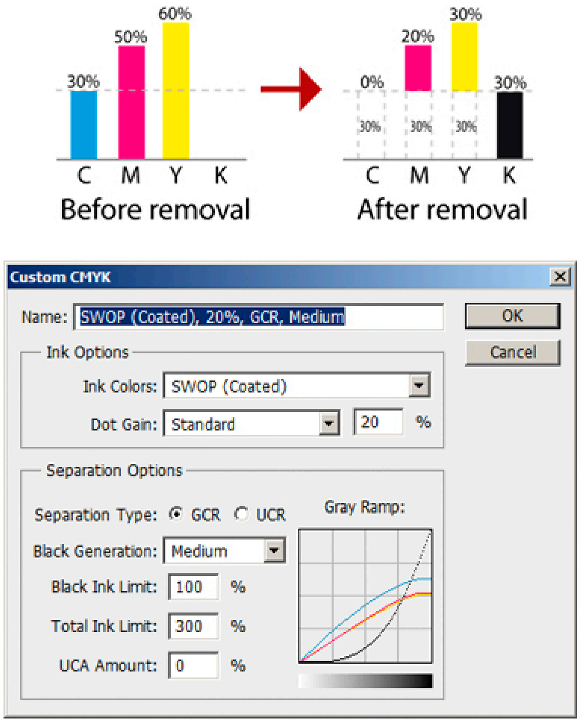
**Gray component replacement** (GCR) is used where a color uses all 3 primary inks (CMY). As each primary color can be reduced by an equal amount and this can be transferred to the black channel.

The problem seldom occurs where the black is not printed in process ink, as in spot color printing.

KONICA MINOLTA outward EXPERT




Undercolor removal




100% Gray component replacement

Undercolor and gray color removal are shown with color bars. The controls are in Adobe Photoshop.

The benefits of these processes are:

- less ink is used;
- more stable colors are achieved;
- ink dries faster
- dot gain is better controlled.

Image trapping is a better process to control black density than heavy overprinting of dense black.

Low density of process black allows the orange bottle to show through



Higher density of black masks orange by overprinting an opaque black or trapping

Black density is an important item for quality control.

# 3 Stabilizing offset printing quality

People in the printing industry always strive for consistently high quality printing. Stabilizing quality refers to the quality-control processes used to handle variables. This is desirable, so quality can be achieved reliably and economically.

A number of methods are used to stabilize quality: the printing environment must be stabilized, and solid-density and dot-gain need to be managed. This management involves linearizing and characterizing digital equipment (these processes are explained later in this section).

Many printers manage workflow with proprietary digital systems that use a *job ticket* - carrying processing instructions through all phases of a project. This can assist with stabilizing offset printing quality.

One such digital system is Heidleberg's *Prinect Calibration Toolbox*. It has a calibration manager and a quality monitor which generates and administers calibration data. This is for the linearization and process calibration of CTF imagesetters and CTP platemakers, digital-imaging printing presses, and halftone proofers. The entire process is handled from prepress right through to printing.

Another corporate system holds the target profiles of thousands of printers in many countries. Desktop files and computer monitors can be adjusted to these profiles, thus ensuring consistent results.

## 3.1 Stabilizing methods

### 3.1.1 Keeping print conditions constant

There are many variables that influence the output of printed matter. To minimize variables, the process is stabilized by following and maintaining established standards.

**Relative humidity and temperature** can significantly influence results. Both can influence stock, plate and ink. Pressrooms are usually air-conditioned, and sophisticated systems exist to automatically adjust plates when temperatures change.

Stock and ink are two other significant variables.

**Stock** expands in a humid environment, and shrinks when humidity drops. A stack of paper will change at the edges with the result that the sheet is not flat. Good storage and air conditioning are essential for good stabilization.

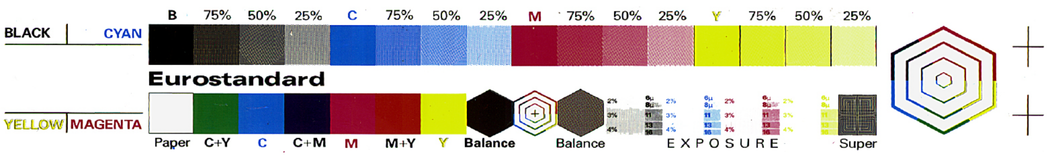
Because there are many different types and manufacturers of stock, printed results on one stock are likely to look different than on another. Exact stock specifications are needed to stabilize printing.

**Ink** characteristics: body, length, tack, and drying (*see* **2.5.1 Inks**) are influenced by the pressroom environment. However, most important thing is that the ink, stock and press must be matched.

### 3.1.2 Managing solid ink-density

Solid ink-density generally relates to ink film thickness: ink with a higher pigment load can give the same density with a thinner film, and thus helps control dot-gain and meet density requirements.

Standardized color patches are set in the original computer files. Their density can be measured on proofs and printed samples for checking that tolerances are being met. Such patches are calibrated and registered with the authority administering the standard. A densitometer or spectrophotometer, are used for the measurement. Before work is started, national printing standard profiles are agreed to by all parties (*see* also **4 Standardized color for offset printing**).


APPROXIMATIONS OF TWO STANDARDIZED COLOR PATCHES. They are a reference that are used at proofing and on the press, and must refer to a specific user, device, raster image processor (RIP), and the vendor. Their use is registered with the national standard administrator.

### 3.1.3 Managing dot-gain

Because solid ink-density and dot-gain are closely linked, they are measured similarly. The control of dot-gain quality is also similar by using standards.

Dot gain is the measurement of the printed dot compared with the dot on the pre-press film (expressed as a percentage). It is managed by compensating for the expansion of the printed dot by reducing it to a set amount in the desktop software. It is necessary to benchmark the dot gain of a press under normal printing conditions to have an accurate gauge of what dot gain percentage is necessary. Another method is by controlling the components of cyan, magenta and yellow which create gray, and replacing them with a tone of black. This reduces the need for using the three color dots (CMY), and increases the value of the black dots.

### 3.1.4 Stabilizing dot-gain with CTP

Dot-gain can be an obstruction to achieve excellent printing quality. It can be controlled by stabilizing the workflow from desktop software to printing press.

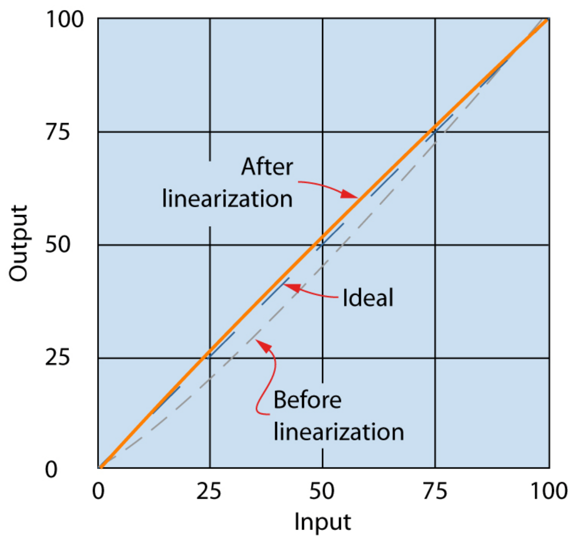
We seek to control the performance of devices by:

- linearizing each step in the process, so the variables are reduced. (Review the example in the box from section **5 Standardized printing profiles** which amplifies the advantages of standardization).
- characterizing each one, so we know how it performs.

### 3.1.5 Linearizing

Devices in the digital processing path (i.e. scanners, platesetters, and densitometers) may have inherent flaws. They are not linear in their color performance which means the output is not always the same as the input. When performance is not linear result have a colorcast. This appears like looking at a landscape through yellow glass – the greens will be lighter and the blues will be stronger.

Linearization is the process of adjusting devices to be linear in their performance – to be free from color distortion. Ideally, all devices should be adjusted to be linear. Occasionally, devices are not themselves adjusted to be linear, rather they are adjusted to make the output of the whole chain as linear as possible, through the use of software.




A graph showing linearization: in the ideal, input and output are the same. Before linearization, the output is a bit less than the input. After linearization, the output is not perfect, but is very close.

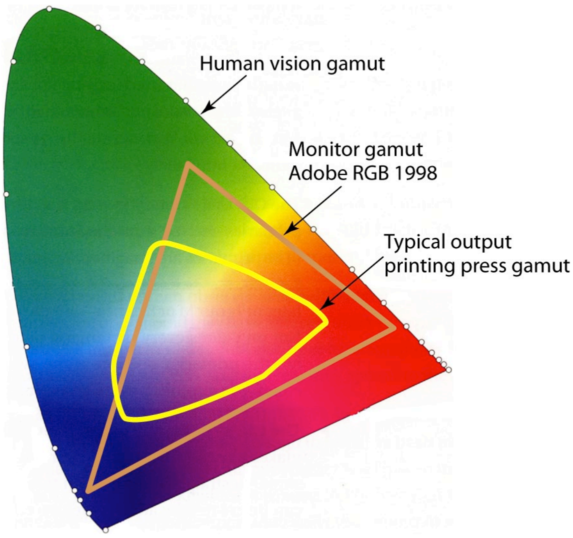
### 3.1.6 Characterizing

Characterizing (or *profiling*) is the process of defining the way that devices perform, by creating an input-output profile. A profile is a digital file that contains information to let a color management system adjust colors to suit a chosen color-space.

In characterizing we talk of *device color-space* and *editing color-space*.

**Device color-space** Each piece of equipment that is involved with images is referred to as a device: cameras, scanners, computer monitors, proofers, platesetters, and printing presses are all devices.

No device can reproduce the whole of the visible color spectrum. The range of colors that an individual device can reproduce is called the *gamut*. The color-space for a particular device is defined digitally, and is called a device profile. Each device profile has categories: input, output, and display profiles.




A CIE chromaticity diagram showing a generic interpretation of the colors visible to the human eye (the human vision gamut). The computer monitor can display a wider and richer gamut than the printer. Inside the brown line is the gamut which is displayed by a computer monitor. Inside the yellow line is the gamut of a generic offset printing press.

**Editing color-space** (or *working color-space*) is a gamut where the editing of images can be performed in a controlled and consistent way. Whilst a device's color-space is specific to a particular device, an editing-space is independent of devices. They are said to be gray-balanced: colors with equal amounts of red, green, and blue appear neutral gray. Editing-spaces are perceptually uniform; i.e. changes to lightness, hue, or saturation are applied equally to all the colors in the image. A commonly used editing color-space is the Adobe RGB 1998. (sRGB is a color-space describing the gamut for low end monitors and is best used for web browsers.)

### 3.1.7 Color viewing conditions

Correct viewing conditions are essential for stabilizing print quality. When color is viewed on a computer monitor or paper stock, it is influenced by:

- the color of the surrounding white light;
- the walls of the room, and
- clothing which can produce a color-cast reflecting on a monitor.

For accurate color and tonal value perception, the lighting color temperature of 5000K or 6500K is the international standard ISO 3664:2000 *(Viewing conditions – Graphic technology & photography*) and ISO 12646:2004 *(Graphic technology – Displays for color proofing – Characteristics and viewing conditions)*.

The viewing area should be glare-free neutral gray.

# 4 Standardized color for offset printing

## 4.1 What is standardized color?

Standardized color is the color that is output under the conditions stipulated in the international standard ISO 12647–2. Amongst other subjects, compliance is required for solid-density and dot-gain.

A printing company achieves correct results with standardized color when it follows the standard.

The ISO standard provides for one standard color specification for a country. These include:

- SWOP for USA
- Eurostandard Color for Europe
- 3DAP for Australia. Latest version now based on ISO 12647-2
- Japan Color for Japan

Advantages of printing standardized color are:

**for the client,** a consistent printed output can be expected.

**for the printing company,** printing standardized color delivers reliable quality.

## 4.2 Printing with standardized color

In today's commercial markets, more printing is being done for multi-national firms in many locations around the globe. With this in mind, most regions are moving towards a single international standard for color offset reproduction - known as ISO 12647-2. This is implemented in different regions by accreditation companies, and may be known by these accreditation companies such as FROGRA or PSO certification.

# 5 Standardized printing profiles

## 5.1 What is a standardized profile?

A standardized profile is the target profile established to achieve standardized color (*see* **4 Standardized color for offset printing**). An offset press that complies with a standard can use a general profile (*see* diagram in **5.2.5 How to simulate colors on proofers**).

**Example**

To highlight the importance of standard profiles, we can take a hypothetical example of printing a picture of an apple. If ten sets of four-color printing plates are produced and given to ten different printers (without the original sample). The printers would then print on a four-color offset press, using their own in-house standard - but with the same ink and paper. You would probably get ten different prints of the apple. However, if a print sample were supplied, you would probably get only two or three different color prints of the apple. But, if all ten presses were adjusted to the same profile, all the ten companies would produce very similar results.

Furthermore, when using standardized profiles to send CMYK digital data on communication lines for remote printing, the printing colors sent and received will be the same at both ends of the line. Without standard profiles, digital data can't be sent reliably.

## 5.2 Knowledge required

### 5.2.1 Proofs

Proofing is a part of the offset printing workflow. Its purpose is to check the various elements of a printing job. Proofing includes checking that:

- all type and illustrations are present, and in the correct place;
- colors are applied in the correct places and that colors are accurately reproduced;
- spelling and other checks of grammar are also made.

The machine that is used to produce a proof is called a proofer.

### 5.2.2 Types of proofers

Ideally, proofs should be produced on the offset press that will be used to print the final job. However, this is impractical because of time and cost. So, the final offset printing is first simulated using prints from:

- a direct digital color proofer (DDCP); or
- an ink jet printer ; or
- a laser printer.

As mentioned in **1.1.2 Where do Konica Minolta products fit?** there are two types of proof: the layout proof and the contract proof. The contract proof needs to be as close to the final offset printed job as possible, and not all proofers can do that. Sometimes initial layout proofs may be produced on a less-capable proofer, with the contract proof being produced on a professional device.

In choosing a proofer, the following factors are taken into consideration:

- ability to accurately simulate the finished job in color;
- the representation of halftone dots;
- the ease of profiling the proofer;
- cost of the proofer;
- the time a proofer takes to produce a proof;
- the availability of RIP software for the proofer; and
- the range and size of stock that the proofer can use.

Proofers fall into two general categories:

- proofers that can output a direct digital color proof (DDCP);
- proofers that can’t produce a DDCP. These include laser printers and ink jet printers.

The proofer should be stabilized to the output characteristic of the target offset press.

| Proofer type | Halftone available | Running cost | Output speed | Gamut | Stock size | Stock range |
|---|---|---|---|---|---|---|
| Direct digital color (DDCP) | yes | high | very slow | wide | big | wide |
| Inkjet | yes | low | slow | wide | big | Wider |
| Laser * | no | low | fast | narrow | limited | limited |

* Because of the many disadvantages of laser printers as proofers, they are limited to layout proofs.

### 5.2.3 Simulation

Proofs can only simulate the color characteristic of an offset press. For this reason proofing is also known as simulation.

### 5.2.4 Target profiles

A target profile generally contains the characteristics and color gamut of the target offset press. It is essential to have the target profile for the whole chain of device-profiles to work together. To meet printing standards, all offset presses must have a target profile created.

Since the final output of the printing process is the offset press, then the target profile should be that device. The press profile and the prepress profile are married in the digital proofing system.

### 5.2.5 How to simulate color on proofers

To effectively simulate the output of an offset press with a proofer, the output profile of the proofer must match the target profile of the press.

Desktop publishing is performed in the RGB color-space because that is the space used by scanners, digital cameras, and computer monitors. However, as printing presses work in CMYK color-space, RGB needs to be converted to CMYK.

**Conversion of RGB images to CMYK images** can be done in two ways.

- image processing software like Adobe Photoshop; or RIP software. This conversion is called *ripping*, the initials RIP stand for *raster image processor*. Ripping involves a computer process that analyzes all the images, and apportioning its assessment of the RGB colors to four files for each color in the CMYK output.

- proofers have to work in the CMYK color-space.

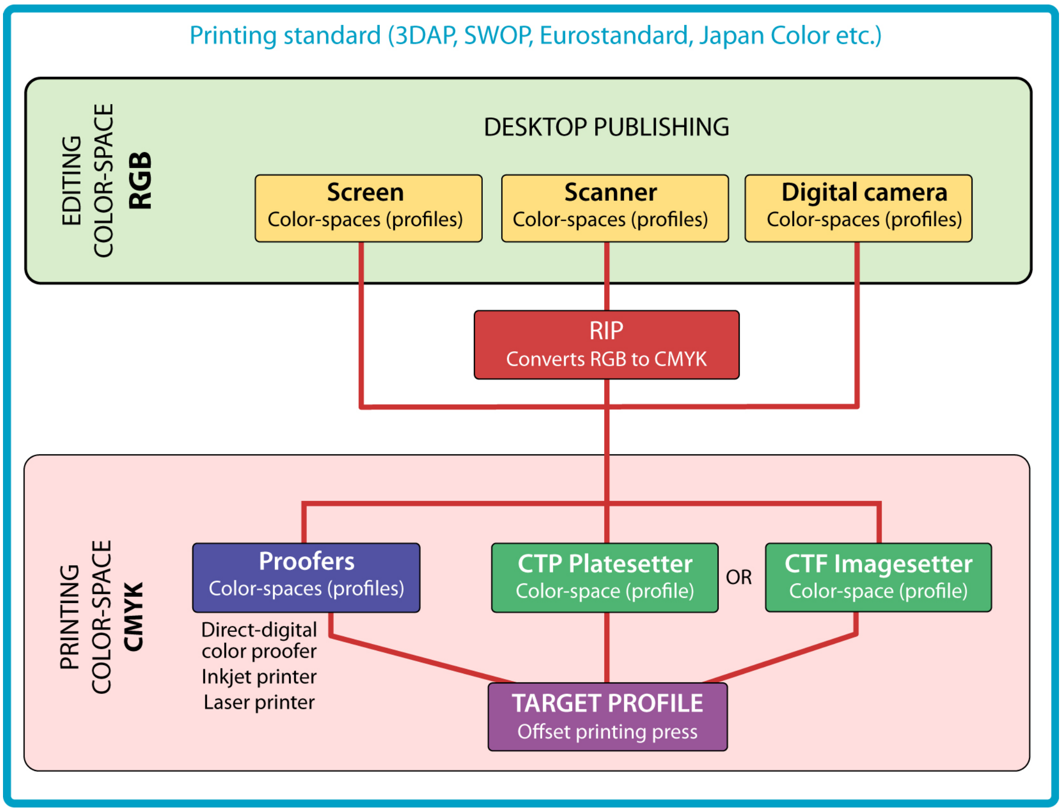
## Conversion of CMYK images to CMYK

It is possible to convert CMYK-to-CMYK, but the process is not recommended because it rarely gives good results, especially in the reproduction of blacks. Most affected are pure blacks that have no other colors – they will be converted to a black color that also contains other inks other than true black.

If you decide to convert CMYK-to-CMYK, one method is to use a type of ICC profile that is known as a *device link*. The process can be performed with software like ProfileMaker Professional, or MonacoPROFILER.

*See also* the modules *DTP Applications*, Section 1.1.2, and *Color printing workflow for DTP*.

The target profile and device profiles are a core part of establishing reliable quality offset printing.




APPLICATION OF PROFILES. The target profile (purple box) is the profile that all other devices must ultimately refer to. Proofers, platesetters, imagesetters, and desktop files are adjusted to represent the target profile of the press. Each box represents a device. Different phases of the work are performed in different color-spaces (RGB or CMYK). The blue outline indicates that all the work is controlled according to a standard that has been selected.

# 6 Standards

Throughout this module, there are references to standards. It is important to know what standards are to be used for printing when assessing the need for a proofer.

Standards for offset printing are issued by the International Organization for Standardization (ISO), and various countries.

## 6.1 International standards

- ISO 3664 *Viewing conditions – Graphic technology & photography*
- ISO 12646 *Graphic technology – Displays for color proofing – Characteristics and viewing conditions*
- ISO 12642–1 *Input data for characterization of 4-color process printing–Part 1: Initial data set*
- ISO 12647–2 *Process control for the manufacture of half-tone color separations, proof and production prints–Part 2: Offset lithographic processes*
- ISO 15930–4 *Prepress digital data exchange using PDF -- Part 4: Complete exchange of CMYK and spot color printing data using PDF 1.4 (PDF/X-1a)*
- ISO 15930–6 *Prepress digital data exchange using PDF -- Part 6: Complete exchange of printing data suitable for color-managed workflows using PDF 1.4 (PDF/X-3)*

## 6.2 National standards

National standards specify and set tolerances for factors in the workflow. These may be colors, inks, stocks, dot gain management, ink density, screen frequency, and the conditions under which offset printing is conducted.

National standards are produced under the provisions of the ISO standards that provide for a single standard for each participating country.

Within every country there are sometimes more than one standard. Typically there are standards for:

- Coated stock
- Uncoated stock

- Newspapers
- Magazines
- Sheet-fed printing
- Web-fed printing

### 6.2.1 Example

Japan Color is the standard for printing stipulated by ISO/TC130 Japan committee. ISO12642 pattern (928 colors) measurement value is shown in data. Regarding printing conditions, referring international standard ISO12647-2, popular ink and paper are used. Conventional JC97 colors that used only art paper but JapanColor2001 specifies about 4 types of paper.

Some details of Japan Color are tabulated below.

| JAPAN COLOR SUMMARY | |
|---|---|
| **Parameter** | **Details** |
| Ink | Japan Color Ink (Japan color complied process ink which each ink manufacturer sells.)<br>(Examples: Toyo ink Hi-eco series, Dainippon Ink, GiosG, Dainichiseika Nouvelle maxi AF, etc.) |
| Printing density management | JC2001 specifies measurement value. Density value slightly changes depending on type of ink or densitometer. Therefore, it is recommended to obtain and measure the JapanColor print sample with the densitometer at hand. |
| Paper | Japan Color Paper (Japan color complied paper which each paper manufacturer sells.)<br>Examples: Mitsubishi Paper Mills Limited, Oji Paper Co., Ltd) |
| Solid patch color | see table below |
| Dot gain amount | see table below |

| JAPAN COLOR SOLID VALUE | | | |
|---|---|---|---|
| **Color** | **L*** | **a*** | **b*** |
| Cyan | 53.9 | -37 | -50.1 |
| Magenta | 46.6 | 75.1 | -4.4 |
| Yellow | 87.9 | -7.5 | 91.5 |
| Black | 13.2 | 1.3 | 1.9 |
| Red | 46.5 | 68.5 | 48 |
| Green | 49 | -73.5 | 25 |
| Blue | 21 | 20 | -51 |
| White | 93 | 0.5 | 0.4 |

| JAPAN COLOR DOT GAIN | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Original percentages** | | | | | | | | | | |
| | **0%** | **10%** | **20%** | **30%** | **40%** | **50%** | **60%** | **70%** | **80%** | **90%** | **100%** |
| Cyan | 0 | 4 | 8 | 12 | 14 | 17 | 16 | 14 | 10 | 6 | 0 |
| Magenta | 0 | 6 | 10 | 13 | 15 | 17 | 16 | 14 | 11 | 7 | 0 |
| Yellow | 0 | 5 | 9 | 11 | 13 | 15 | 14 | 12 | 9 | 6 | 0 |
| Black | 0 | 5 | 9 | 13 | 14 | 16 | 15 | 13 | 11 | 8 | 0 |

## 6.3 Sources of standards

Standards are often revised as technology progresses, and it is desirable to have the latest version.

If you need to refer to a standard, your client company should have the relevant publications.

There are references to standards on the World Wide Web, but because they are copyright, they have not been reproduced here.

# 7 Glossary

**aliasing** Visibly jagged steps along angled lines, or the edges of a piece of line art. This is caused by sharp tonal contrasts between pixels.

**bit depth** The number of bits used to represent each pixel in an image, determining its color or tonal range.

**chroma** The intensity of a color.

**CMS** Color management system. A process that attempts to ensure color uniformity from input to output, so that printed images match the originals.

**CMYK** The four process inks used in four-color process printing. The letters stand for cyan, magenta, yellow and black. *See* **2.4.6 Process color**.

**CTF** The process of making printing plates where computer images are fed to a device (imagesetter) to produce same-sized film, from which the plates are made photographically.

**CTP** The process of making printing plates where computer images are fed to a device (platesetter) to make the plates without the use of film.

**color cast** An overall color imbalance that makes the work look as though it is being viewed through colored glass.

**colorimeter** A measuring instrument that characterizes color samples to provide an objective measure of color characteristics, especially computer monitors

**color management system (CMS)** A system that interprets and translates color accurately between devices. It compares the color space in which a color was created to the color space in which the same color will be output, and makes the necessary adjustments to represent the color as consistently as possible among different devices.

**color profile** A mathematical description of a device's color space which is generated by profile software.

**color temperature** A measure of the color of a light source, expressed in kelvins, a measure of thermo-dynamic temperature (similar to Celsius and Fahrenheit scales). A lower color temperature number has more yellow and red (but the color is often called *warmer*). A higher color temperature number has more blue (but the color is often called *colder*). The mean noon sun is taken to be 5,000 kelvins (abbreviated 5000K), and this is the color temperature widely adopted for matching printed colors.

**color-space** The range of colors that an individual device can reproduce –its g*amut*. *See* **1.1.1 What is offset printing**.

**contone** An abbreviation for continuous tone. A color or grayscale image format that displays continuously varying tonal ranges, as opposed to line art.

**DDCP** An abbreviation for direct digital color proofer.

**densitometer** A measuring instrument that measures the density of an image. *See* also spectrophotometer

**density** The degree of opacity of an ink. It is a function of the pigment that sets the color of the ink.

**device** Any piece of electronic equipment involved with image processing. It includes cameras, scanners, computer monitors, proofers, platesetters, and printing presses.

**dpi** Dots per inch. A measurement of output device resolution, e.g. the sharpness of printer images. *See* **2.4.3 Screen frequency.**

**eps** Encapsulated postscript.

**flexography** A printing process using printing plates made from rubber or plastic. It is used mostly for printing on fabrics, plastics and metals.

**fountain (solution)** The part of an offset printing press that moistens printing plates, so that ink doesn't stick to the non-image parts of the plate. The solution is the water-based liquid used in the fountain.

**four-color process printing** The printing of color by the use of four special translucent inks: cyan (a shade of blue), magenta (a shade of pink), yellow and black. *See* **2.4.6 Process color**.

**gamma** A setting that affects the brightness of the mid-tone values of an image displayed on a monitor.

**gamut** The range of colors that a particular device can display or print.

**GCR** Gray component replacement. The replacement of gray tones created by CMY inks, with black ink so that the reproduction will appear normal. *See* **2.6.4 Black reproduction in process printing**. *See also* UCR

**gravure** An abbreviation of photogravure. A printing process using printing plates on which the images are etched into the plate.

**gray balance** The balance between CMY colors required to produce neutral gray without a color cast.

**grayscale** A continuous tone image using comprising black, white and gray data; though colors other than black can be used.

**gsm** Grams per square meter. A measure of the mass (weight) of stock per square meter. It is constant for a particular sample, regardless of the size of the sheet.

**halftone** The simulation of continuous tones by printing with dots of varying size, using CMYK colors.

**hue** The color of an object.

**ICC profile** A format defined by the International Color Consortium (ICC) as a cross-platform standard.

**intaglio** The method of printing from plates on which the image has been incised (cut) or etched.

**ISO** International Organization for Standardization.

**line art** Page objects that a constructed from vectors that describe paths. Can include text.

**lpi/lpcm** Lines per inch, or lines per centimeter. A measure of screen ruling. More lines gives higher resolution.

**pixel** A very small area of illumination on a computer monitor or scanned image. The eye merges pixels into continuous tones.

**PostScript** A digital computer language used to describe all the images on a page. It is also called a page description language. A proprietary product of Adobe.

**ppi/ppcm** Pixels per inch, or pixels per centimeter. A measure of image resolution as displayed on a computer monitor, or as scanned by a flatbed scanner.

**prepress** Those operations which are done before printing plates are put on a printing press. Included are: desktop publishing, proofing and platemaking.

**press** Abbreviation for printing press or, in the context of this module, offset printing press.

**process colors** *See* four-color process printing.

**profile** The color characteristics of a device, used by color management systems.

**raster** A pattern of lines displayed by a computer monitor. *See* RIP

**reflective art (photograph)** Art or photograph that is on an opaque substrate. For the opposite, *see* transparency.

**registration** is the process on a printing press of ensuring that images are very accurately aligned.

**RGB** Red, green and blue. The primary colors seen by the eye and displayed on a computer monitor.

**RIP** Raster image processor. A computer program with which the original artwork files are processed to convert them from RGB colors to CMYK colors.

**saturation** The property of a color by which we perceive the 'purity' of the color. A highly saturated color has a limited range of wavelengths—a less saturated color has a wider range of wavelengths. It is independent of brightness.

**scanner (drum)** A device in which transparency originals attached to a rotating drum, are scanned by a white light beam. Early drum scanners separated the original color image into CMYK, and then produced separated negatives held on a second rotating drum.

**scanner (flat bed)** A device in which originals (transparency or reflective) are laid, face-down, on a stationary flat glass plate. A carriage with a light passes under the original, and a digital RGB file is generated.

**screen** A film ruled with lines, used in the past, to break a continuous tone photograph into dots. *See* **2.4.2 Halftone screens**.

**screen frequency** The number of rows or lines of dots in a halftone image. The higher the screen frequency, the more detailed the image. In multi-color printing, screens will need to be angled differently to retain correct tonal balance. *See* LPI

**screen ruling** *See* screen frequency

**separations** Color images that are separated (electronically or photographically) into the four component colors. *See* **2.4.7 Separations**.

**spectrophotometer** An instrument that breaks light into its component wavelengths (colors). *See also* densitometer

**stochastic** A screening method which, instead of a regular pattern of dots of different sizes, uses a random placement of same-sized pixels.

**stock** *See* substrate

**substrate** The material on which printing is done. In offset printing, it is usually paper or board. It is also frequently called stock.

**tack** The property of cohesion between particles of an ink; the 'stickiness' of an ink against another surface. A high-tack ink does not break apart easily.

**transparency** Art or photograph that is on a transparent substrate – usually photographic film like the well-known 35mm slide. The opposite of transparent art is reflective art.

**trapping (image trapping)** Where different solid colors overlap, or abut CMYK images, there can be color distortion and an unwanted build-up of ink. Image trapping deals with these problems by removing some of the color (knock out), then creating a small overlap of ink (a trap) to disguise any misregistration in printing. (see **2.6.3 Image trapping**)

**trapping (ink trapping)** is the way ink sticks to a particular stock, especially to how the second or successive layers of ink stick to previous layer(s). A stock with good ink trapping is a stock where the same amount of ink transfers to previously-printed ink, as does to the paper when it is blank.

**UCR** Undercolor removal. A technique for reducing the cyan, magenta, and yellow content in neutral gray shadow areas of a reproduction. *See also* GCR