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## Colour Management Systems – Introduction

Good colour management usually defines a product based on a printing process, for instance, sheetfed offset, on a specific substrate (paper). This colorimetric definition forms the basis for the optimal generation of reproduction parameters, such as colour separation and its simulation in prepress at various phases of the workflow in order to ensure a repeatability of the data that is ideal for a particular printing process.
The basis of good colour management is a standardised printing process that can be reproduced with predictable tolerances. Before implementing a colour management system, the printing standard needs to be defined using quality control instruments or adequate machine-based printing process controls which adhere to the appropriate standards.

# Colour management basics

## Colour recognition and colour reproduction

Each device used in the production process has different colorimetric properties, and these properties must be known when working with a CMS workflow. The following are the primary influencing factors in each link of the production chain.

**Originals**
- Film and photo paper materials
- Primary colours
- Contrast range

**Input**
- Flatbed scanners / digital cameras (CCDs)
- Correction options
- Different separation algorithms

**Processing**
- RGB phosphors (not standardised)
- Electron beam drive
- Video cards
- Setup options
- Interpretation of the application programmes
- Additive colour mixture
- Ambient conditions

**Output**
- Printing inks, foils, toners, etc
- Printing substrates
- Influencing variables when printing, dot gain,
- Process fluctuations
- Autotypical colour mixtures
- Viewing light

## In-house CMS

What does a user need to utilise a customised CMS? Basically, four independent fundamental building blocks are required:

- An application for generating profiles
- A measuring technique which defines the individual colour spaces (spectral photometer)
- A colour engine (CMM)
- ICC compatible applications.

## Why do we need colour management systems?

The increased use of flatbed scanners and digital cameras, which generate images in RGB, means that prepress is also confronted with the problems of colour space transformation from RGB to CMYK.
Even if colour correction is done in a prepress company on, as it would seem, identical computer system, nevertheless manual "calibration" still delivers different looking results.
Displays of the same colour values are also inconsistent due to the different interpretations by the various applications. The monitor drivers used mean that different colours are displayed on the monitor. This leads to false interpretation of the corrections required. Using CMS allows identical visualisation at different work stations. This allows greater production security, reduces costs and guarantees interchangeability.

## Measuring techniques

It is worthwhile acquiring the colorimetrics appropriate for the colour management software for the individual monitor and output characteristics. The measuring device is connected via the serial interface with the computer. To avoid the time-consuming measurement of each value, special measuring tables are available which allow automatic measurement of large test formes.

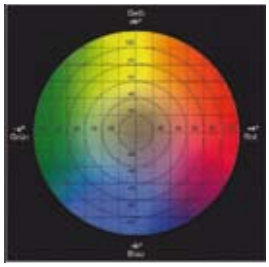
Gretag Spectrolino/Spectroscan

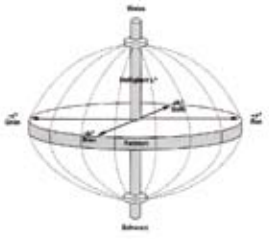
## Colour measurement processes

Colour measurement is the definition of a colour with reference numbers according to precisely specified standards. It is based on three values, due to the fact that every colour can be defined in 3 dimensions.
An instrument for measuring colour needs to be adapted to the human eye and ideally should simulate it. Replication of the properties of the eye is, therefore, a decisive prerequisite for measuring devices. These standards ensure that measuring conditions are harmonised. All measuring devices are based on eye sensitivity curves.
The standard observer was defined by the CIE (Commission International de l'Eclairage). This eye sensitivity has been defined as being representative and all measurements are based on it. Other standards define the observer's field of vision, the type of light and the measurement geometry.

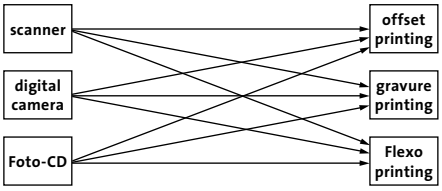
## Colour spaces

When certain original colours need to be reproduced identically, it is useful to evaluate these colours using colorimetrics. This can be done in XYZ or L*a*b*.
When transforming colour spaces, these device-independent colour systems are used to link the two colour spaces. It is important to note that transformations from RGB to CIELab or RGB to CIEXYZ are accurate and therefore reproducible. Transformation from RGB to CMYK is colorimetrically inaccurate and requires extensive mathematics to produce an acceptable quality.
The RGB colour system is used for scanners and monitors. The CMYK system is usually used in multicolour printing. These systems are device-dependent and are not suitable for absolute colour characterisation. The separation of files from device-dependent colour systems requires its own individual colour space transformation for each interface. This results in innumerable conversions that are poorly matched with each other.



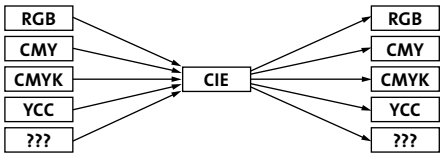


CIELab colour star




## Device independency

CIELab and CIEXYZ are device-independent colour systems. Colour values with these systems define a hue in absolute terms. The transformation of RGB to Lab is not a change in hue, but merely a different numerical allocation. If a colour system is device-independent, colour data can be used without reference to their original source. This means that such files do not need to be assigned to an input device or monitor and therefore do not require an input profile. The transformation from Lab to CMYK is only done when required. It is possible to send different separations of the same file to the relevant output devices. An image archive can be made up without any reference to output, which makes it media-neutral.




## How is a fingerprint (ICC profile) generated for the print process?

**Print standard:**
**What has an effect on printing?**

To be able to answer this question, first of all we need to know what the influencing variables are that affect quality. Print reproduction depends mainly on factors such as tonal reproduction, hue reproduction and sharpness.
These parameters, with the exception of sharpness, are laid down in an ICC profile and thus form the basis for the optimal reproduction capability of data for this process.

**Dot gain**

The bulge (balloon effect / distortion of the blanket) causes the cylinder circumference to change, and the printed image shifts minimally in the printing direction. The logical consequence is a "distortion" of the screen dots. This effect is called mechanical dot spread. Another influence on reproduction is the light scattering between the substrate (paper) and screen dots (ink) on the paper. Less light is reflected than is proportionally present. We call this effect optical dot spread. Both effects together are included in the print characteristics which describe the change in tonal value as dot gain with reference to each original tone. This variable can be influenced by the attributes of the blanket (Shore hardness) and the press setting (formation of bulge on the blanket caused by the plate cylinder).

**Ink – paper – additives**
**(reference to ISO standards)**

The exact portrayal of the printing colour space is determined by the type of ink used in combination with the type of paper. On the basis of the defined chromaticity coordinates of the printing inks (according to ISO standards), the actual values deviate at times considerably from the target values. Clearly, we are not referring to speciality printing here! These deviations are further increased by the printer him/herself (ink additives). On the other hand, ink manufacturers supply modified colour scales on the basis of printing requirements and data. Changes, such as modified pigmentation, purity, contamination or tackiness, are often only ISO-compliant over an extended tolerance range.

**Colour sequence –**
**ink trapping**

The sequence of colours in printing is another cause of deviation. Attempts at standardisation are also being made here, although individualists still outnumber the rest when it comes to putting these standards into practice. Understandably, in offset printing, identical tonal values printed in various colour sequences will give different impressions of colour. The effect is called ink transfer behaviour or ink trapping. Generally the first colour is applied perfectly to the printing substrate because the best conditions for the printed areas (lipophilic) and non-printed areas (hydrophilic) prevail. If the second colour is then printed on the already damp substrate, "ink splitting" occurs. A certain amount of the ink that has already been printed is removed and the desired amount of the second colour cannot be transferred. This is why the separation mechanisms UCR (Under Colour Removal) or GCR (Grey Component Replacement) may need to be used.

**The CMS target is the**
**printed result**

The target for every CMS is the printed result on output. But before the CMS test forme can be printed, the given processes mentioned above need to be standardised. It is this standardisation alone that forms the basis for the correct results that will generate a reliable ICC profile.

**Reproducible – Standard**

This ICC profile contains the basic printing parameters such as chromaticity coordinates of the primary, secondary and tertiary colours, as well as the reproduction set up, for displaying colour values correctly to ensure optimal production. Such a profile is a reproducible "fingerprint" for each printing process.