

*Prinect*  
Color and Quality

**HEIDELBERG**

User Guide

Gray Reproduction and Gray Balance  
Fundamentals and Application (3. Edition)

## Color and Quality

### Prinect User Guide – Color and Quality

In the publication series "Prinect User Guide – Color & Quality" we aim to take a closer look at individual aspects of the color workflow, while focusing on practical applications.

#### *The integrated color workflow: reliable color and reproducible quality*

With Prinect you can ink up fast and reliably, while checking and maintaining consistent quality throughout the entire print run. The Prinect integrated color workflow allows you print to well-defined and standardized values that can be reliably controlled with measurement equipment. This means you can define the parameters for automatically presetting your press as early on as in the prepress stage, merging prepress and the pressroom into one system.

Prinect enhances your cost-effectiveness by giving you control over your color and quality management, ensuring you can reliably reproduce the results again and again and ink up rapidly with fewer waste sheets and shorter make-ready times. You benefit from consistent production run quality and get more out of your press.

#### *Printing to standards and norms*

In practice, your print results can be impacted by so many different factors: from the type of paper, the halftone screening and the printing inks, through to the actual press itself, but you can only coordinate proof, plate and print when you know what these factors are.

Prinect brings reliability to your production process. Verifiable values and tolerances only need to be defined once to set up a standard that coordinates proof printer, plate setter and press. This standardization ensures that both the proof and the print are perfectly matched. You can accurately maintain inking values, while optimizing your color and quality management.

Inking is easier and faster, and if there are any deviations or customer complaints, logs documenting the production process are available to make your negotiations that much easier. You can use established standards such as the ISO standard or the process standard for offset printing, or you can easily implement other specifications, such as your customer's.

Standardization brings reliability for both you and your customer. You can be sure you are printing according to your customer's specifications on each and every press, while your customers can be sure you deliver the quality they are looking for and will want to come to you again. This is the surest guarantee in the long-term that your print shop remains profitable.

The interaction between the individual components in color workflow is complex. The publication "Prinect User Guide – Color & Quality" aims to make this interaction more transparent for you, the user.

## Gray Reproduction and Gray Balance – Fundamentals and Application

The correct reproduction of gray values is one of the keys to quality in the print process. The human eye finds it visually irritating when gray values deviate from print substrates (paper and carton) perceived as being color neutral, particularly in large areas.

When the press operator sets up a print process for a specific ink batch and a specific print substrate – alongside ensuring the solids are accurately inked and the tone value increase is correctly calibrated – he also needs to make sure gray is correctly reproduced. Normally, to do this he regulates the ink film thickness at the press. Sometimes when larger changes are made to the ink film thickness of the solids, the chromaticity coordinates and tone value increase can deviate too far from their optimal values. Every so often satisfactory gray values simply cannot be reproduced by just changing the ink film thickness.

Processes in which defined tone values are replaced by a defined gray balance cannot be properly analyzed by conventional methods of process calibration and, therefore, require new analysis methods.

The aim of the publication “Gray Reproduction and Gray Balance – Fundamentals and Application” is to explain the basic fundamentals of gray reproduction and gray balance, as well as describing how to use gray balance calibration and gray balance optimization in Prinect Color Toolbox.

## Software Versions

This publication refers to the following software versions for Prinect products:

Prinect Color Toolbox	Version 13.0
Option Profile Tool	Version 13.0
Option Quality Monitor	Version 13.0
Option Calibration Tool	Version 13.0

Higher, and sometimes even lower, versions of the software will usually support the functions described, or at least some part of these functions.

This may, however, cause changes in the user interface. You can find hints and tips on this in the relevant product and user documentation. The products and options described here may not necessarily be supplied as standard with your Prinect modules and may need to be purchased separately.

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## Fundamentals

### Introduction to Gray Reproduction and Gray Balance

Correct reproduction of gray values is one of the keys to quality in the print process. The human eye reacts highly sensitively when the white of a print substrate which the eye perceives as being neutral shows the smallest of deviations. The perceived white of the print substrate does not, however, only depend on its physical properties but also depends on the various ambient viewing conditions. It makes a real difference whether you are looking at a gray under standard lighting, artificial lighting or by daylight. In this publication we will be taking a closer look at the relationship between the white of the print substrate and the gray that the human eye perceives as being neutral.

#### A Short Historical Overview

Gray balance in relation to the correct reproduction of gray values is a much discussed topic. Not too long ago, gray balance was in fact a highly decisive element of color reproduction. In those days, the rule was that gray balance had to conform to certain values. The ISO standard on process control ISO 12647-2:1996 even defined target values (“unless otherwise specified, gray balance should be given ... 25-19-19, 50-40-40, 75-64-64”). Analogue drum scanners used these target values in their separation tables; analogue proofing systems were based on these target values and printers set up their inking units so that they were able to achieve correct gray reproduction with this gray balance.

Today, analogue drum scanners are rarely used, analogue proofing processes are on the wane and digital technologies hold sway over everyday routine. Today, color image scanners and digital cameras produce media-independent data in the same way as graphics programs (AdobeRGB, eciRGB, sRGB ...). Digital proofing systems are capable of simulating all kinds of different output processes (sheet-fed offset, web offset, newspaper printing, gravure ...) on all kinds of different papers using a range of different inks.

The print process has also seen many changes – ink pre-settings, color control and spectral measurement technology – and along the way gray balance has lost its prominent significance. Witness to this is also the latest ISO standard on process control ISO12647-2:2004 in which gray balance has been completely dropped from the standard and banished to an appendix for information only.

This ISO standard is being revised at present and when it is released will introduce a new concept on the basis of defined gray reproduction. Gray balance will then be treated as a dynamic, process-specific factor. The software we describe here (Prinect Color Toolbox 13) takes this new concept into account.

#### Dependency of the Gray Balance on the Printing Process

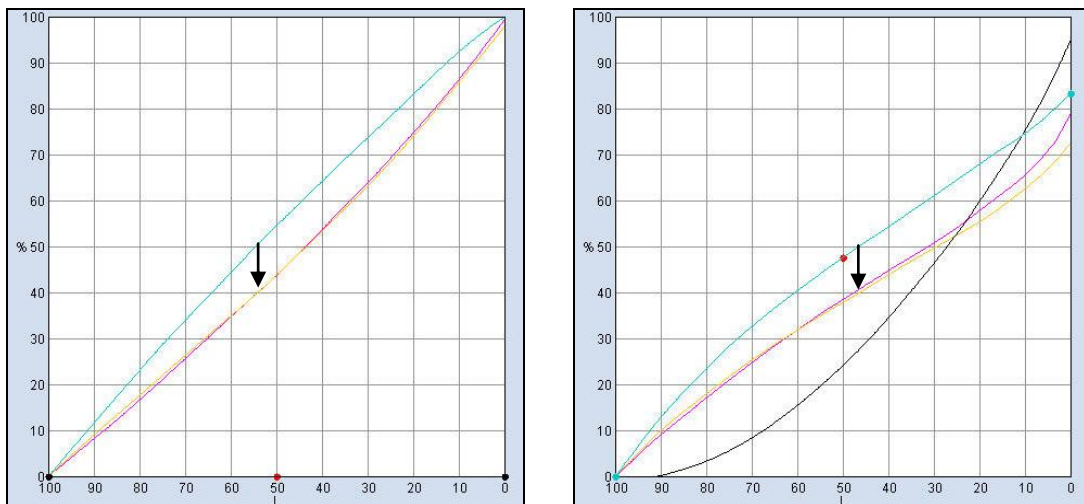
Generating characterization data and the ICC profiles for sheetfed and web offset gives us far-reaching insights into gray balance behavior. Small changes in inking within the tolerance range of the ISO standard rapidly lead to changes in gray balance. Likewise, changes in tone value increase within the tolerance range of the ISO standard also lead to visible changes. The color printing order, however, has not been examined in depth. However, we know from other tests that gray balance is highly dependent on the color printing order.

While you can often assume a classic gray balance situation when the printed colors exhibit relatively low ink coverage, any deviations can easily become larger with higher ink coverage. This is to do with the ink acceptance behavior in wet-on-wet printing. When the ink coverage in gray areas is lower, the screen dots tend to be positioned alongside each other and have no effect on their neighbors. When the ink coverage is higher, the screen dots are printed over each other, which means they impact on each other.

The following figure (Fig. 1) shows on the left the gray balance for FOGRA39 characterization data for offset printing on coated paper, and on the right the corresponding reproduction with the print profile ISOcoated\_v2 with conventional black composition. Drawing a line vertically downwards from the 50 % value for cyan will give you the corresponding tone values for magenta and yellow. This matches reasonably well with the frequently used reference values 50/40/40.

In this example, we need to be careful that we are looking at gray balance independently from paper white (so-called relative colorimetry).

The right-hand figure shows us how the color images are separated.



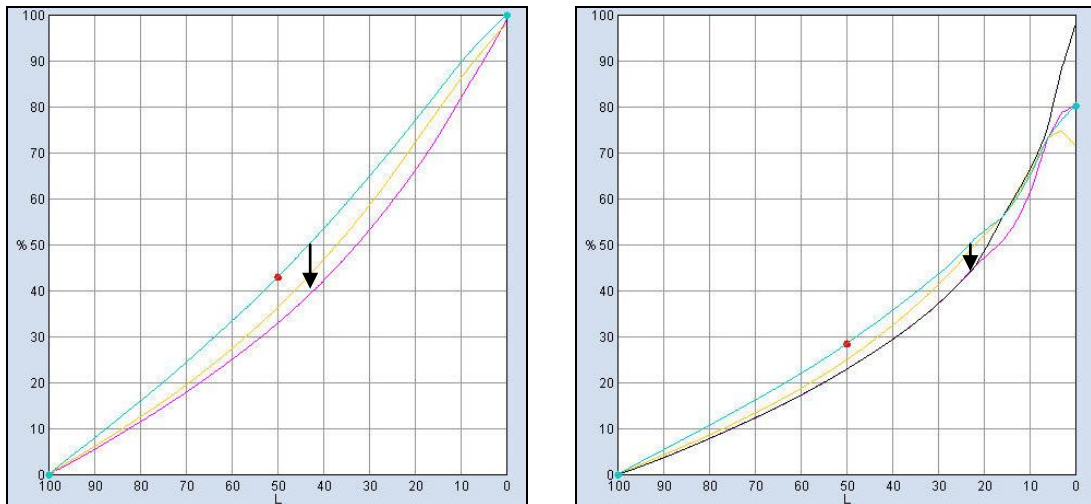
**Figure 1:** Gray balance FOGRA39 / ISOcoated\_v2 (conventional black composition)

In traditional reproduction, a short skeleton black was used for separations and printing. Today, this has all changed. The black in the gray area begins much earlier. This enables us to achieve much more stable gray reproduction. Applying GCR<sup>1</sup> improves gray reproduction even more.

Moreover, gray balance also seems to depend on the halftone screening. This can be seen clearly when comparing gray balance in periodic screening (Fig. 1) and non-periodic screening (Fig. 2).

You can see the differences when you take a look at the 50 % value for cyan in non-periodic screening and then calculate the corresponding values for magenta and yellow. In comparison to Figure 1, Figure 2 shows a very different balance between the chromatic colors for achieving a neutral gray as well as a very different color separation.

<sup>1</sup> GCR: Gray Component Replacement, the replacement of chromatic gray components with black



**Figure 2:** Gray balance FOGRA43 / ISOcoated\_NP (non-chromatic composition with GCR 50)

In practice print results prove that conventional gray balance belongs to the past. If you still want to work with gray balance today, you will need to generate it specifically for that process.

### Some Definitions

After these preliminary considerations, the time has now come to define the terms gray reproduction and gray balance. Reference books describe the definitions for the two terms as follows:

#### *Definition of Gray Reproduction*

Gray reproduction is a set of color values (CIE  $L^*a^*b^*$ ) for controlling the print process which defines a printed area under defined viewing conditions and defined printing conditions without any visible color perception.

#### *Definition of Gray Balance*

Gray balance is a set of tone values (cyan, magenta, yellow) for setting up the print process which defines a printed area under defined viewing conditions and defined printing conditions without any visible color perception.

Gray reproduction is to do with how colors are visually perceived (defined by standardized color values). Gray balance refers to the abstract numerical values (defined by percentage values) in a data record.

This means gray balance is defined as a set of tone values for cyan, magenta and yellow which when printing according to predefined print conditions under predefined viewing conditions produces a neutral gray<sup>2</sup>. These printing conditions are, for example, defined in the relevant process standards (the German Printing and Media Industries Federation (bvdn) Process Standard Offset) on the basis of the ISO specifications (ISO12647-2:2004 and the appendix to this standard Amd1 from 2007). Viewing conditions have also been standardized by ISO.

In practice, these days there are two definitions for a neutral gray which are explained for informative purposes in the ISO standard 12647-2:2004 appendix:

<sup>2</sup> The terms “neutral gray”, “achromatic color”, and “without any visible color perception” describe the same situation in gray reproduction but in different words

- a) a hue that has the same  $a^*$  and  $b^*$  values in the CIELAB color space as the print substrate and
- b) a hue that has the same  $a^*$  and  $b^*$  values in the CIELAB color space as a black hue of the same lightness on the print substrate.

The definition in a) is more suitable for light gray values where the print substrate plays a major role. The effect of the print substrate becomes less apparent in dark gray values and here the comparison with black becomes more important. In such cases definition b) is more preferable.

This makes it worthwhile in practice to calculate values for gray reproduction that combine definition a) in the highlights and definition b) in the shadows.

A uniform procedure is being developed and will be described in the new version of ISO 12647-2: on the basis of the measured  $a^*$  and  $b^*$  values of paper white, a function dependent on the lightness  $L^*$  of the gray is defined that delivers target values  $a^*$  and  $b^*$  for process control. This also takes into consideration that by screening parts of the paper white can still be perceived and that the human eye does not completely attune to paper white<sup>3</sup>.

## Process Calibration and Gray Balance

The technical specification ISO/TS 10128 on process calibration in offset printing describes the various methods for calibrating a print process in plate imaging. These methods include methods for calibrating or adapting tone value curves, methods for applying gray balance scales and methods for applying multidimensional transformations with Device Link profiles.

Applying Device Link profiles, i.e. multidimensional transformation of the process colors, is not process calibration in the true sense. For this reason this procedure is only mentioned here for the sake of completeness. This procedure is supported by Heidelberg in the same way as the previously mentioned procedure (see User Guide “Generation and Application of Device Link Profiles”).

### Calibration of Tone Value Curves

The methods for calibration of tone value curves are well known. On the basis of a defined reference printing condition with specified chromaticity coordinates of paper and printing inks for this specific paper, the tone values in printing are set by means of calibrating the tone values on the printing plate.

In the following we use the FOGRA39 standard reference printing condition again as an example to describe such a standard-compliant printing process. The gray balance of the chromatic colors and the gray balance when printing the chromatic colors with black is an integral part of the characterization data for the reference printing condition and can be calculated from the data according to the definition.

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<sup>3</sup> The proposed equations for calculating the  $a^*$  and  $b^*$  values are:

$$a^* = a^*_{\text{Paper}} \times (1 - 0.85 \times (L^*_{\text{Paper}} - L^*) / (L^*_{\text{Paper}} - L^*_{\text{cmy}}))$$

$$b^* = b^*_{\text{Paper}} \times (1 - 0.85 \times (L^*_{\text{Paper}} - L^*) / (L^*_{\text{Paper}} - L^*_{\text{cmy}}))$$

$L^*$ ,  $a^*$  and  $b^*$  are the gray values,  $L^*_{\text{Paper}}$ ,  $a^*_{\text{Paper}}$  and  $b^*_{\text{Paper}}$  are the paper white values and  $L^*_{\text{cmy}}$  is the lightness value of the three-color overprint. The factor 0.85 describes the human eye's incomplete chromatic perception.

In day to day printing routine, deviations often occur in gray reproduction. This is frequently caused by the differences in paper whites (e.g. as a result of using optical brighteners), ink properties, ink acceptance by the printing inks when overprinted and by halftone screening.

Normally gray balance is corrected at the press by altering the ink film thickness. Changes in the ink film thickness lead to changes in the color of the solids and the halftone screening, which in turn result in changes in the tone values. Altering the ink film thickness enables you to optimize gray reproduction in critical gray areas.

### **Calibration of Gray Balance**

Sometimes values are outside the tolerances for color and dot gain specified in the process standard or the press operator is unable to achieve a uniform gray balance. This makes it well worthwhile taking gray balance into account when setting up the print process by selectively changing dot gain for the chromatic process colors. The advantage of such a non-standard procedure is that you can achieve uniform gray balance as well as nevertheless optimal ink film thickness or inking in the chromatic colors. It does not matter if dot gain is actually outside of the normal tolerance range.

This non-standardized procedure uses so-called near neutral scales. These scales describe the target values of the chromatic process colors for defined gray color values, usually using the CIELAB color space. The objective of gray balance calibration is to change the tone values on the printing plate to such an extent that the gray color values are achieved. The procedure is relatively complex and is not easy to carry out without using special tools.

A procedure developed and successfully tested by Heidelberg is based on the one hand on an analysis of the reference printing conditions, and on the other hand on an analysis of the current print process to be set up. The data from this analysis enable calibration of the tone values with unequal tone value increase curves in the print. The print result, however, is visually comparable to the reference printing condition in terms of lightness gradation and gray reproduction. This procedure delivers very well-matched results when printing on different presses, with different papers and different halftone screening.

The procedure is as follows:

- Select and define a reference printing condition
- Define a test chart and image this test chart
- Print the test chart under standardized conditions
- Measure several printed test charts, average and smooth the data
- Calculate the gray balance corrections with Prinect Color Toolbox
- Calculate the new tone value increase corrections with Calibration Tool
- Apply the corrections when re-imaging the test chart
- Print the test charts and check the results

The procedure for calibrating gray balance is especially suitable for visually adjusting printing conditions that do not precisely conform to the standard with paper types and paper colors that deviate from the reference, printing inks that deviate from the reference, halftone screening that deviates from the reference and ink acceptance behaviour that also deviates from the reference.

When both the press and the print process have been set up well, differences between calibrations will only be minimal.

The gray balance calibration process is, therefore, not in basic contradiction to the ISO standard and to the offset printing process standard (PSO). It is in fact a worthwhile aid in achieving a specific objective. Standardized printing and the development of reference printing conditions can only be established in conformity with the ISO standard and PSO. Certification can also only be carried out in conformity with the ISO standard and the PSO.

### **Gray Balance Optimization**

Calibrating a print process is a procedure that is only carried out under certain conditions: when using a new type of paper, a new printing ink batch or carrying out a critical job. If a calibration deviates from the target values, you can also carry out an iterative correction. To do this, special small control elements (Mini Spots) are also printed in the on-going print job. Iterative correction or optimizing gray balance can also be carried out using a gray balance control element.

The procedure for iterative correction is as follows:

- Select a control element (e.g. ECI/bvdm gray control strips)
- Position the control strip on the current job
- Set up the print process for optimal inking
- Pull several sheets for evaluation
- Manually optimize gray reproduction and production of the job
- Assess the control strips on the sheet you have pulled
- Calculate new tone value increase corrections
- Use these corrections for the next job

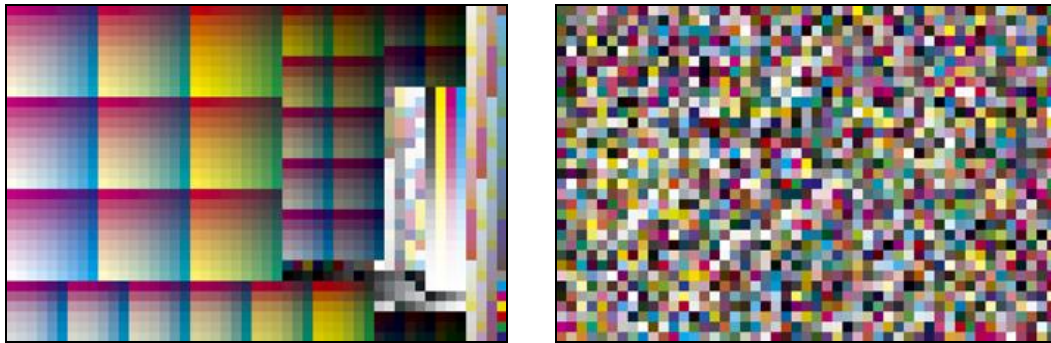
This procedure is described in detail further on.

### **Characterization Data, ICC Profiles and Gray Balance**

Reference printing conditions and printing conditions in practice (including target printing conditions) are defined by characterization data and the ICC profiles calculated from these data (reference print profiles and practice or target print profiles). The gray balance values of a print process are contained in the characterization data and ICC profiles and can be calculated from them both.

Characterization data are the definition of an unambiguous relationship between digital tone values and the measured color values in the print process (CMYK process colors/CIEXYZ or CIELAB color values or spectral colors). Characterization data are used in color management-based workflows to describe different input and output processes. They are the starting point for calculating device profiles or print process profiles and can also be used to control print processes.

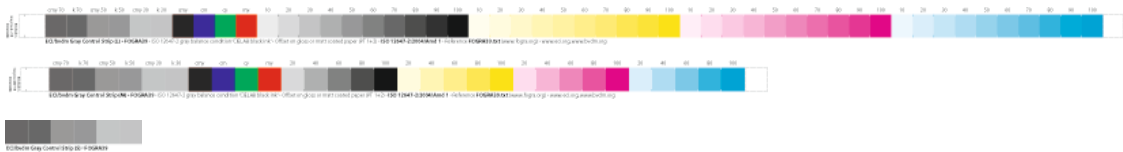
Characterization data are calculated using a test chart according to ISO 12642-2:2006.



**Figure 3:** ISO 12642-2-compatible test charts (visual and random)

ICC profiles or device profiles are standardized files that describe the color characteristics of devices, images and graphics using colorimetric standards. ICC profiles provide color management systems with the information they need to transform color data between all kinds of different color spaces. ICC profiles contain the gray balance values of a print process.

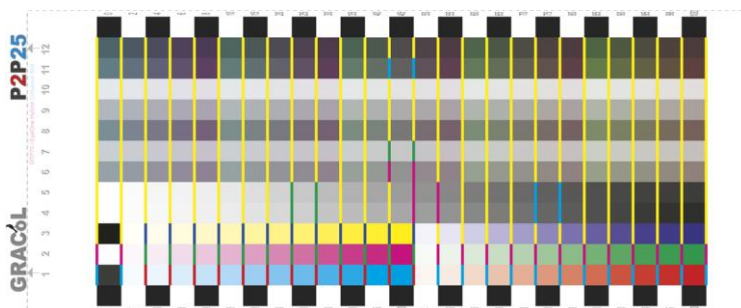
Together with the bvdm, the ECI (European Color Initiative) has developed gray control strips for visual control and measurement control in all the usual printing conditions. They determined the color values on the print substrate for defined black fields (30 %, 50 % and 70 %) and calculated chromatic color combinations with similar lightness from the ICC profile. Both patches (black and chromatic gray) are positioned adjacent to each other so they can also be compared visually. They can also be compared by measurement using Quality Monitor.



**Figure 4:** ECI\_GrayConL, ECI\_GrayConM and ECI\_GrayConS (from top to bottom)

Adjustment to your own printing conditions is easy with the ECI templates (see literature appendix). The relevant control elements and definition files for various measurement devices for the more common sheet fed offset printing conditions are supplied with Color Toolbox.

Beside the already described test charts and gray control strips there are other test elements like the P2P25 test chart from IDEAlliance.



**Figure 5:** P2P25 test chart from IDEAlliance

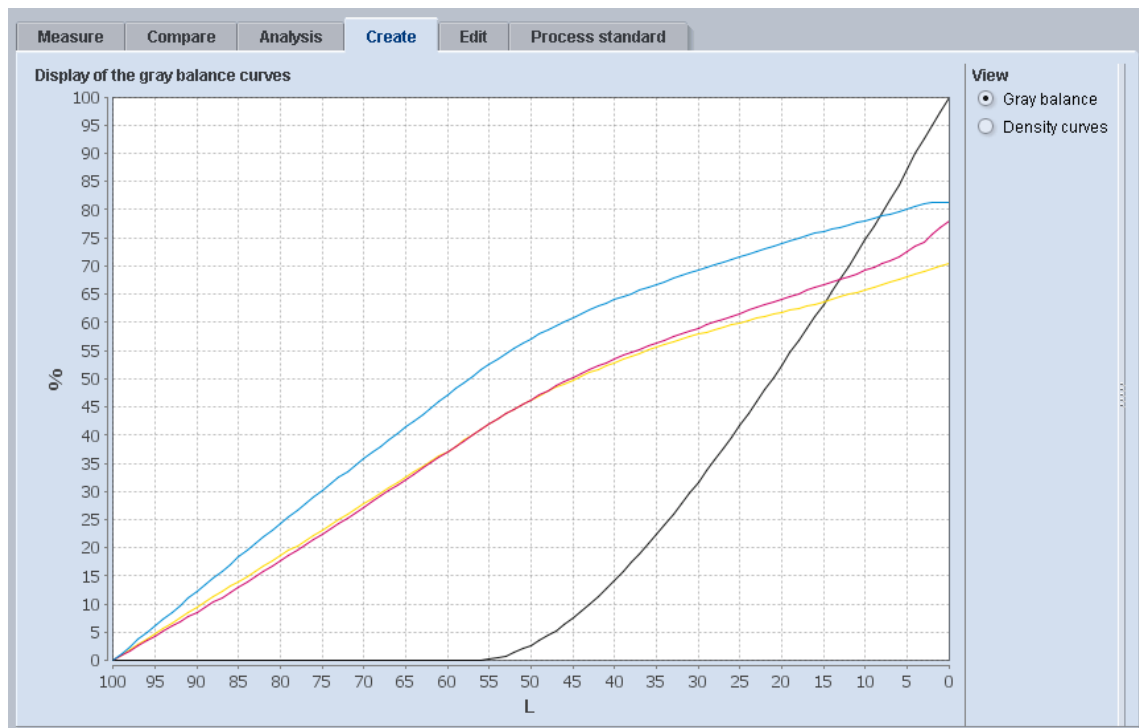
Based on the tone scales of the color patches and gray patches and on the patches covering the surrounding of the gray axis it is possible to perform a gray balance calibration as well as a process evaluation. The test chart is supported by Prinect Color Toolbox 13.

### Influence of the Color Separation on the Gray Balance

In practice, gray is rarely made up purely of chromatic colors. When image data are separated using ICC profiles, a significant amount of black ink is present in the gray axis and can even dominate color composition from a certain threshold onwards. Gray graphic elements such as logos or diagrams are usually not generated with chromatic inks.

#### Gray Balance and Conventional Chromatic Composition

In conventional chromatic composition, the gray component of the chromatic colors in gray is replaced by black from a defined level onwards. One strategy here is to begin with black at a later point. This black is also called skeleton black because it only occurs in dark gray areas. Figure 6 below shows just such a gray progression<sup>4</sup>.

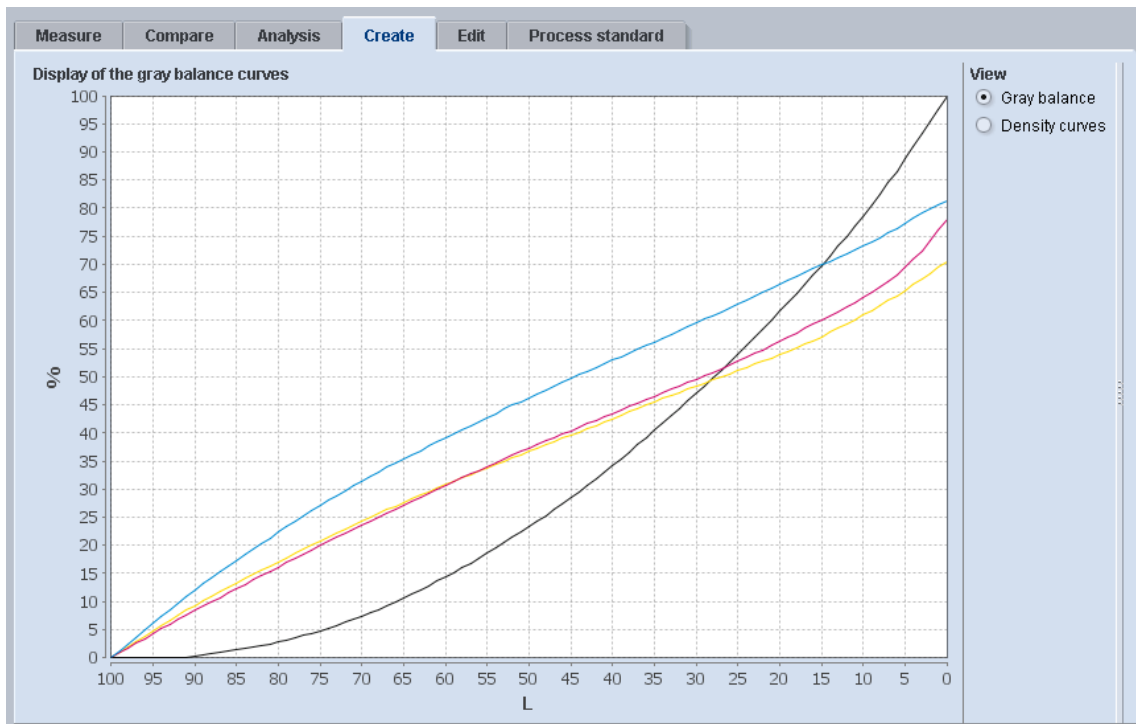


**Figure 6:** Gray balance of a standard profile: Conventional black with a length of 5

The relative lightness  $L^*$  is shown on the horizontal axis in this and in the following figures. Paper white shows  $L^* = 100$ . The tone values are shown from 0 to 100 % on the vertical axis. By restricting the total area ink coverage, the use of black makes for a significant reduction in chromatic colors. Maximum area ink coverage is achieved when lightness  $L^* = 0$ , i.e. in the absolute shadows.

Today, black is often allowed to begin very early on, which means that the chromatic colors are only slowly replaced by black.

<sup>4</sup> The following shows as far as possible only parts of the Color Toolbox user interface so that you can see the essential information more clearly.

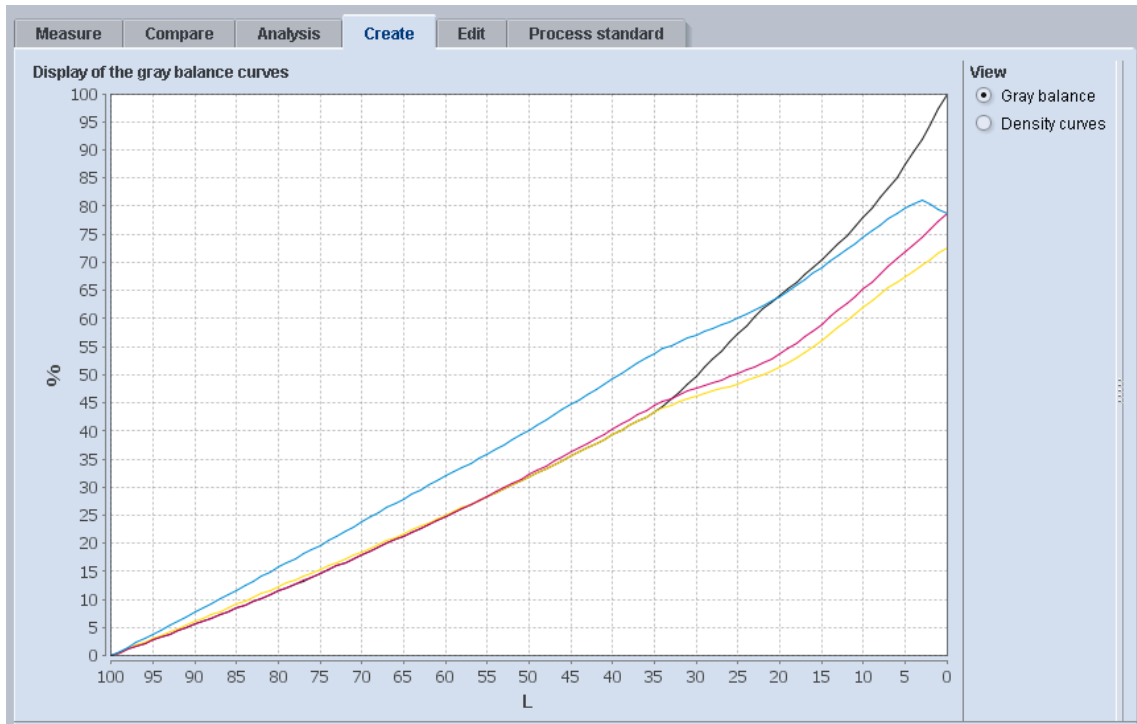


**Figure 7:** Gray balance of a standard profile: Conventional black with a length of 9

The above diagram shows the gray balance of a typical ICC profile in which black starts at around 10 % cyan. Overall, a considerable proportion of chromatic colors have already been replaced by black. This means that gray reproduction is much less susceptible to fluctuations in inks.

#### ***Gray Balance and Achromatic Composition***

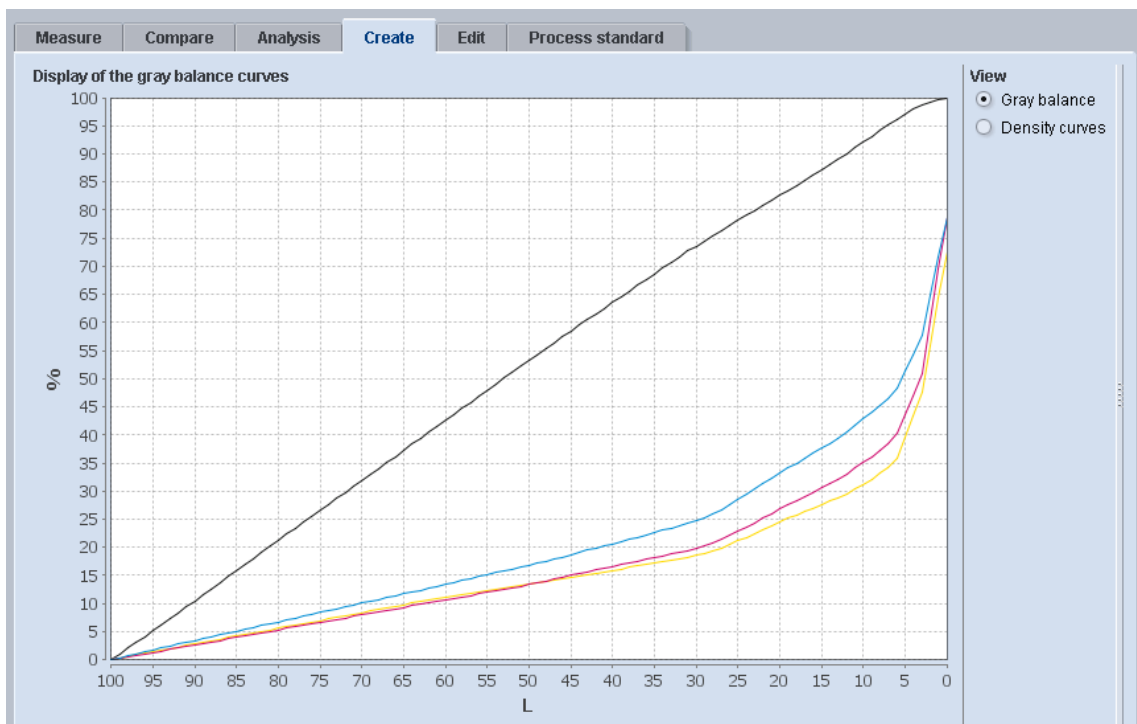
In achromatic composition, an even larger proportion of chromatic colors is replaced. Originally this term referred to the complete replacement of chromatic colors with black. However, in practice this led to disharmonious images so that printers have now abandoned this procedure. Today, there is a seamless transition between heavy chromatic composition and short skeleton black, since Profile Tool can continually adjust the use of chromatic color replacement and the extent of chromatic color replacement in achromatic composition when generating profiles.



**Figure 8:** Gray balance of a standard profile: Achromatic composition with G50

The diagram above shows the replacement of chromatic colors in a medium achromatic composition with 50 %. There are as many chromatic colors as black over a large area of the gray axis. Black only becomes dominant again in the shadows. Although not visible in the print, the slight bend in the gradation of the colors at around  $L^* = 30\%$  is caused by limiting the total area ink coverage.

The next diagram shows a heavy achromatic composition in which 80 % of the chromatic colors have been replaced by black.



**Figure 9:** Gray balance of a standard profile: Achromatic composition with G80

### **Gray Balance and Print Stability**

To assess the impact of the change in tone value increase on the stability of gray reproduction in various color compositions, you can carry out either test prints or approximate calculations on the basis of profiles and typical gray values.

To achieve medium gray (e.g.  $L^* = 50$ ) you can determine the CMYK tone values from different profiles with varying color composition. Then you can change the CMYK tone values within the permitted tolerance ranges. You can then determine the matching color values from the new CMYK tone values and calculate the differences.

When using a short black in the color separation (U300 K100 5-5)<sup>5</sup> a change of 4 % in cyan becomes very apparent. A  $\Delta E$  of 3.0 in a gray results in a clearly visible deviation which is generally not acceptable. This also applies to a profile with a long black (U300 K100 9-5). In this case there is less cyan but the fluctuation is just as great.

There is only an improvement when moderate achromatic composition (U300 K100 G50) is used. A deviation of 4 % in cyan in the mid-tones causes a color shift of  $\Delta E = 1.9$  in medium gray. This result is better but again not completely acceptable. Only when heavy GCR is used does the deviation become less.

Normally such large deviations do not occur during production printing. However, there are always small fluctuations in process colors. This makes it even more important that these fluctuations have no significant effect on gray reproduction. This is best achieved with (moderate) achromatic composition.

## **Process Control and Gray Balance**

Process control and regulation are based on print control strips. With Prinect Image Control, the entire printed sheet can be used for control and regulation. This specific case is, however, beyond the scope of this user guide.

### **Checking Inking Values in Printing**

Reference printing conditions and reference print profiles in sheet fed offset printing are based on a white measurement backing and standardized papers and inks. Usually a black backing is used when printing. Papers and inks can sometimes deviate considerably from the standard. Added to this, the color values can change again depending on the inks' drying behaviour. This means that printing requires reference values that take the different measurement backings, the different papers and the varying printing inks as well as the inks' drying behaviour into account. With just a little effort, it is possible to determine the best achievable values and store them then as a reference.

This reference is then used for setting up and controlling production during the printing process. Any follow-up assessments in which other control elements such as step control wedges are used and assessed are compared against these reference printing conditions.

### **Checking the Tone Value Increase**

The reference printing condition defines the tone value increase. Tone value increase should be set up independently from the measurement backing, paper and printing inks and their drying behaviour. In practice, there is a slight relationship between the meas-

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<sup>5</sup> This is the usual definition of the color composition in Profile Tool in Prinect Color Toolbox. U300 defines a total area ink coverage of 300 %, K100 defines the maximum black in the shadows, 5-5 defines the black length (starting point) and black width along the gray axis.

urement backing and drying behaviour, although it is negligible within the tolerance range.

Tone value increase is not usually checked during make-ready and production as only a few color patches are available in the print control strip. This means you need to carry out process calibration especially carefully beforehand.

Today, providing there is enough space, additional control elements such as step control wedges are very often positioned on the printed sheet. These control elements can be assessed later on and used for recalibration.

### **Checking the Gray Balance**

On some print control strips there are approximate chromatic gray elements with values of e.g. 70-60-60 or 50-40-40. Target values can be calculated from the reference printing conditions. These values, however, are not without their problems since they generally refer to another paper and other measurement conditions. This means that when setting up the printing process at the press, you need to adjust neutral gray visually on the basis of the relevant motif so that you can then use the gray value of the control element for checking production printing.

At present there are no generally accepted control elements and evaluations for a printing process that has been set up using the gray balance optimization method. The chapter Application describes one way of overcoming this problem based on the ECI gray control strip.

## Application

This chapter describes how to calibrate the gray balance of a print process using an example from printing in real life. The standard FOGRA39 is used as the reference printing condition, since this is the standard most frequently used in sheet-fed offset printing on coated paper, and ISOcoated\_v2\_eci is used as the reference print profile. A print run from a test series on gray balance calibration carried out in autumn 2010 is used as the print condition to be calibrated.

We printed on a Speedmaster SM74 on coated paper (BVS) and used the printing inks marketed by Heidelberg (Excel, Ink100). We carefully checked the printing press and plate-setter before we began our printing tests.

## Gray Balance Calibration Procedure

The following is a brief description of how to perform gray balance calibration:

### *Linearization of the plate-setter (optional)*

It is not absolutely essential to carry out linearization of the plate-setter for the printing plates used but it is useful if you are aiming at seamless process control. Linearization can be carried out with Calibration Tool and a plate measurement device.

### *Imaging a set of plates with ISO 12642-2 or P2P25 test charts*

Whether you have selected the option to linearize or not, a set of plates is output on the plate-setter. This set of plates contains not only elements for process control (print control strips, step control wedges) and for visually assessing gray balance (images from the roman16 series) but also a test chart for characterization of the printing process. This set of plates is output without process calibration.

### *Running the press to a standard printing condition*

The optimal inking values for the process standard used can be set using the imaged plates and print control strips. Once the press is printing consistently, several sheets are pulled and the inking values and settings are saved as a reference for subsequent print runs.

### *Measuring the test charts*

Test charts are measured with Prinect Image Control or another suitable external measurement device. Color Toolbox in Quality Monitor averages, smoothes and evaluates the data. The color of the measurement backing plays little role in gray balance calibration. However, if you are using the measurement values for process control, you will need to think about the measurement backing (an exception to this is high-grammage papers).

### *Calculating an ICC profile (optional)*

A standard ICC profile can optionally be generated and saved using Profile Tool. The profile settings for ink coverage, black composition and gamut mapping are of no significance here, since only the absolute color values from the ICC profile are used for gray balance calibration.

### *Calculating gray balance calibration*

A correction data record is calculated and saved using the application for gray balance calibration in Color Toolbox. The characterization data set or the ICC profile from the reference printing condition and the characterization data set (ISO 12642-2 or P2P25) or the ICC profile from the above described print run are used for this.

### ***Importing gray balance calibration values into Calibration Tool***

Process calibration is calculated in Calibration Tool on the basis of a linear set of process curves and stored in the internal database.

### ***Output and print of a set of calibrated printing plates***

When the process calibration is activated, the calibrated set of printing plates is output again, and printed according to the process standard selected. As soon as the press is printing consistently, several printed sheets are pulled and are visually assessed and also measured. It is worthwhile comparing them to a proof that corresponds to the reference printing condition.

### ***Re-measuring the calibrated test chart***

The newly printed test chart can be used as a process control during production and for profiling the print process. The inking values of the print process and the (varying) tone value increase curves can be stored in Quality Monitor as target values.

### ***Process control***

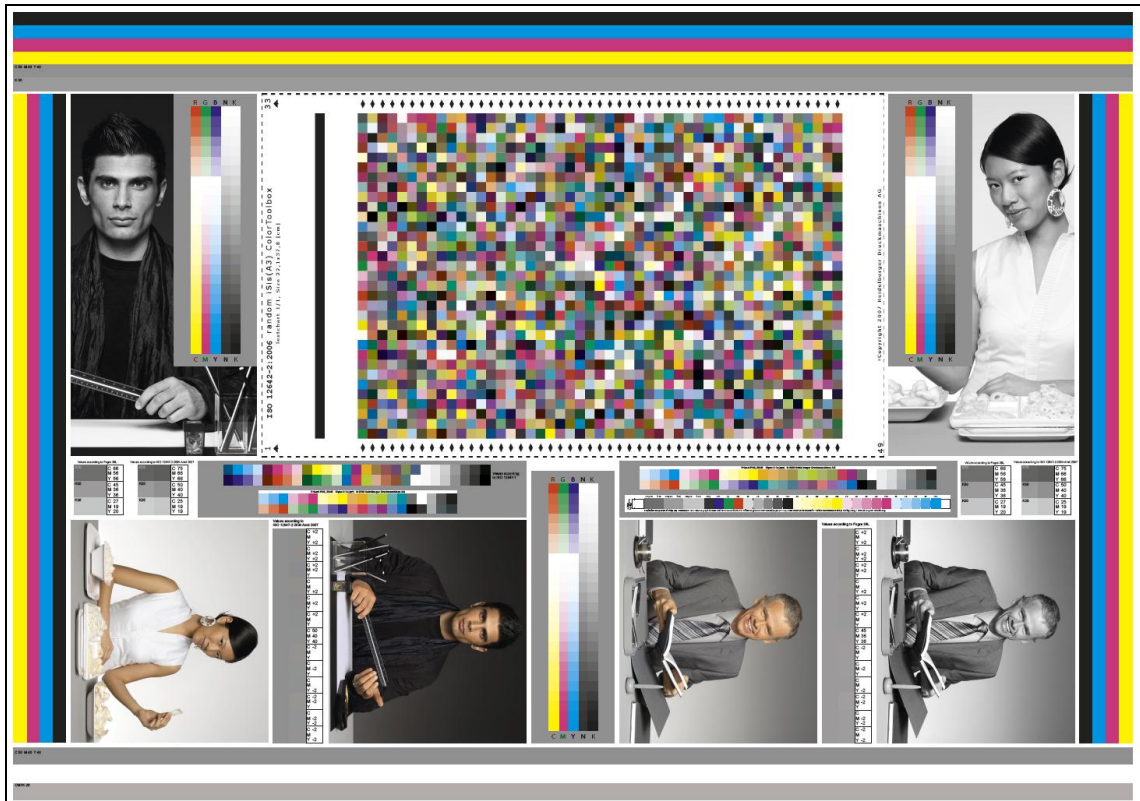
Alongside checking the inking values and the (varying) tone value increases, you can also use an ECI/bvdm gray control strip that has been specially adapted to the reference print for process control. The control strip (large, medium or small) is positioned on the printed sheet. Once it has been measured, Quality Monitor can then evaluate it.

### ***Iterative optimization of gray balance***

If you find in everyday routine that you continually need to re-adjust gray reproduction, iterative optimization of the gray balance may be the answer. To do this, you need to position the ECI/bvdm gray control strips on a printed sheet for the relevant printing condition.

## **Test Charts for Gray Balance Calibration and Gray Balance Optimization**

In principle, you can use any kind of test chart with an ISO 12642-2 compatible test element or with a P2P25 compatible test element together with the relevant print control strips. In practice, however, it is worthwhile positioning a number of additional gray elements and images on the test chart for visual assessment. Several step control wedges distributed over the sheet are also useful for checking or adjusting tone value increase at the same time. An ECI/bvdm gray control strip is required for iterative gray balance optimization. These control strips are available for all normal standard printing conditions.



**Figure 10:** Example test chart for gray balance calibration

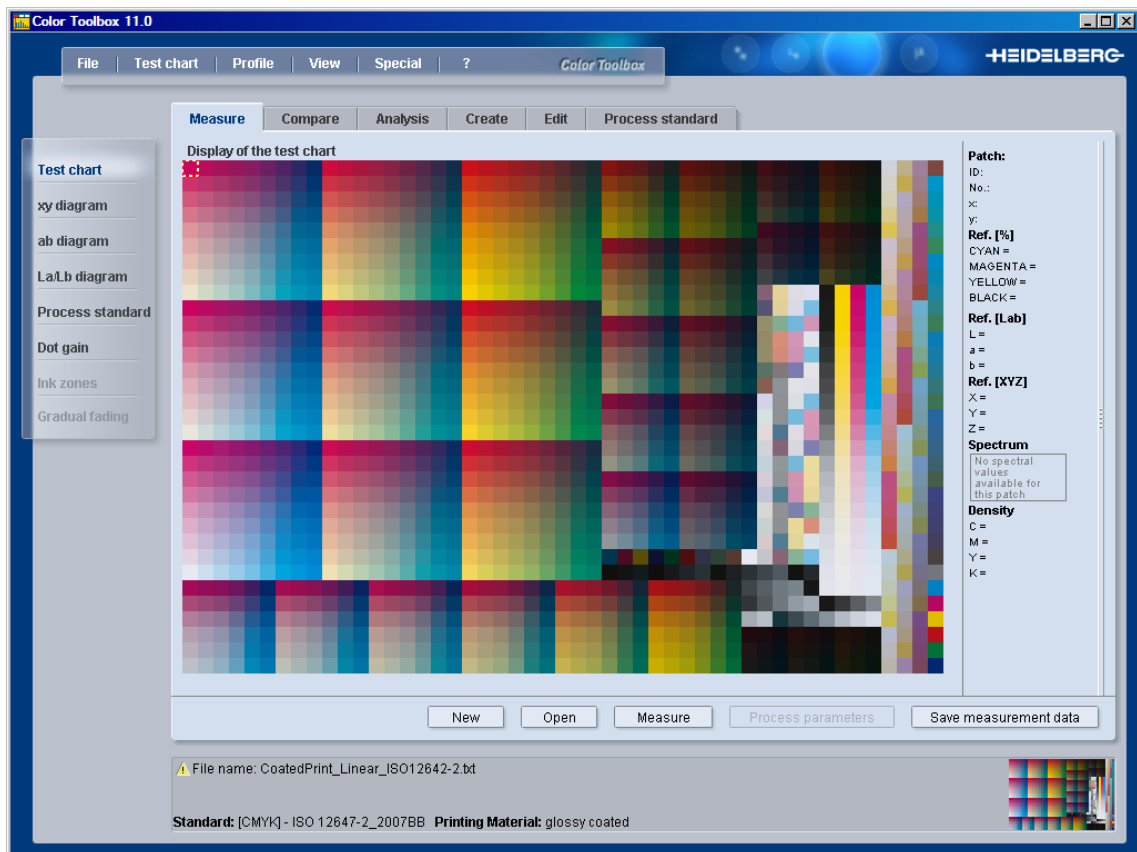
We used the test chart above for a test print carried out in Heidelberg. In the centre you can see the ISO 12642-2 test element in a form that ensures even ink coverage. The step control wedges for optionally evaluating tone value increase are positioned underneath on the right, the left and in the centre.

The print control strips are automatically positioned at the lower sheet edge during the imaging process (not shown here). We used images from the German Federal Printing and Media Association’s “roman16 bvdm reference image” series.

### Measuring and Evaluating the Test Charts

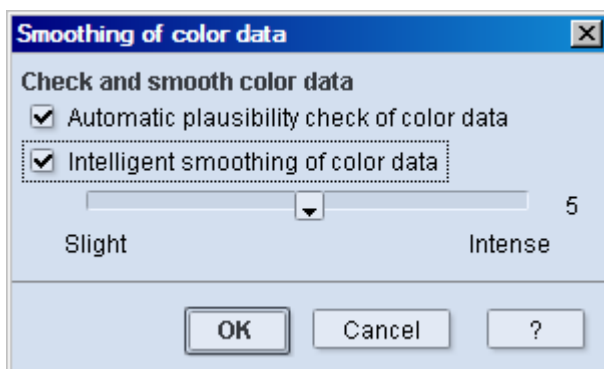
In Prinect Image Control there are appropriate masks that can be selected to automatically measure the ISO 12642-2 test chart and the step wedge. Several sheets printed at various times should be measured to ensure you have a reliable set of data for further analysis. These measurement values are then forwarded via Color Interface to Quality Monitor.

You can also use different measurement devices for this, as long as they deliver measurement values in a standardized format according to ISO 28178.



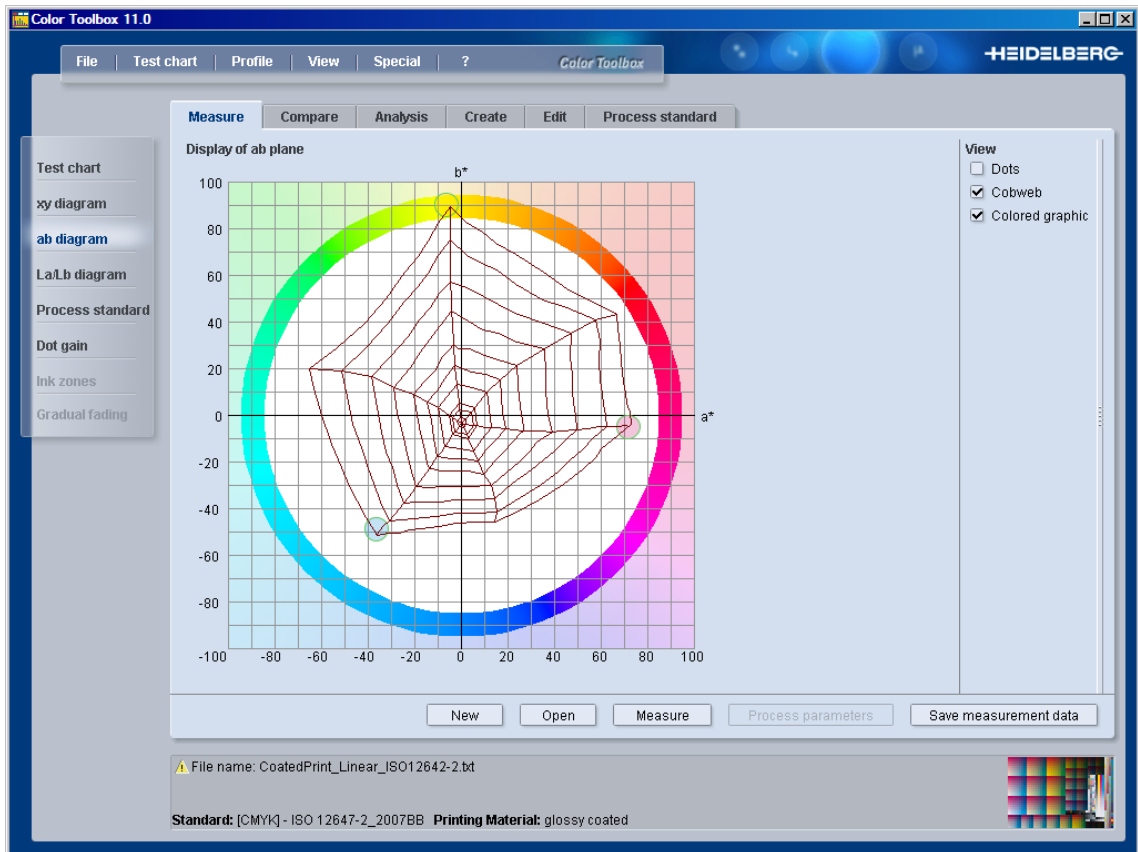
**Figure 11:** ISO 12642-2 test element in ordered view

Quality Monitor averages the measurement values from the ISO 12642-2 or P2P25 test charts and then slightly smoothes them. The spectral data remain unaltered when the measurement values are averaged. However, they are lost during the subsequent smoothing process, which means that the tone value increase curves do not match the usual values and gradations. For this reason, the step control wedges should be used for assessing tone value increase, especially since they show a better average result because they are averaged over the entire sheet.



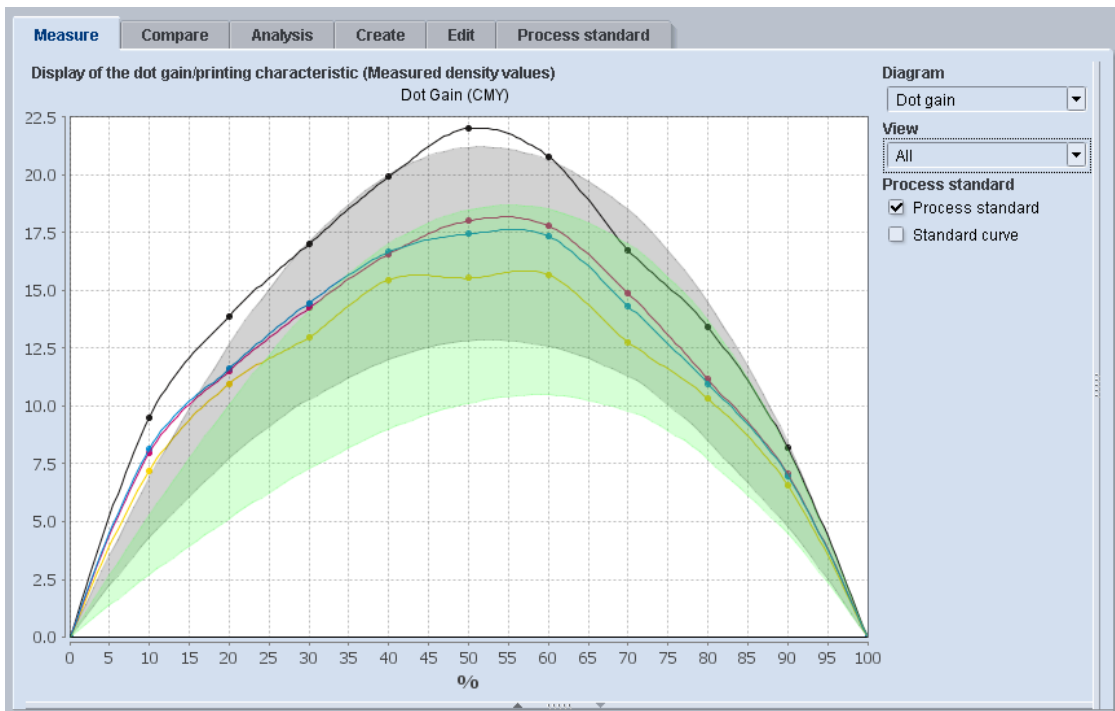
**Figure 12:** Setup smoothing of color data

The smoothed measurement values can be depicted and assessed as an overview in a  $a^*b^*$  diagram.



**Figure 13:** Display of smoothed color data in a  $a^*b^*$  diagram

Similarly, the tone values from the step control wedges are also averaged in Quality Monitor. The tone value curves cannot be smoothed here, but they can be smoothed in Calibration Tool.

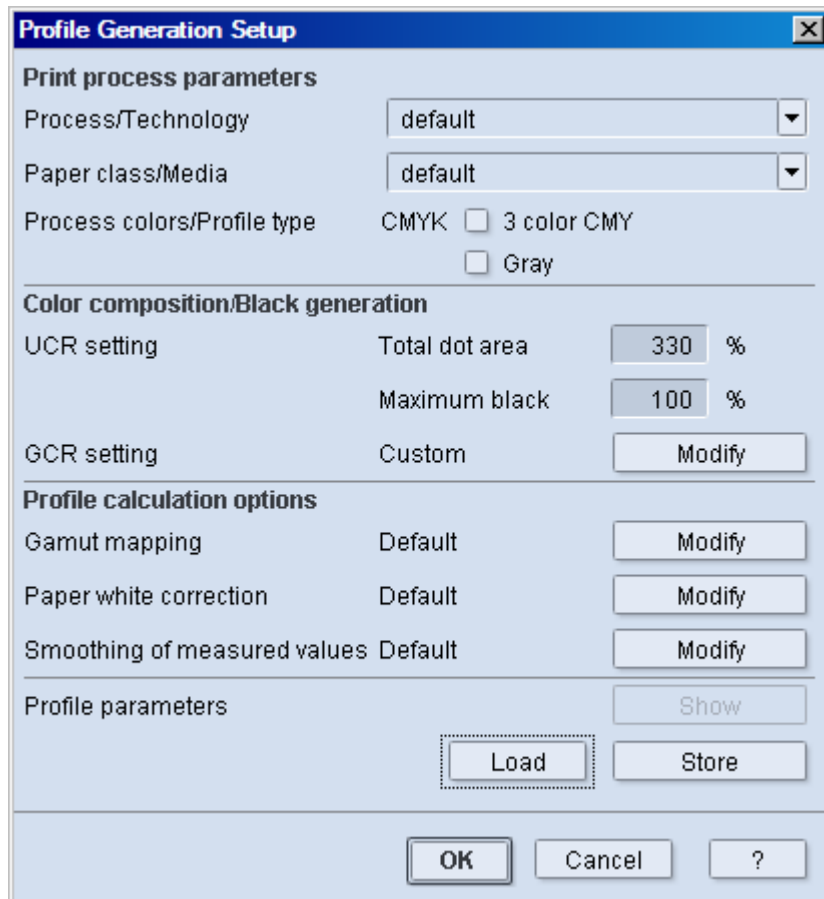


**Figure 14:** Display of tone value increase of the non-calibrated print

The step control wedge’s tone value curves are required later on for the (optional) comparison with the curves after gray balance calibration. They are also required for a possible comparison with the curves after calibration of tone value increase .

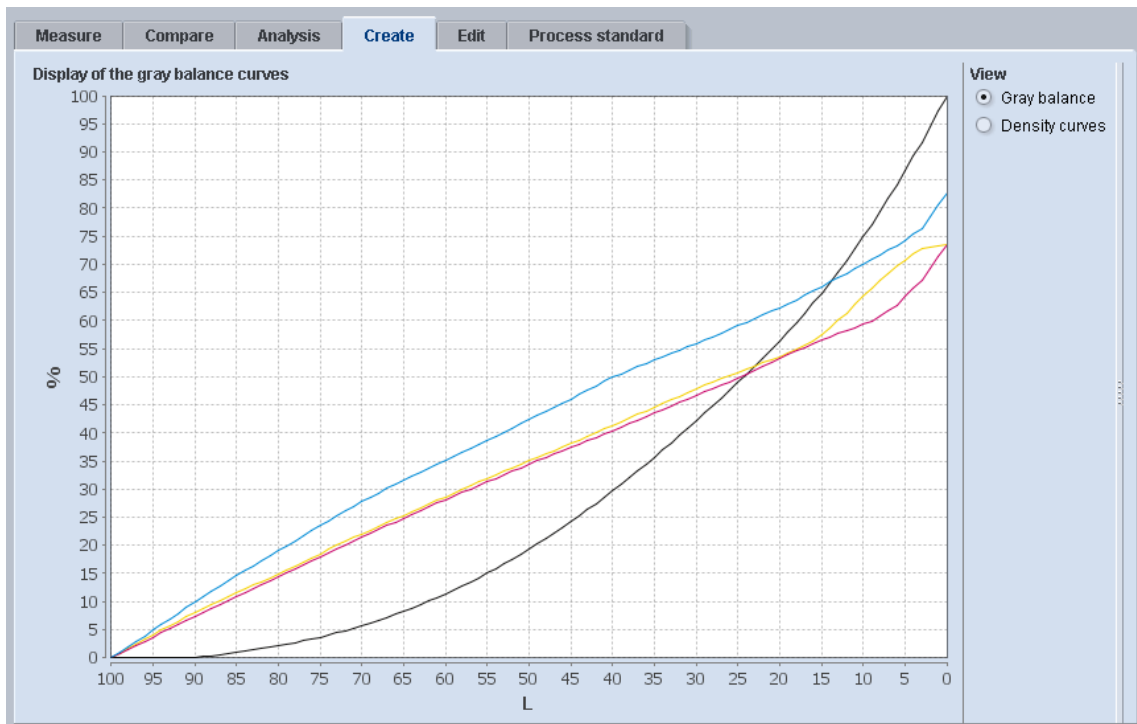
**Profile Calculation (optional)**

There are no particular settings in Profile Tool required for calculating the optional profiles. The default settings for offset printing on coated or uncoated paper can be used. The profile is only temporarily used for gray balance calibration and can be deleted afterwards.



**Figure 15:** Profile setting parameter U=330 K=95 length=7 width=5

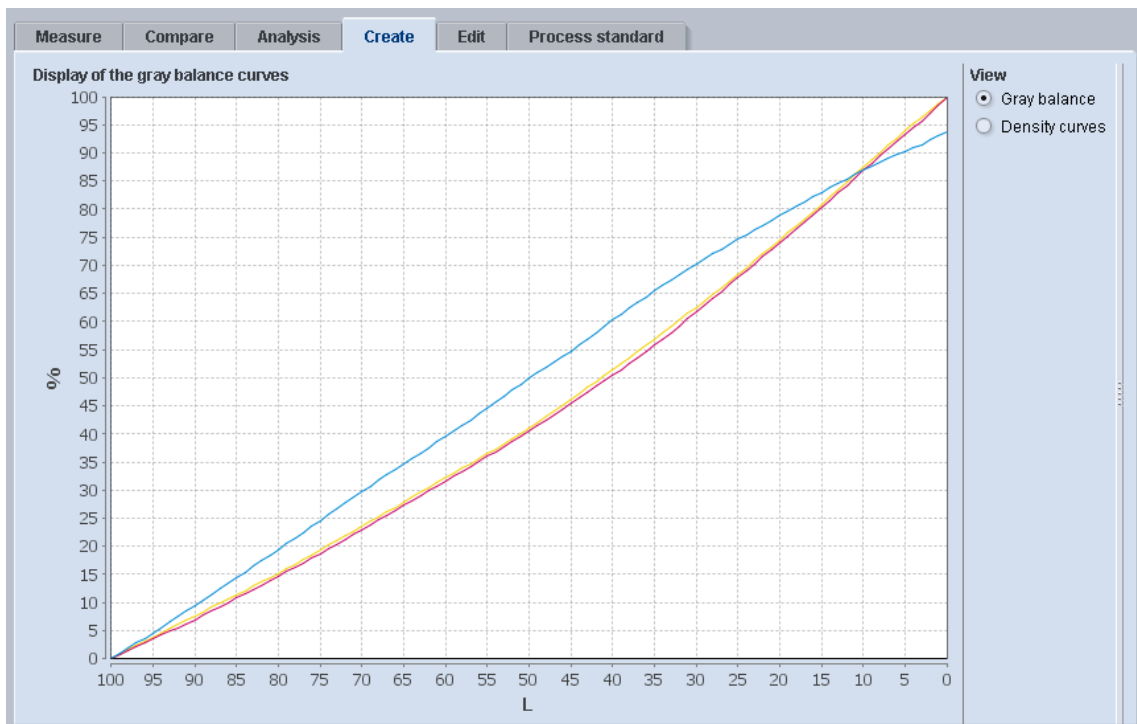
The averaged and smoothed measurement data are used to generate the profile for the non-calibrated print process. When the profile has been calculated, you can view the gray balance of the non-calibrated process.



**Figure 16:** Gray balance out of profile (with black)

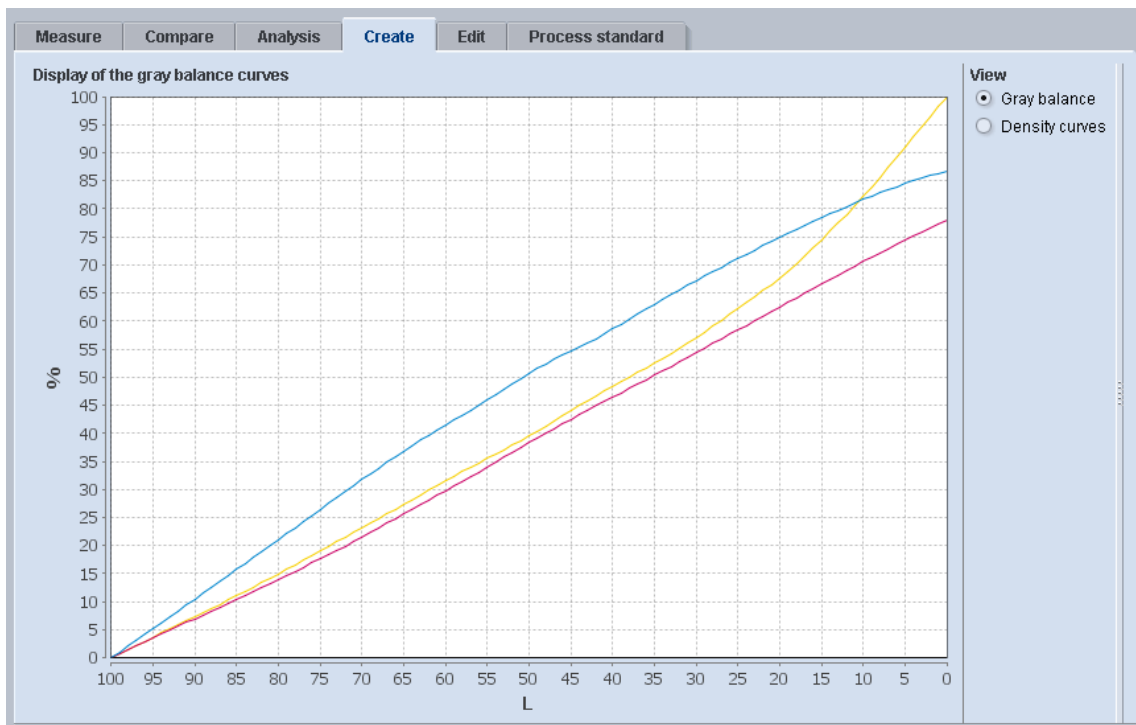
In the example above, there is too much yellow in both the highlights and in the shadows along the neutral gray axis ( $a^* = 0, b^* = 0$ ). However, this depiction of gray balance is not necessarily meaningful. Here, as is often the case, the current paper white has not been taken into account correctly when depicting gray balance.

Calculating a three-color CMY profile in Profile Tool will enable you to view pure gray balance without black



**Figure 17:** Gray balance out of profile (three-colors)

The above example shows a good overprint behaviour of the three process colors between each other, as well as with black, which was printed first (Figure 16). With a little experience, the overprint behaviour will tell you if there are any problems with the inking settings for the print (see Figure 18).



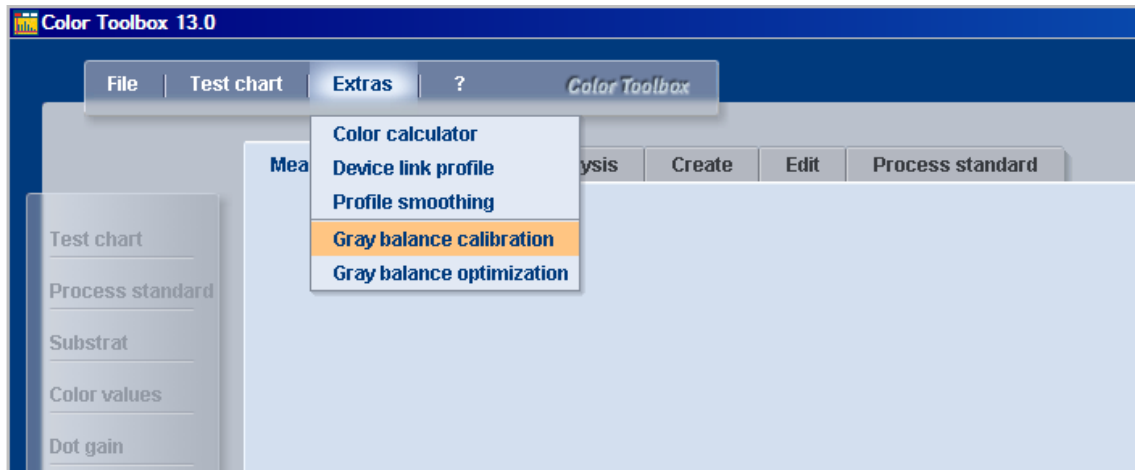
**Figure 18:** Gray balance out of profile (three-colors) with insufficient ink trapping

Here you can clearly see that there is a problem in the print process. A very high proportion of yellow is required for the neutral shadows. Since yellow was the last color printed, either the yellow is under-inked (the ink film thickness is too low) or the ink acceptance behaviour in overprinting is far from ideal. Visually assessing and measuring the printed sheet confirms that too little yellow was printed. The neutral gray tones have a strong, blue color cast and insufficient yellow ink was printed (density).

Gray balance calibration ensures satisfactory gray reproduction, even when the print process is badly set up. Simply correcting tone value increase would not have had the same result. Nevertheless, it is always better practice to setup the print process beforehand to avoid having to repeat printing a press proof in such a case.

### Gray Balance Calibration with Profile Tool

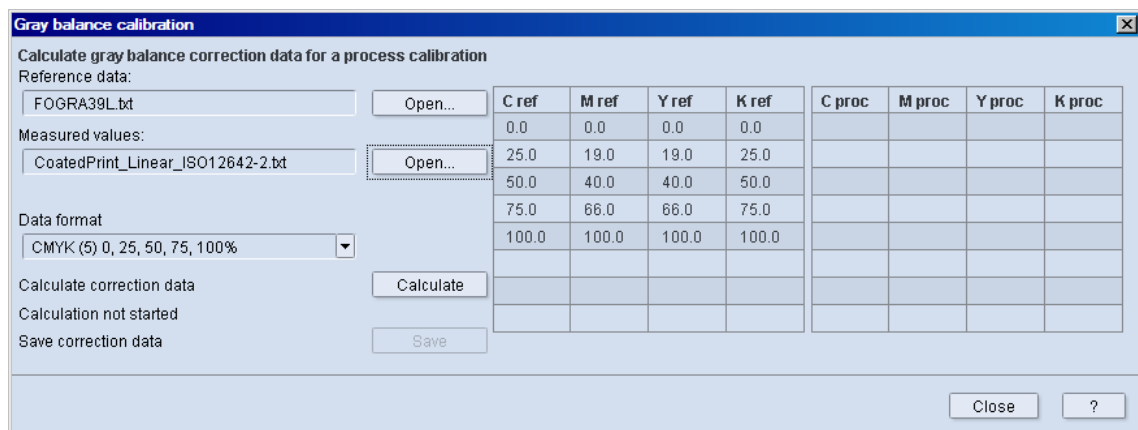
Gray balance calibration is opened in the menu bar selecting “Gray balance calibration” from the drop-down menu “Extras”.



**Figure 19:** Opening Gray balance calibration

### Calculating Correction Data

Once you have opened “Gray balance calibration”, select either a reference characterization data set or a profile. The next step is to open the measurement data (either characterization data or P2P25 data) or an ICC profile for the print process you want to calibrate and then select the correction data format. Gray correction data can be calculated with either 5 or 8 reference points. This can be set in the dialog box “Data Format”.

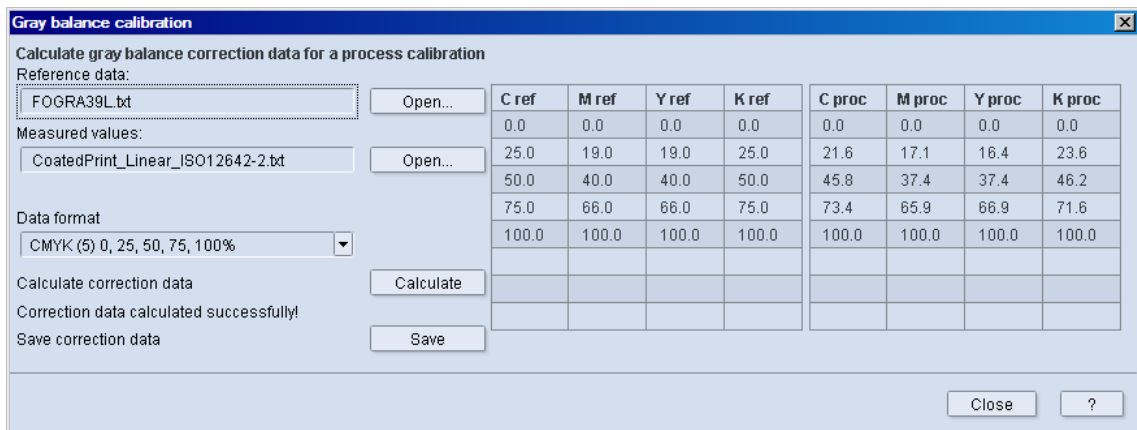


**Figure 20:** Gray balance calibration setup

If you are calibrating gray balance with 5 reference points, corrections are calculated at 25 %, 50 % and 75 % (the values refer to cyan; magenta and yellow are then lower at 19 %, 40 % and 66 %). This would seem to be generally sufficient. Gray balance calibration with 8 reference points is slightly more precise, since here corrections are calculated for 15 %, 30 %, 40 %, 50 %, 60 % and 75 %.

Gray balance calibration with values greater than 75 % is not worthwhile, since here black already dominates in the usual color separations. This can lead to unnaturally heavy corrections when the three-color overprint values severely deviate from the reference values in the shadows.

At the same time that gray balance calibration is carried out, tone value increase for the process color black is also corrected. Here the number of reference points is also 5 or 8 and the results also refer to cyan.



**Figure 21:** Gray balance calibration calculation

After you have set all the parameters, calculation can begin. At present this takes some seconds. Afterwards you can save the correction data in Calibration Tool for further processing.

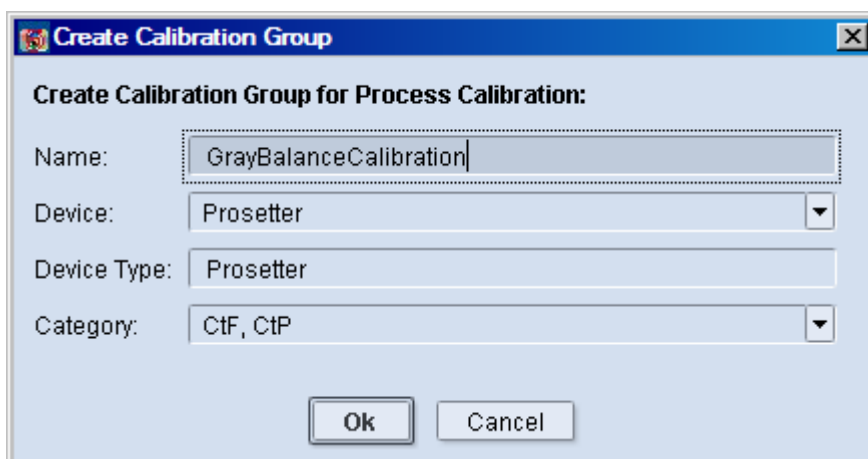
You can view the correction data in the table on the right-hand side of the dialog box. Interpreting the figures takes a little getting used to: the reference values on the left-hand side need to be corrected by a calibration curve in such a way that they result in the process tone values on the right-hand side. The calibration has to change the reference value C = 25 % into the process value C = 21.6 %. This also applies to the values for magenta and yellow. This behaviour becomes understandable when you take a look again at the tone value increase in Figure 14 (tone value increase is clearly too high).

### Gray Balance Calibration with Calibration Tool

Once you have generated a correction data record with gray balance calibration, you then need to calculate a process calibration from these values for plate imaging using Calibration Tool. At this point, we will only describe the steps that deviate from the usual procedure for gray balance calibration. This also assumes you are experienced in working with Calibration Tool.

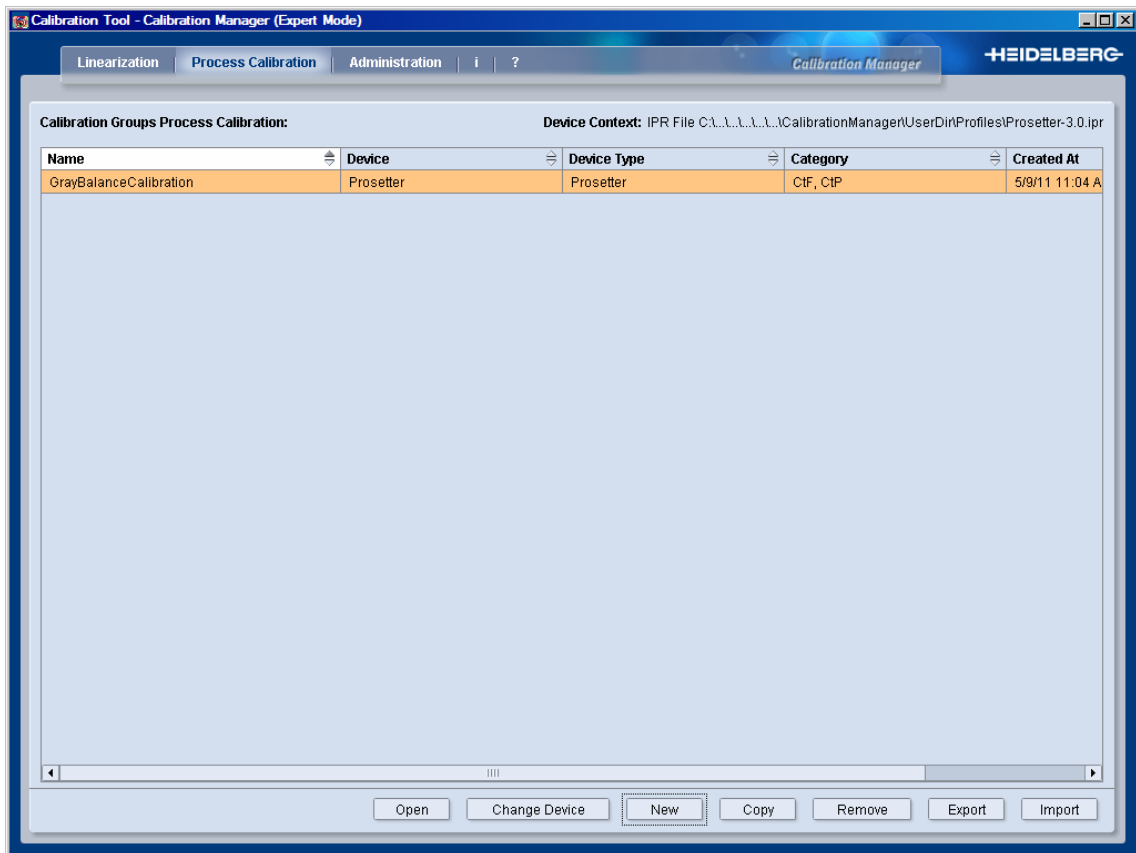
### Creating Calibration Groups and Calibration Data Records

It is worthwhile setting up a calibration group under the name of “Gray Balance Calibration” in Calibration Tool in Prinect Color Toolbox or in Calibration Manager in Prinect MetaDimension.



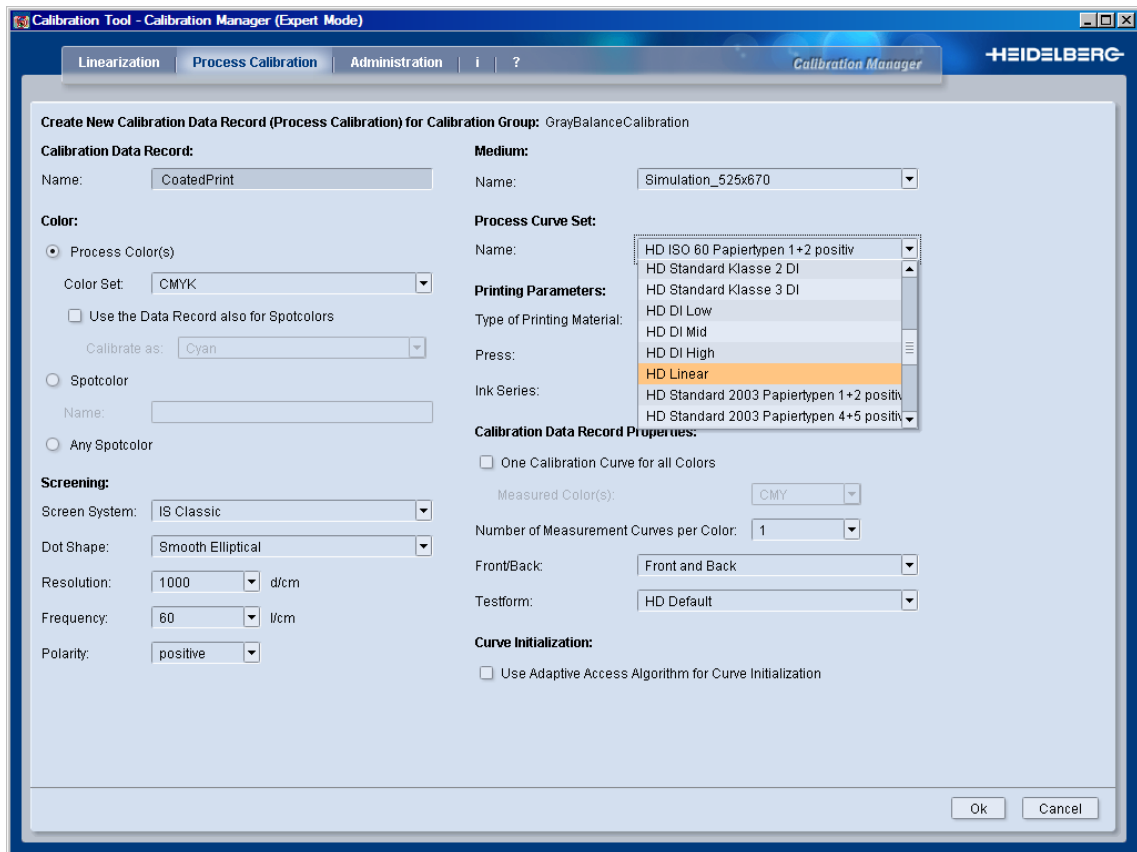
**Figure 22:** Creating a new calibration group

Here, as elsewhere, the name of the calibration group can be anything and serves only as an example.



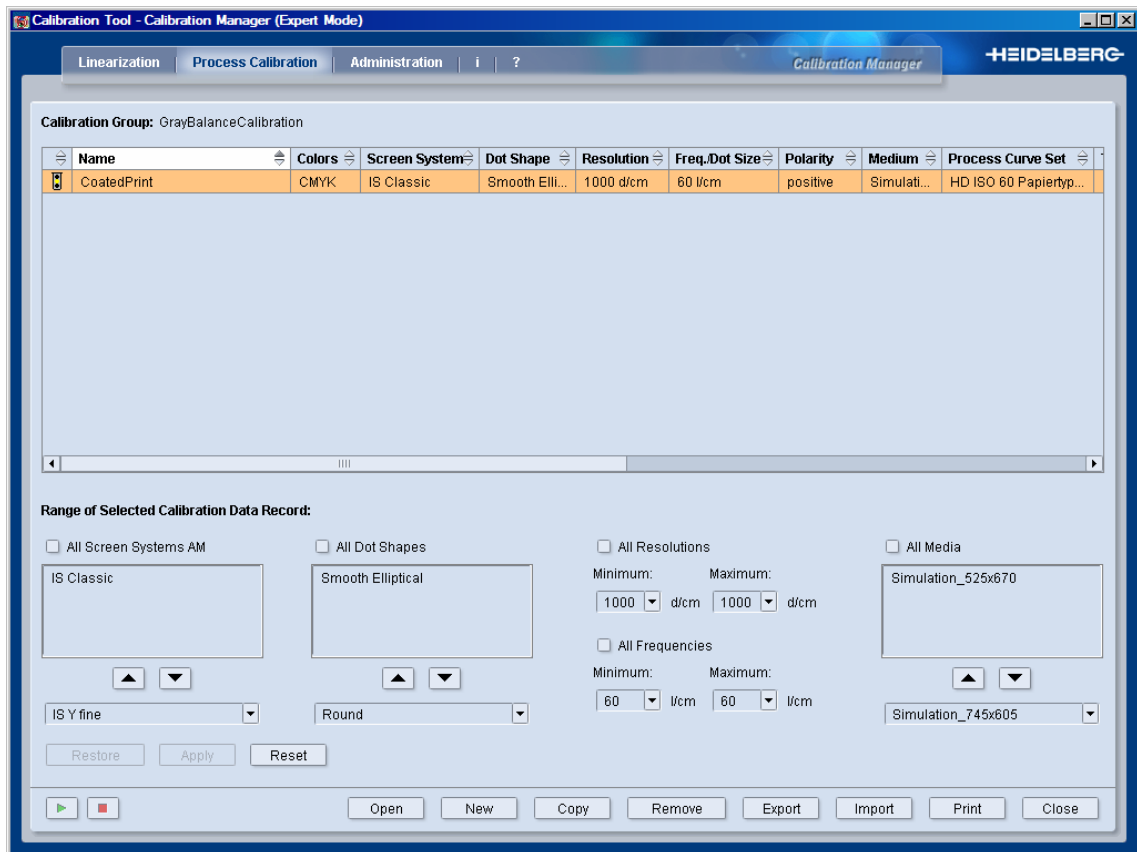
**Figure 23:** Creating a " GrayBalanceCalibration" calibration group

The calibration group is opened and a new calibration data record is created.



**Figure 24:** Parameter a new "CoatedPrint" calibration data record

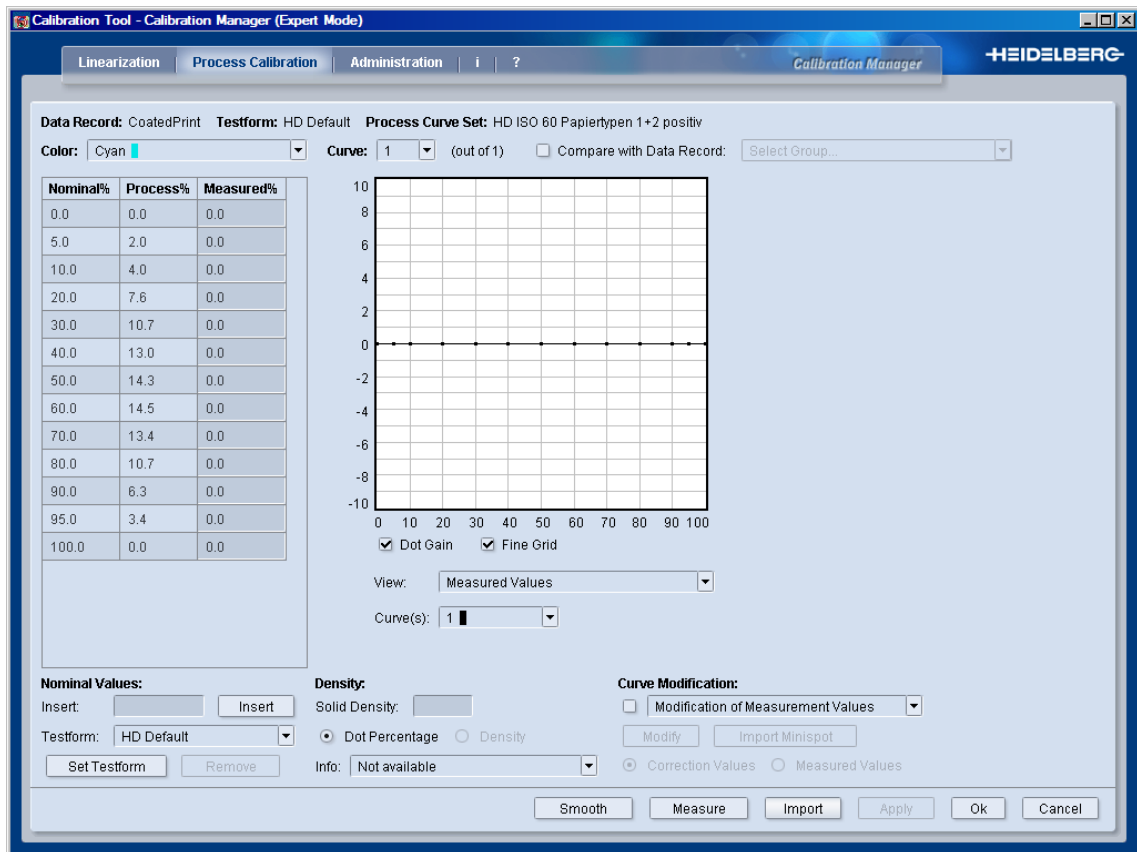
Again, any name can be selected as the data record name; in this example it has been named “CoatedPrint”. Color, screening, medium and print parameters are set as usual. New at this point is that you need to select a linear data record “HD Linear” as the process curve set. Parameterization is concluded with “OK” and the data record then appears in the calibration group.



**Figure 25:** Display and selection of the new calibration data record "CoatedPrint"

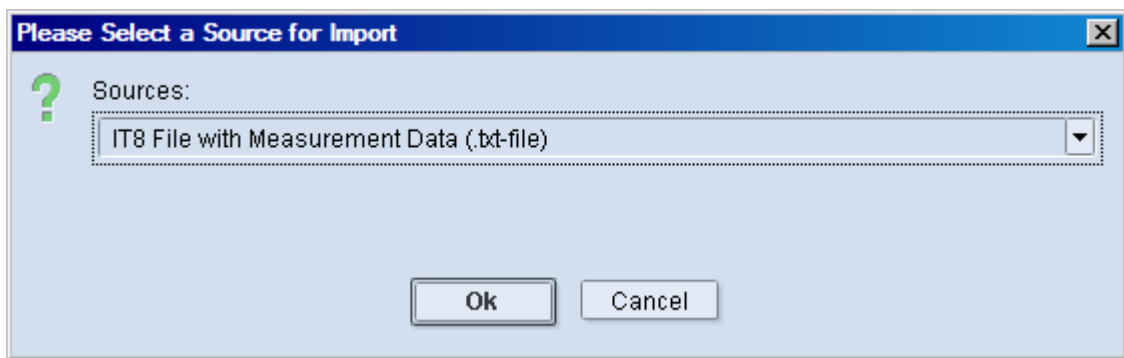
### Importing Gray Correction Data

Once the new calibration data record has been created, the data record is opened and the gray correction data are imported from the gray balance calibration.



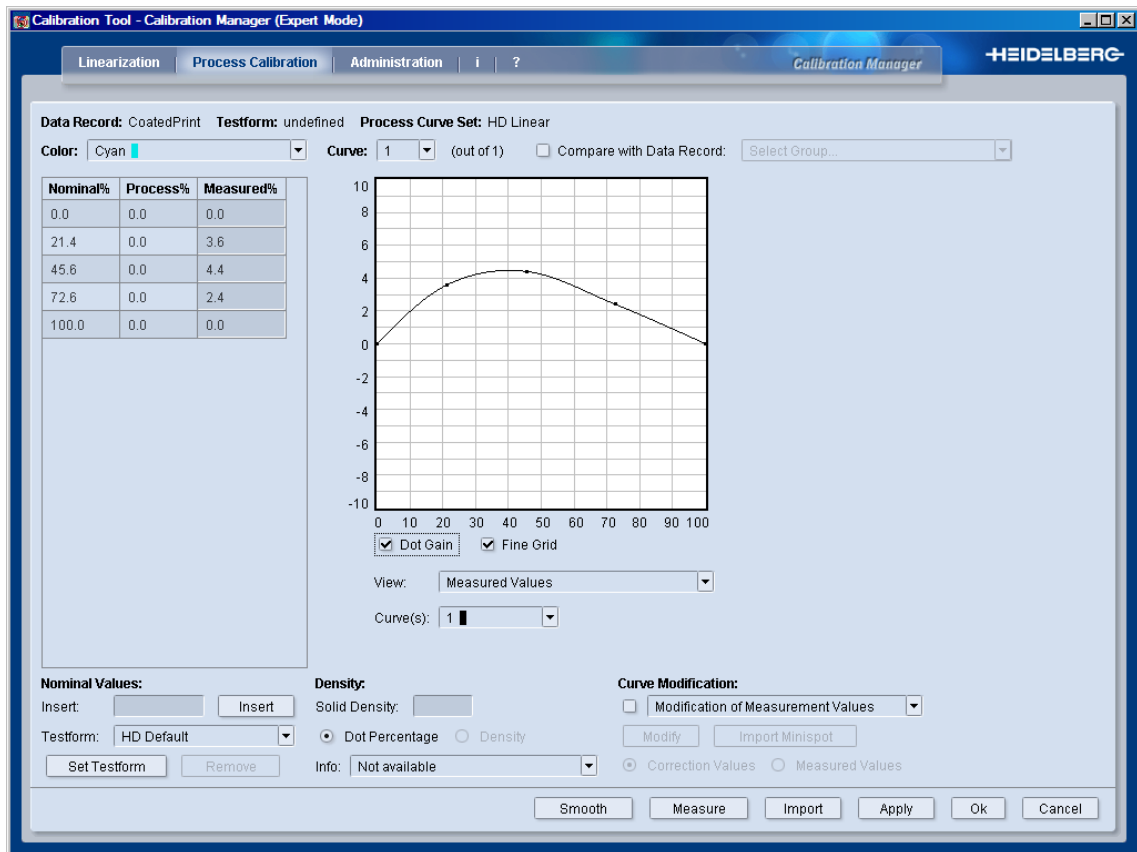
**Figure 26:** Importing the gray correction data

When you click “Import”, a small dialog box appears asking for the type of data source.



**Figure 27:** Selecting the type of data source

In this case, “IT8 File with Measurement Data” is selected as the data type and then in the next dialog box the gray correction data set is selected. Selecting “All Colors”, imports the data, which then are listed in a table and depicted in a diagram.

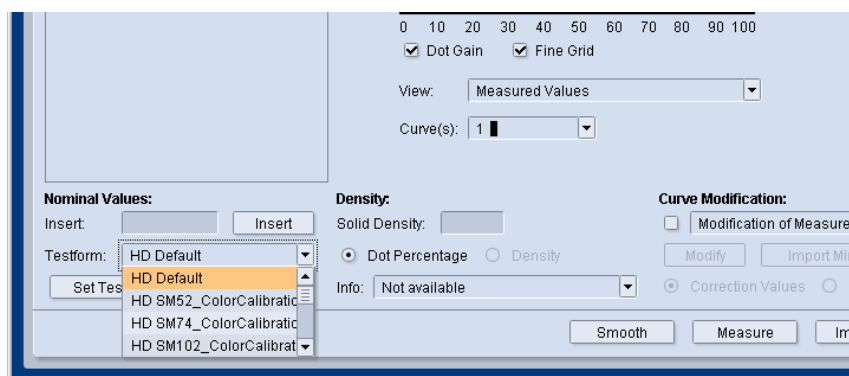


**Figure 28:** Display of the gray correction data record (cyan color)

Clicking the buttons “Apply” or “OK” submits the data to the database.

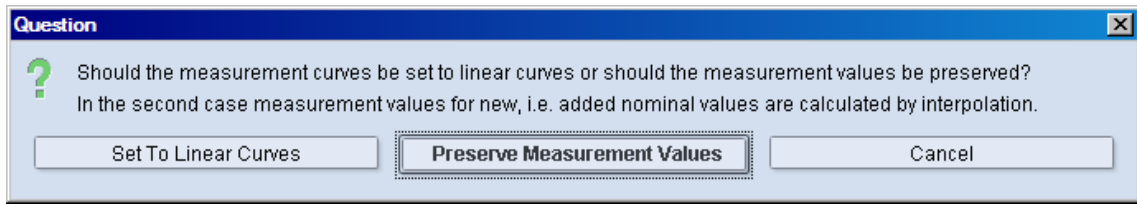
### Exporting Calibration Data Records

The calibration data record can be used in Profile Tool for converting measurement values. To do this, you first need to change the calibration data record into a different format. This is done by inserting nominal values or more simply by selecting a test chart.



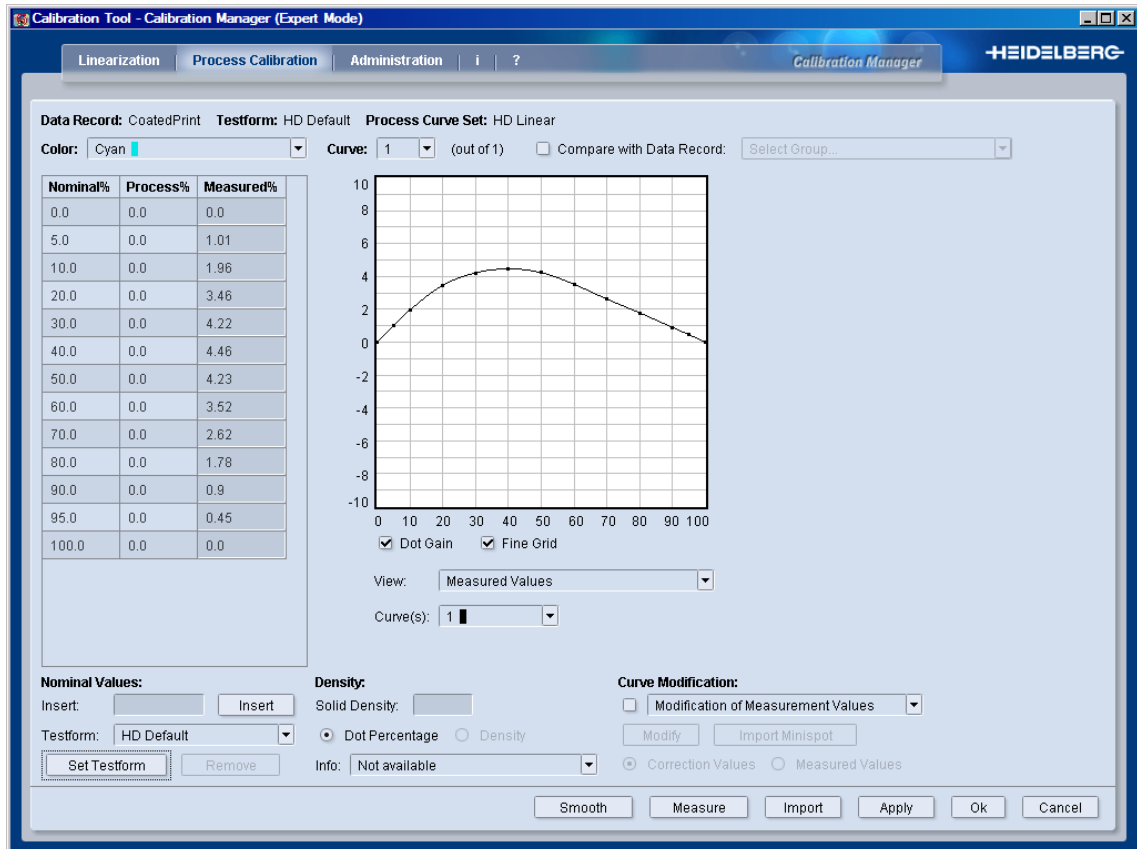
**Figure 29:** Converting the data record

In this example, the test chart “HD Default” has been selected and confirmed with the button “Set Testform”.



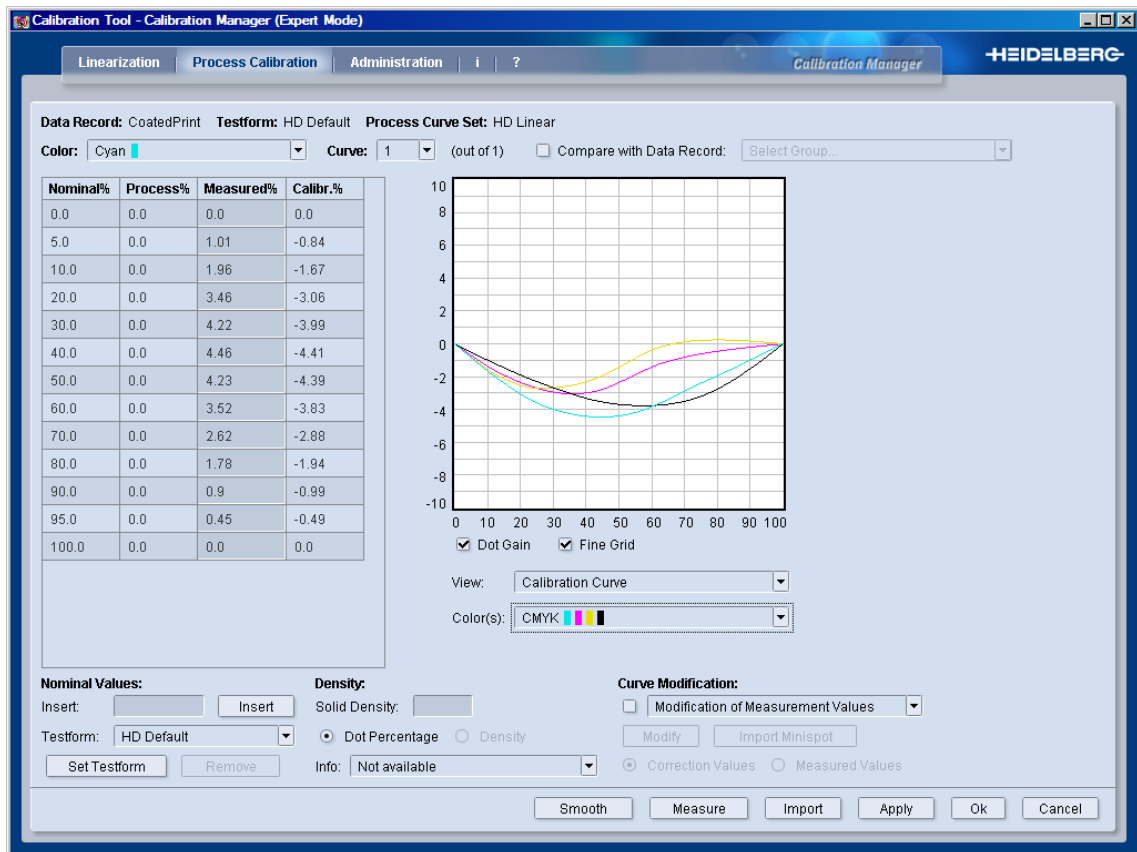
**Figure 30:** Querying test chart conversion method

The user is then asked which method should be used for converting the test chart. In this example “Preserve Measurement Values” has been selected.



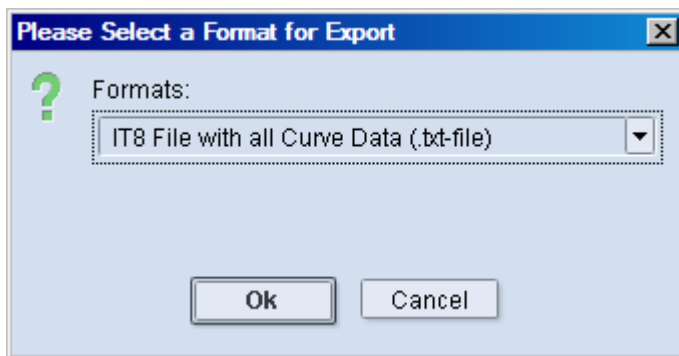
**Figure 31:** Converted measured values

The new values and the new curve are displayed and can be confirmed by clicking the buttons “Apply” or “OK”. Parameterization has been completed and you can now view the calibration curves. To do this, you need to change the view from measurement values to calibration curve and select the colors CMYK.



**Figure 32:** Display of calculated calibration curves

The calibration data record can then be exported from the view “Calibration Group”. The calibration data record contains the measurement values and the process curve, as well as the calibration curve in 1 % steps for the plate-setter.



**Figure 33:** Selection of data format

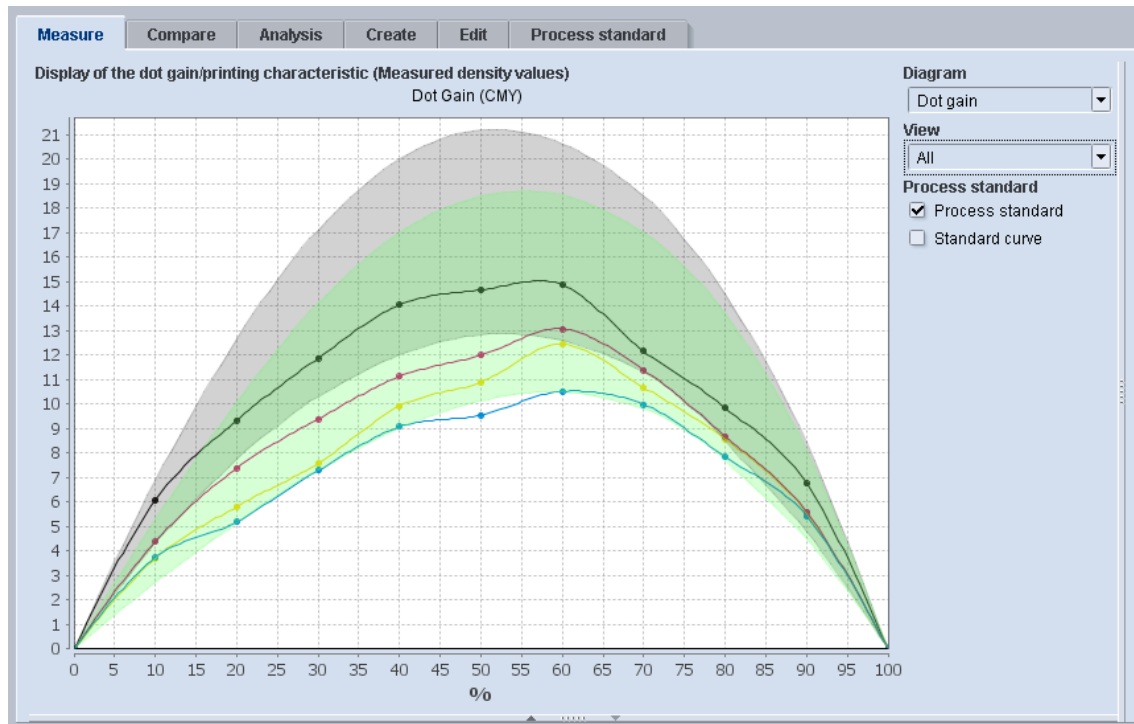
You also need to select the appropriate data format here. In our example we have selected the format “IT8 File with all Curve Data”. The data are given a name and then saved as usual.

### Application of Calibration

At this point it becomes interesting to use the calibration for the next print process and for comparison with a conventional tone value increase -based calibration, which is what we did as part of our test print.

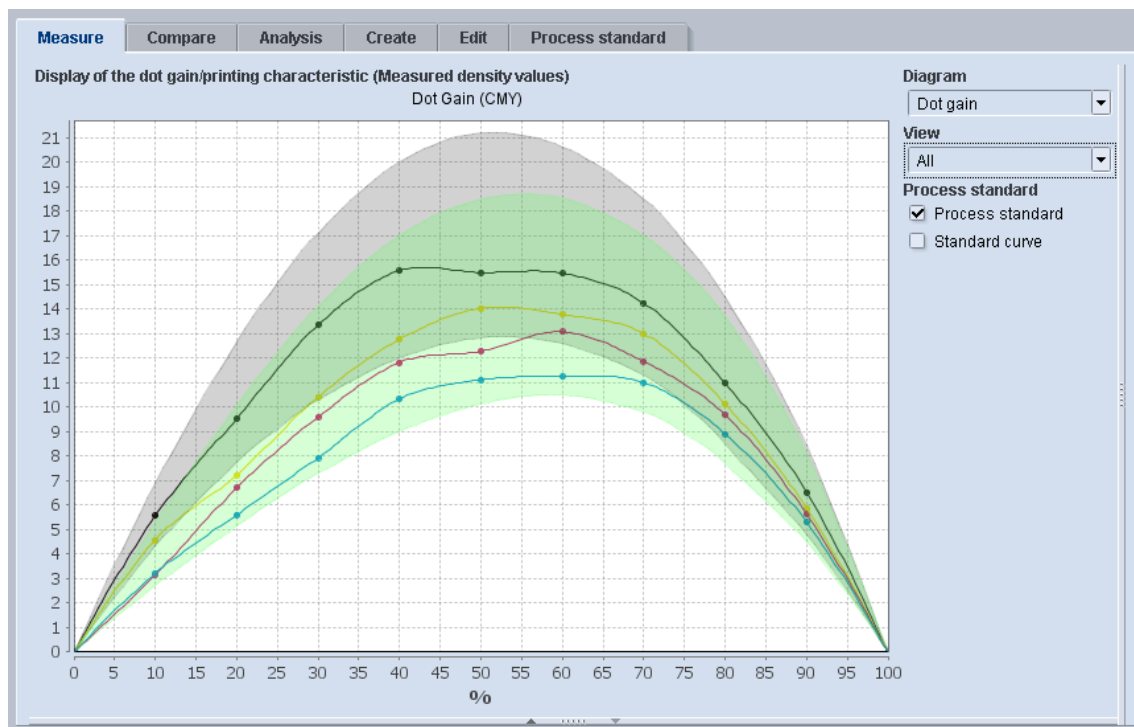
Figure 14 shows the original tone value increase curves before calibration. In comparison to the process standard, tone value increase is far too high here. You can see from

the gray balance calibration in Figure 21 that tone value increase has been reduced while gray reproduction has been corrected at the same time. This can be clearly seen in Figure 34. The data were taken from a subsequent test print.



**Figure 34:** Tone value increase curves after gray balance calibration

Tone value increase is within the tolerance range of the process standard for the chromatic colors as well as for black and the spread is low. This would indicate that the print process has been set up well. Machine settings and materials (paper and printing inks) are a good match.



**Figure 35:** Tone value increase curves after conventional calibration

Figure 35 shows tone value increase in a test print with the same press setup and the same materials but with the difference that tone value increase was calibrated according to conventional methods.

Tone value increase is within the tolerance range of the process standard for the chromatic colors as well as for black. The spread is also low here. You can see slightly different gradations in tone value increase here in comparison to gray balance optimization. Looking at the curve gradation, you can also see that yellow and magenta have been interchanged and that all curves are slightly higher.

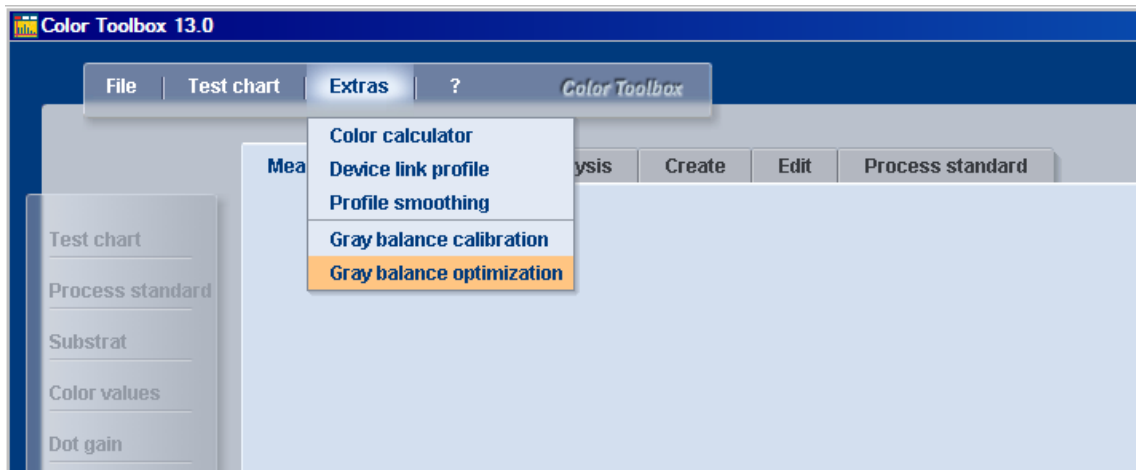
You should be able to see these small differences when comparing the printed images. Direct comparison under standard lighting conditions shows slight differences, although it is a matter of taste as to which of the images is considered to have been reproduced more “correctly”.

### Iterative Gray Balance Optimization with Profile Tool

Iterative gray balance optimization is used when you find that the same gray reproduction corrections continually need to be made manually at the press. In this case, one or more control elements are printed in the subsequent print job as well. These control elements are positioned in an appropriate place on the printed sheet. Current technology supports ECI/bvdm gray control strips.

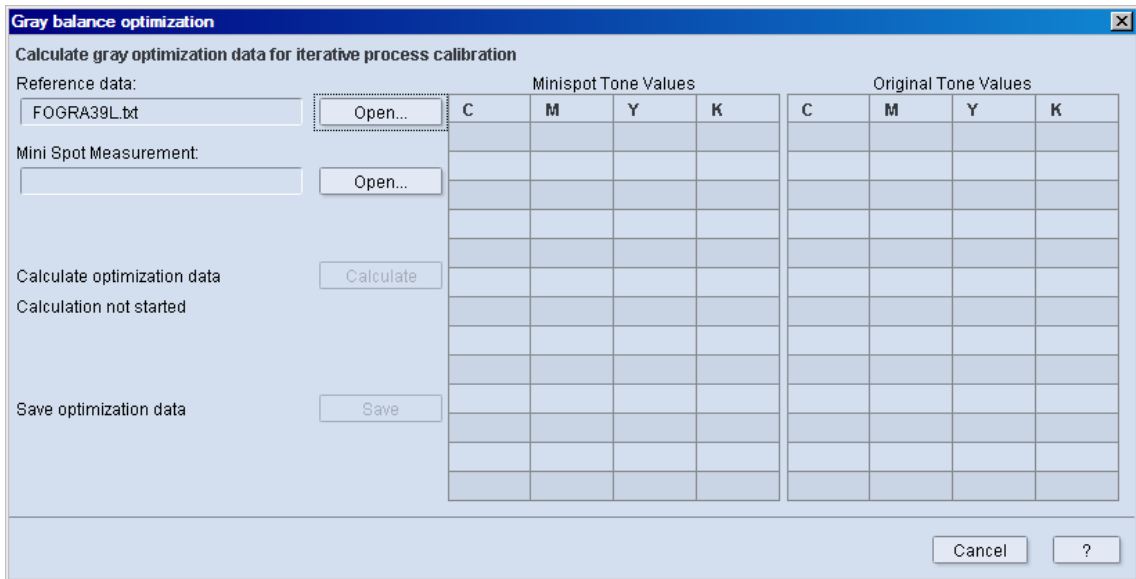
Plate imaging and printing are carried out as usual, but without any corrections for the optimal reproduction of gray values. One or preferably several printed sheets are pulled and the control elements are measured. If several control elements and several sheets are measured, the individual measurements will need to be averaged. This task can be performed easily with Color Toolbox.

Iterative Gray Balance Optimization is opened under “Extras” in the menu bar.



**Figure 36:** Opening gray balance optimization

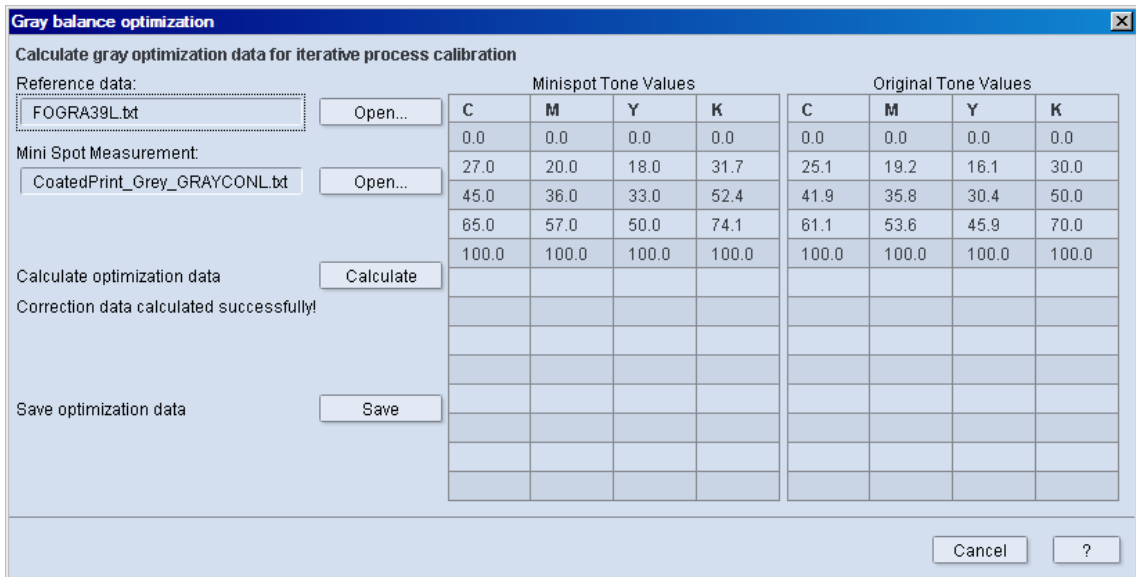
The user interface is shown in Figure 37.



**Figure 37:** User interface Gray balance optimization

After opening the application, first of all a reference printing condition is selected (Characterization data set or ICC-Profile). Then the measurement values of the control elements (Mini Spot measurement values) are loaded. The data format is determined by the control element and cannot be modified.

The following screenshot shows an example of possible parameters and the calculation results. This example is a continuation of gray balance calibration. The measurement values originate from the same test print.



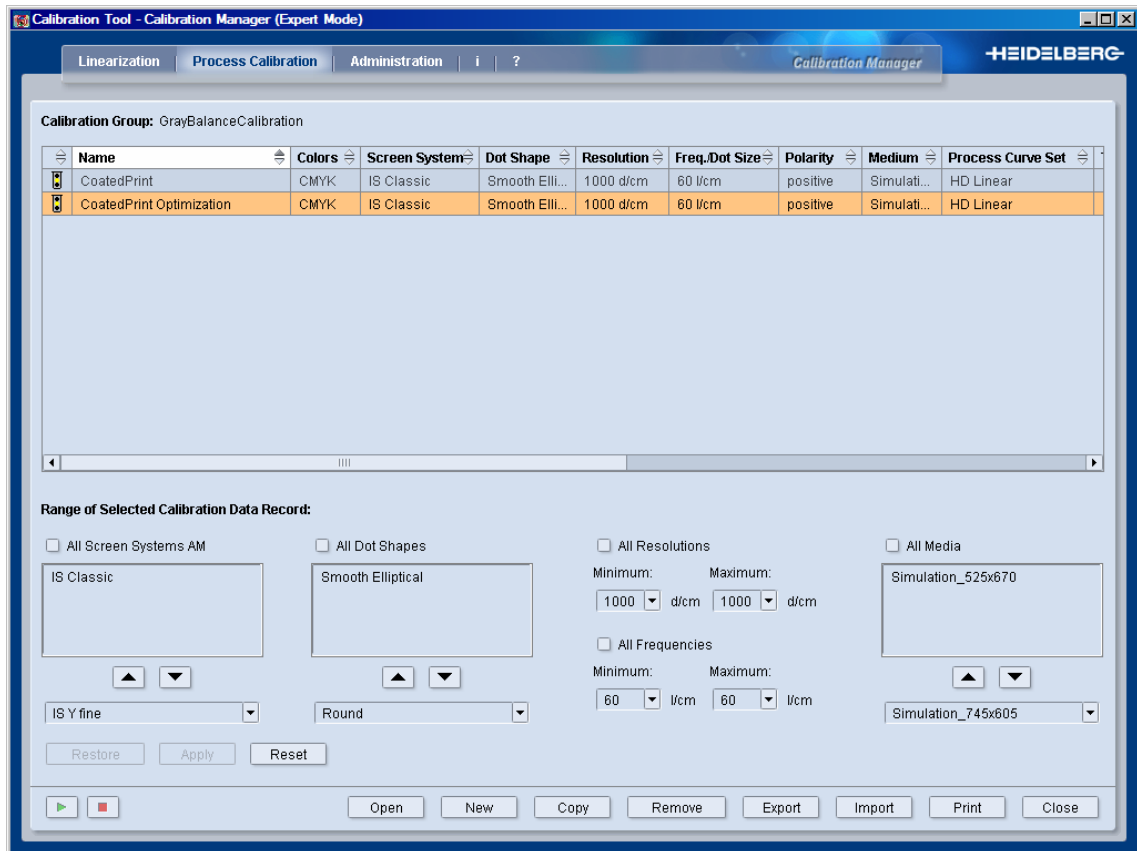
**Figure 38:** Setup and calculation of gray balance optimization

Interpreting the figures takes a little getting used to: the curves should be optimized in such a way that the numerical values on the right-hand side of the table (original tone values) match the numerical values on the left-hand side (Mini Spot tone values). In this specific case, calibration should slightly increase all values throughout. This is consistent with the print results in Figure 34 where the values are slightly too low throughout.

The data from the iterative gray balance optimization are saved and can be further used in Calibration Tool.

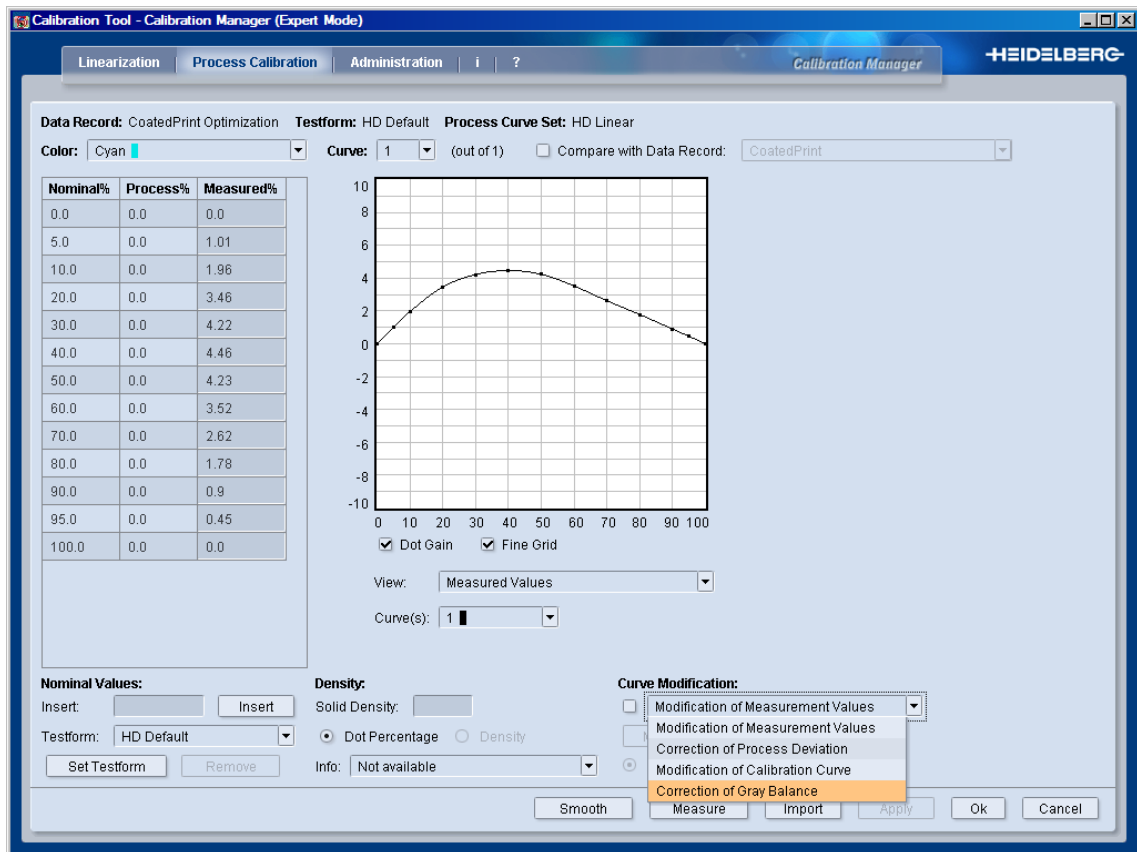
## Iterative Gray Balance Optimization with Calibration Tool

Iterative gray balance optimization is the correction of an existing calibration. We recommend making a copy of the original calibration (in this case CoatedPrint) so that you can carry out corrections on the copy (in this case CoatedPrint Optimization).



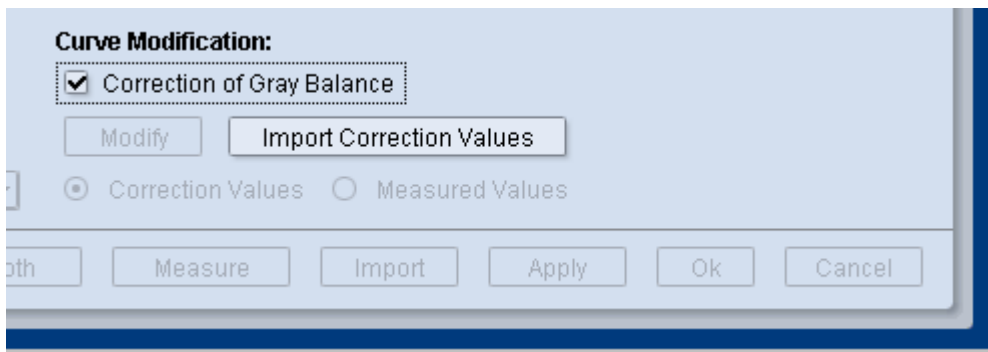
**Figure 39:** Copy of gray balance calibration

This copy is now opened so you can work on it. The dialog box shows the current measurement values. These measurement values should now be modified in such a way that they result in an improved reproduction of gray balance and tone value increase in black.



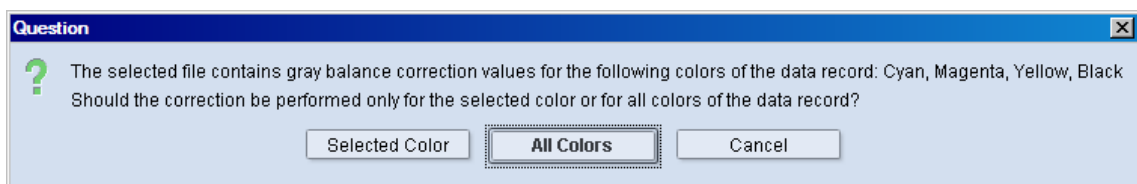
**Figure 40:** Modification of curves

To do this, you need to modify the curves. In this case, a correction of gray balance is necessary. To select the correction method, check the box according to your selection and click “Import Correction Values”.



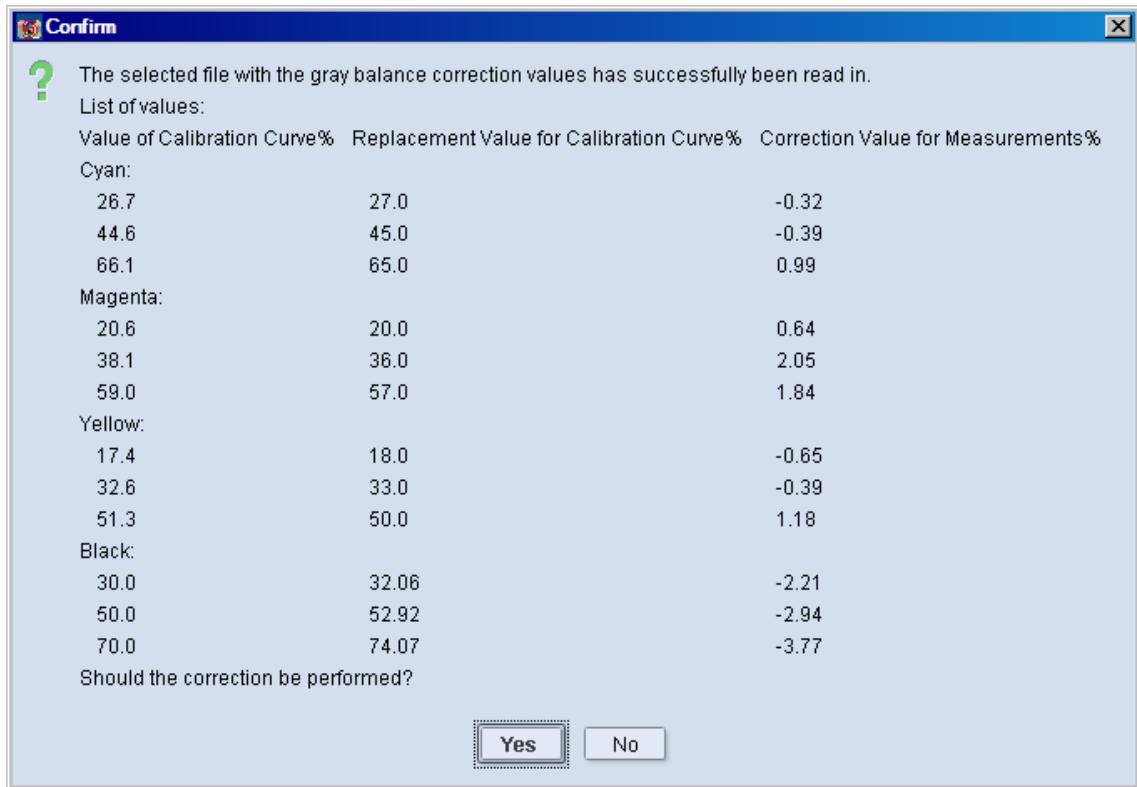
**Figure 41:** Importing correction values for gray balance optimization

The correction values from the iterative gray balance optimization are then imported and a box appears asking whether all colors or only selected colors should be imported.



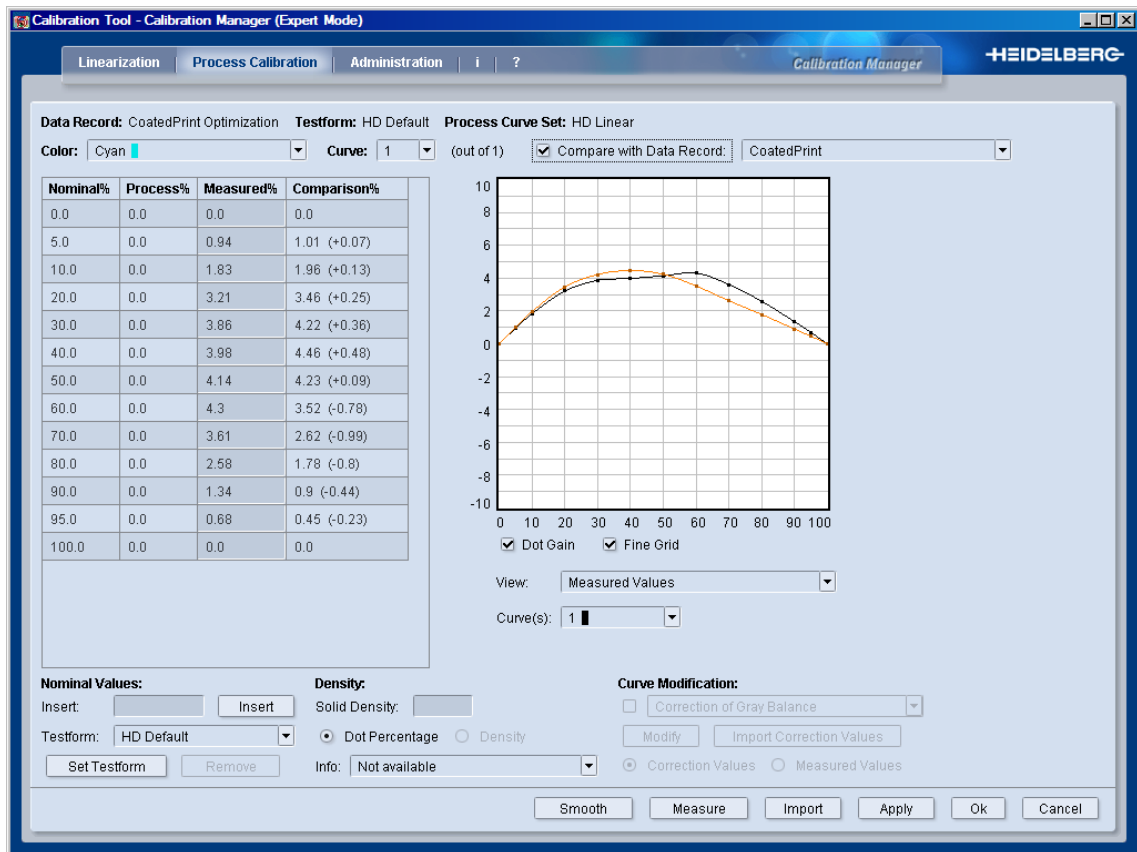
**Figure 42:** Querying import of color data

At this point, you need to correct all colors. The values you want to import are shown in a window.



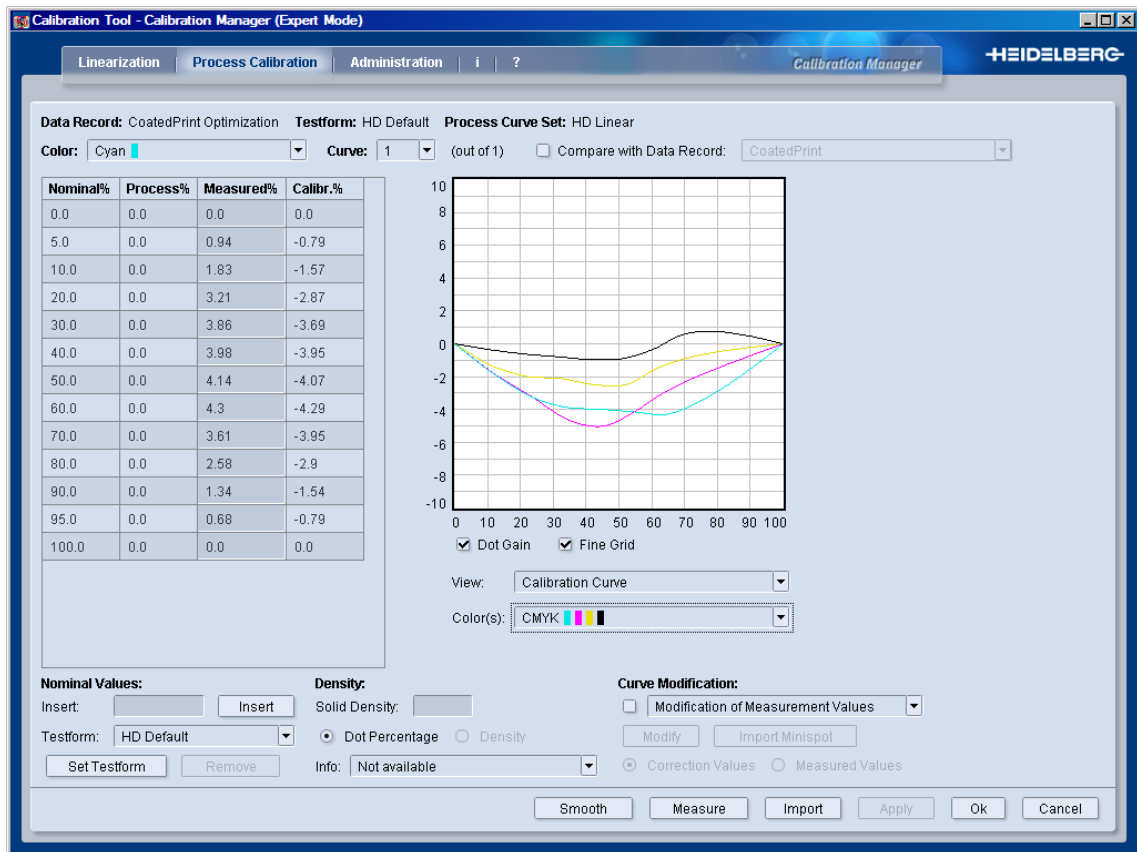
**Figure 43:** Display of imported color data

After you have confirmed with “Yes” that the correction should be performed, the correction values are taken into account in the measurement values and the new measurement values appear.



**Figure 44:** Display of new calculated measurement data and comparison with old measurement data

A comparison between the new and the old measurement values indicates the changes. This comparison can also be carried out with the calibration curves (see the following screenshot).



**Figure 45:** Display of corrected calibration curves

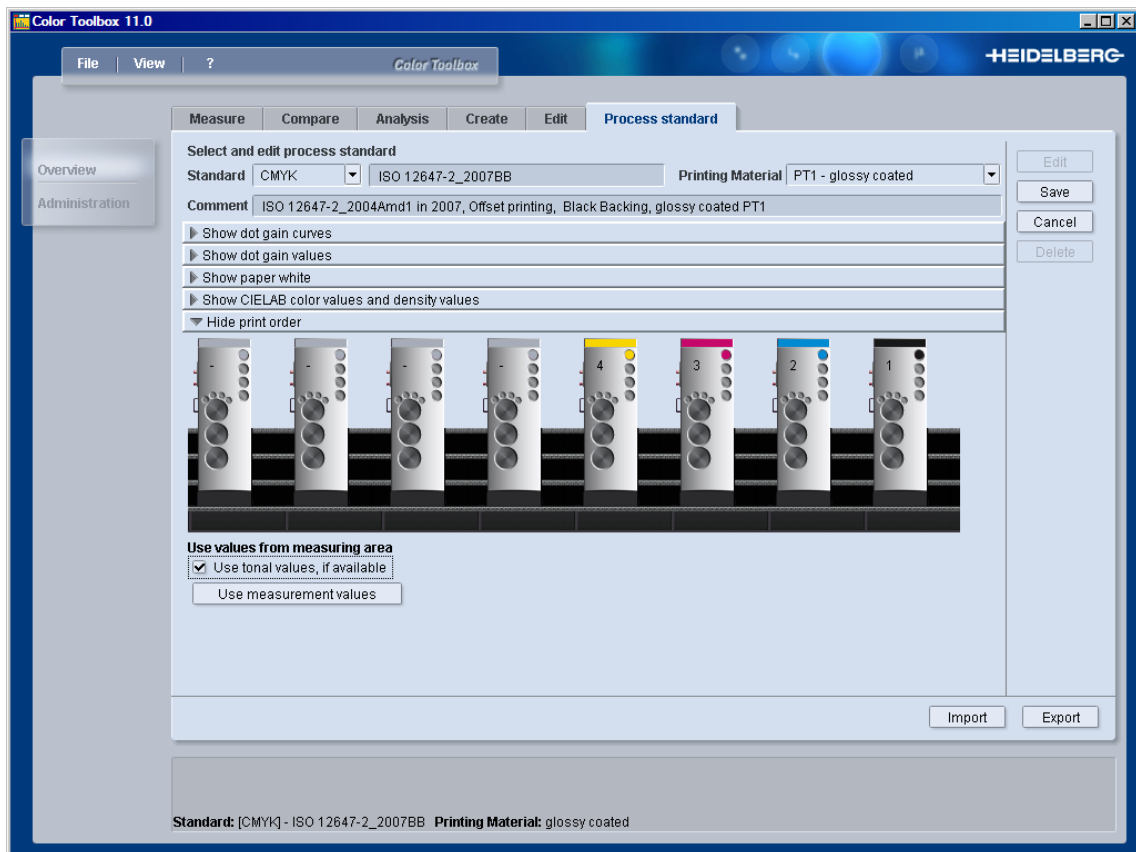
The corrected data are saved with either “Apply” or “OK”, and can be used to correct tone values for the next plate imaging process.

### Process Control with Quality Monitor und Profile Tool

Following gray balance optimization, the tone value increase curves no longer necessarily comply with the specifications of the reference printing condition. The inking values are generally within the tolerance range (unless too many optical brighteners in the paper have led to very large shifts in values). It is, therefore, worthwhile saving the current process as the default standard for further prints.

#### Generating a new Process Standard

With Prinect Color Toolbox, you can save the current measurement values as the process standard and select them when you need them.



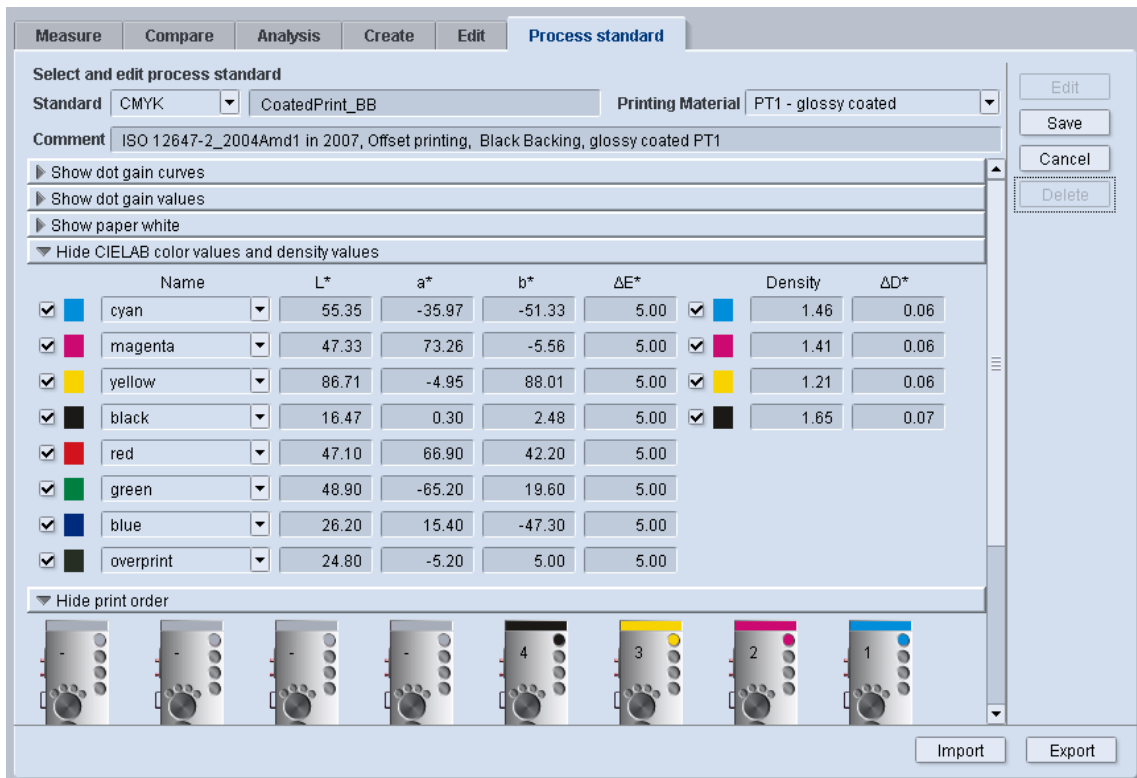
**Figure 46:** Use measurement data as process standard

You can set up a new process standard by clicking “Edit” under “Process Standard” in the main application. First of all, you need to give the standard a new name and it is also worthwhile entering a comment.

Under the toggle “Print Order”, you will find a button “Use Measurement Values”. It is essential that the checkbox for “Use Tone Values” is activated. All the available values are applied and can be checked and manually corrected in the relevant toggles. The values for the secondary colors need to be entered manually afterwards in the toggle “CIE-LAB Color Values and Density Values”.

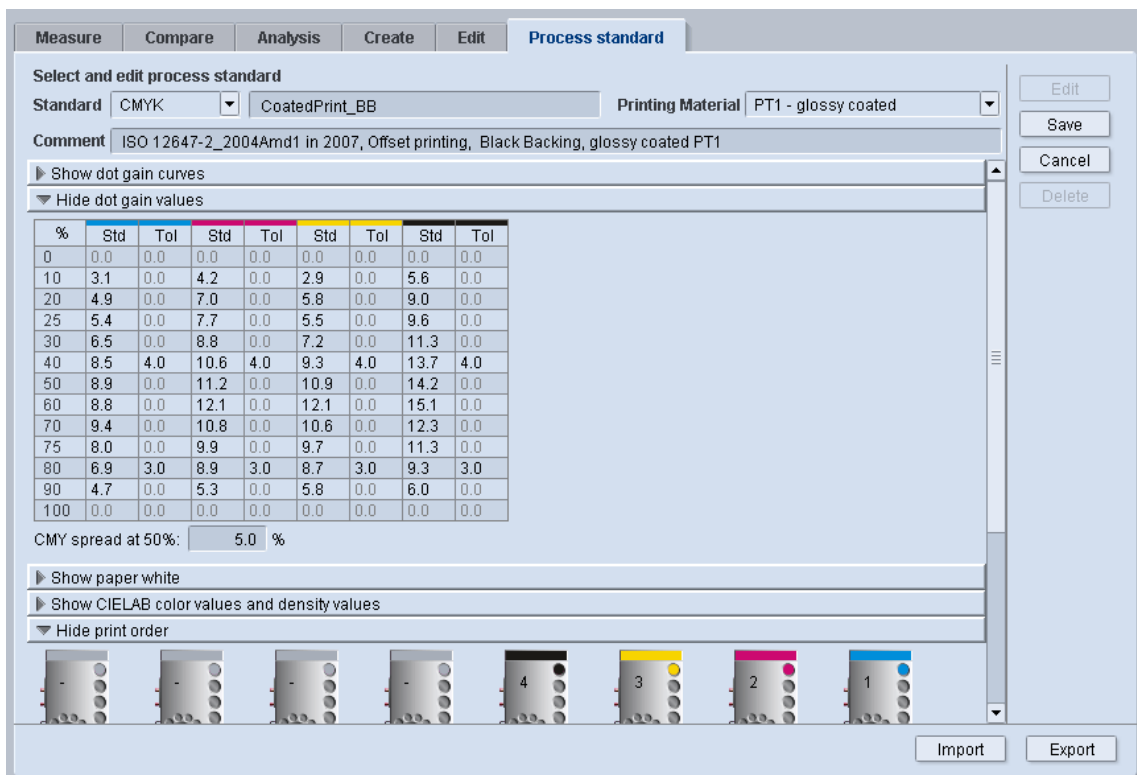
The tone values can also be modified in the toggle “Tone value increase Values”. Frequently tone value curves are slightly wavy since the values can slightly deviate from a harmonious curve due to the design of the test chart and the position of the ink zones. Modifications to the values become apparent in the curves when you first save the standard and then reopen it.

Here, as an example, the measurement values (inking, tone value increase) for the test print have been saved for gray balance optimization. The name of the process standard has been modified accordingly.



**Figure 47:** Setup missing color values for secondary colors

In the screenshot above the secondary colors have been activated to enter their values.

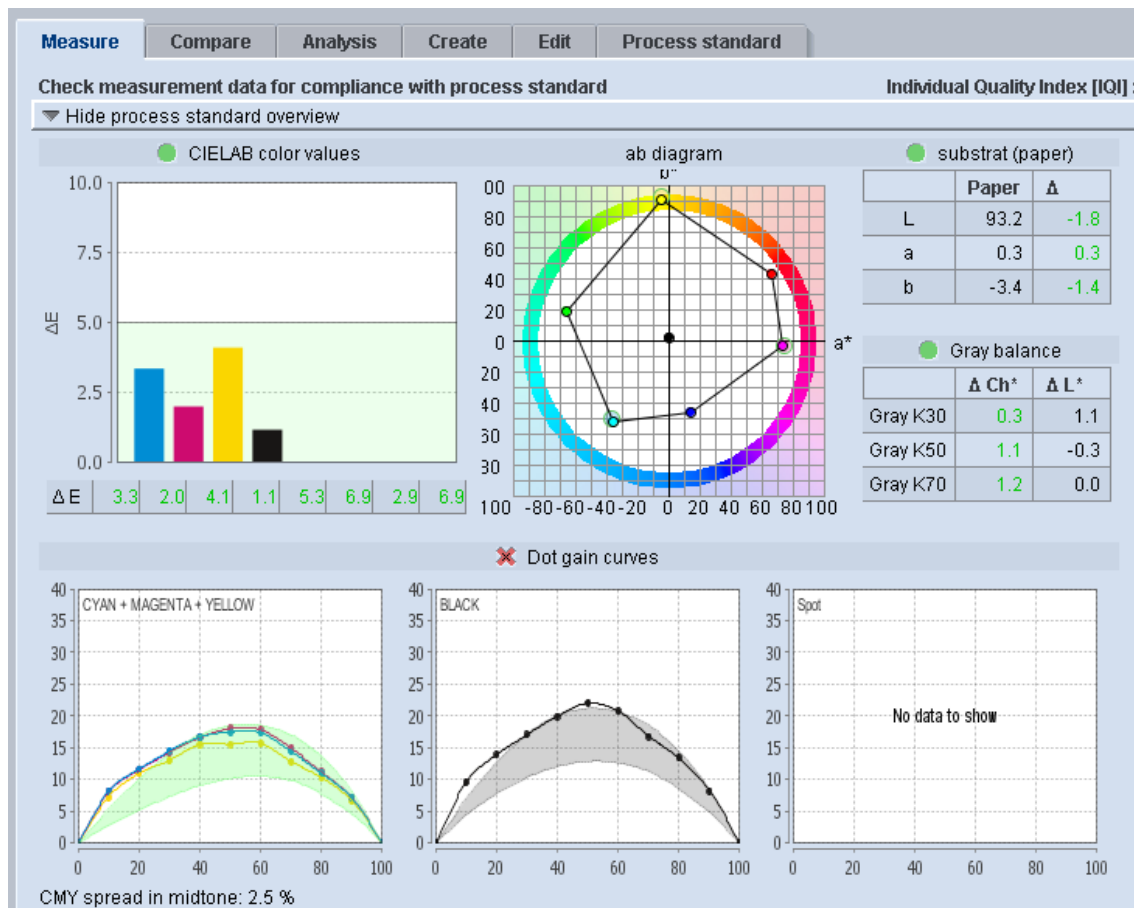


**Figure 48:** Manual setup of tone value increase curves

The tone value curves have not been manually adjusted. The new process standard is saved and is then activated for another process control.

### Process Control of Tone Values and Color Values

Figure 53 shows an evaluation of a gray control strip from the first non-calibrated press proof in comparison to the process standard. The color values are well within the tolerance range. Tone value increase is too high but nevertheless just within the permitted tolerance range. This shows the press has been set up well.



**Figure 49:** Process control tone values and color values from a non-calibrated print run

After gray balance has been calibrated, the tone values and color values are also within the tolerance range (Figure 50). However, tone value increase is slightly low.

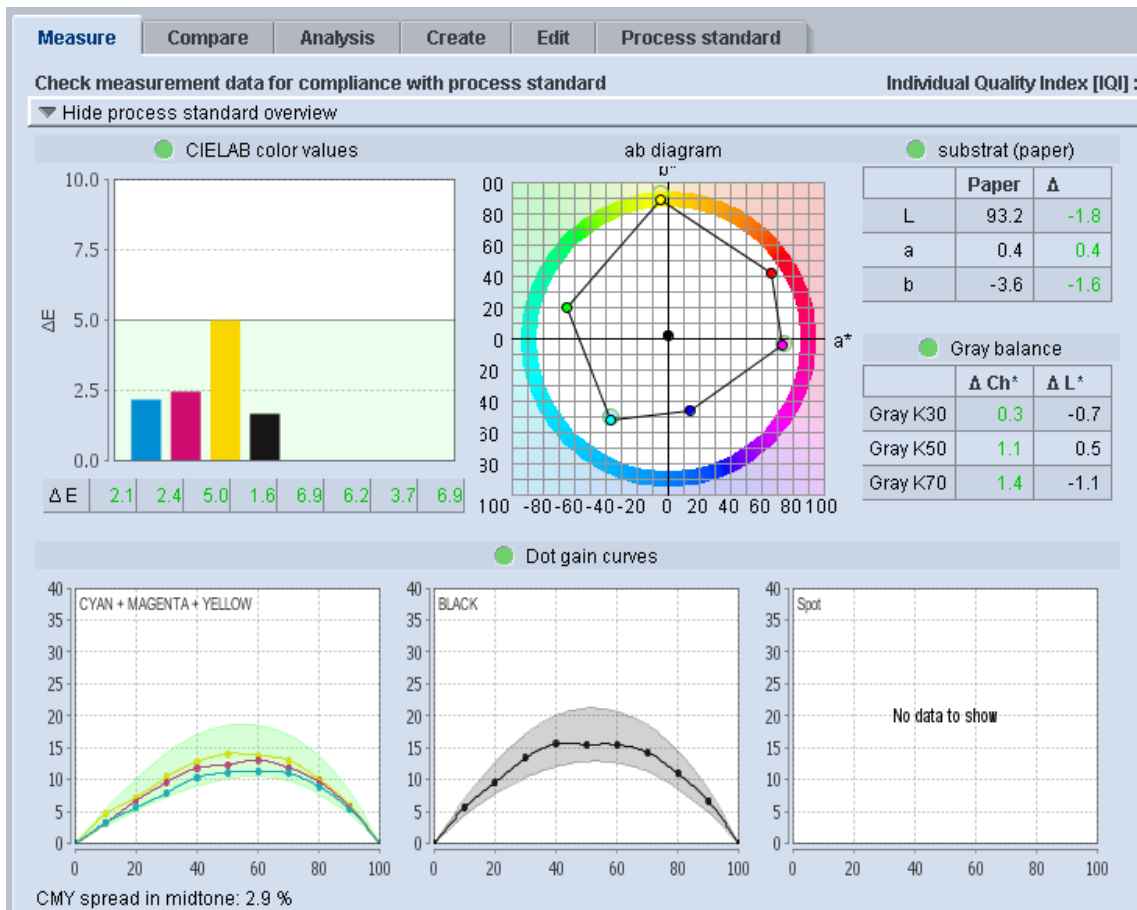


Figure 50: Process control tone values and color values from a calibrated print run

### Process Control Gray Reproduction

Quality Monitor now evaluates the ECI/bvdm gray balance control elements by comparing the chromatic gray patches and the black patch with each other. The following screenshot shows this for the non-calibrated press proof.

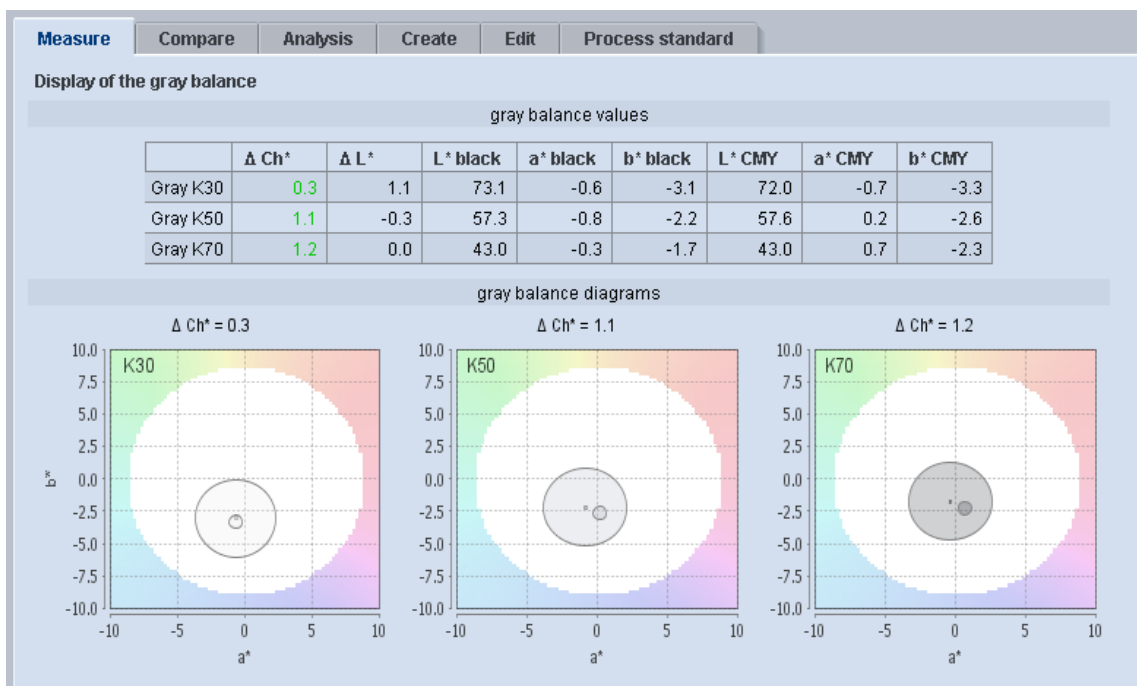
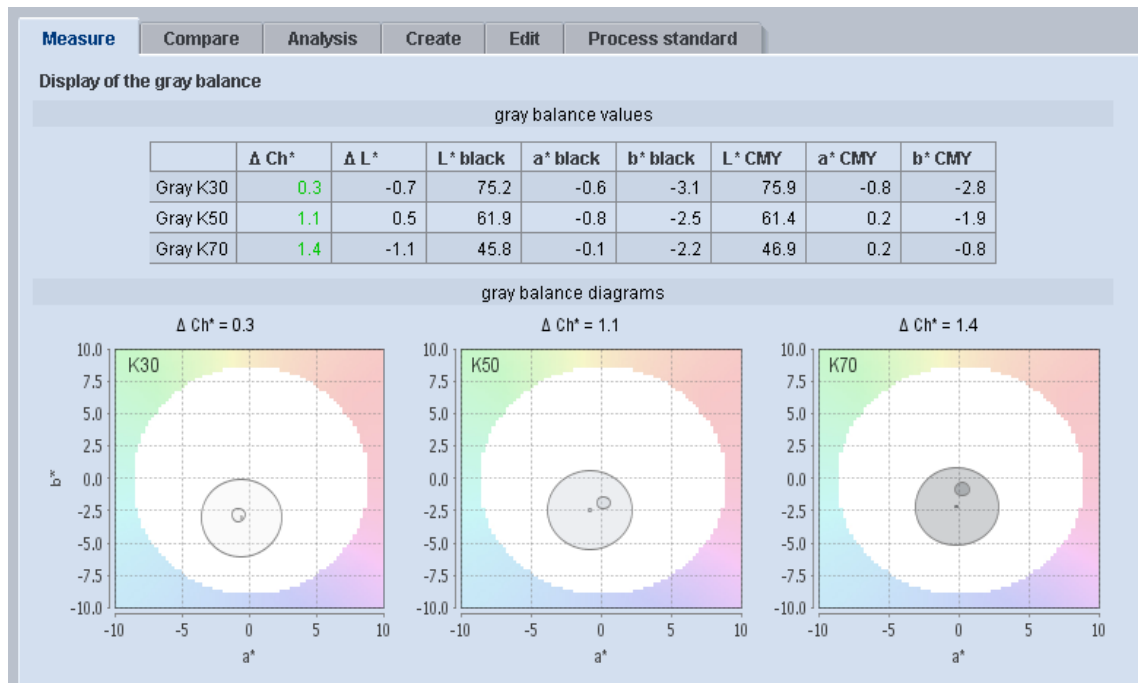


Figure 51: Process control gray reproduction from a non-calibrated print run

The gray balance of the non-calibrated proof was already very good, thanks to the careful setting up of the press and the pigmentation of the printing inks. It was only tone value increase that was too high. This was corrected as far as consistently possible by gray balance optimization so that the gray balance itself has hardly altered (see next screenshot).



**Figure 52:** Process control of gray reproduction from a calibrated print run

While in Figure 51 you can see a slightly violet color cast in gray (cold gray), this has turned into a slightly yellow color cast (warm gray) after calibration. This result was to be expected since the reference printing conditions FOGRA39 and ISOcoated\_v2 also lead to a slightly warm gray.

## Summary

This User Guide describes how to use gray balance calibration and iterative gray balance optimization on the basis of a practical example. Gray balance optimization is a tool for adapting a print process to a specified gray balance derived from a reference printing condition by performing process calibration.

To maintain truly stable print production, special emphasis should also be placed on a color composition with a large amount of black in the gray axis. Following calibration, it is essential that the reference values are saved in the relevant programs for setting up the press and for process control. Following all these points will ensure nothing should come between you and successful printing.

## Glossary

### **Characterization**

Colorimetric description of a (printing) process

### **Characterization data**

Specification of a clear relationship between digital tone values and measured color values (tone values CMYK / color values CIEXYZ or CIELAB)

Characterization data is used in workflows based on color management to describe different input and output processes. It represents the starting point for calculating device profiles or printing process profiles and may also be used for process monitoring.

### **Characterization data record (table)**

Data format for transferring characterization data

The international standard ISO 12642 defines the digital tone values to be used as well as measuring conditions and the file format for printing processes.

### **ECI European Color Initiative**

The European Color Initiative (ECI) is a group of experts who are involved in the media-neutral processing of color data in digital publication systems. It was founded in 1996 as an initiative by the Bauer, Burda, Gruner+Jahr and Springer publishing houses in Hamburg. The ECI develops reference printing conditions in cooperation with Fogra and provides resources such as ICC profiles and control elements ([www.eci.org](http://www.eci.org)).

### **Fogra Graphic Technology Research Association**

FOGRA Graphic Technology Research Association advocates printing technology in the areas of research, development and application and aims to make the results utilizable for the printing industry. The association maintains its own institute for this purpose. Fogra provides characterization data as well as control elements ([www.fogra.org](http://www.fogra.org)).

### **German Printing and Media Industries Federation (bvdM)**

The German Printing and Media Industries Federation (bvdM) is the employers' and trade association of the German printing industry. Its members are twelve independent state associations, in which almost 6000 print shop and media enterprises are organized. The associations of the printing industry are in turn active in national and international committees and associations in order to stand up for the interests of their member print shops. The BVDM provides publications and resources such as the Print Media Standard, the Process Standard Offset or the roman 16 reference images ([www.bvdm-online.de](http://www.bvdm-online.de)).

### **Gray balance**

A set of tone values for cyan, magenta and yellow in the database or on the color separation film which produce an achromatic color when printed under specific printing conditions and viewed under specific conditions

### **ICC profile**

ICC profiles or device profiles are standardized files for describing the color properties of devices, images and graphics when working with colorimetric standards. The ICC

profiles supply color management systems with the required information in order to transform the color data between the widest ranges of color spaces.

**Printing Material**

Paper or material similar to paper for the print job on a sheet-fed offset press

The parameters of current printing materials generally deviate from the reference values of the ISO 12647-2 standard to a larger or smaller extent and exert a considerable influence on the reference values.

**Print order**

Specification of the color sequence in a press run

The characterization data and profiles have been determined for a defined sequence. The usual sequence is K, C, M and Y.

**Process standard**

A specification of the process parameters and their values that should be used when generating color separations for four-color prints or proof prints

**Reference printing condition**

A standardized, generally known printing condition, in which the measured values adopt stipulated reference values

Example: FOGRA39, offset printing according to ISO 12647-2:2004 and Amd1:2007 on 115 g/m<sup>2</sup> coated art paper, process colors in line with ISO 2846-1. Characterization data of reference printing conditions can be downloaded from Fogra.

**Reference print profile**

Exemplary and practice-oriented implementation of a reference printing condition with a defined total area coverage, black composition and adjustment to the color gamut

Reference press profiles can be downloaded from the ECI.

**Tone value increase (tone value increase)**

Difference between the tone values before and after one or more processing steps

The tone value increase can also be negative (tone value decrease). This specification mainly applies to a tone value of 40%. Units: %

**Tone value increase characteristic curve (tone value increase curve)**

Graphic display of the tone value increase of a printing process

The tone values of the data record or film are given on the horizontal axis, and the tone value increase on the vertical axis.

## Literature

### **ISO 12642-2:2006**

Graphic technology – Input data for characterization of 4-colour process printing – Part 2: Expanded data set

International standard

Source: Beuth-Verlag, Berlin ([www.beuth.de](http://www.beuth.de)).

### **ISO 12647-2:2004 and ISO/AMD 12647-2:2007**

Graphic technology – Process control for the production of half-tone colour separations, proof and production prints – Part 2: Offset lithographic processes

International standard

Source: Beuth-Verlag, Berlin ([www.beuth.de](http://www.beuth.de))

### **ISO/TS 10128:2009**

Graphic technology – Methods of adjustment of the colour reproduction of a printing system to match a set of characterization data

International technical specification

Source: Beuth-Verlag, Berlin ([www.beuth.de](http://www.beuth.de))

### **Process Standard Offset 2012**

Description of the inspection methods and materials, the working procedures and requirements of data and films, test and proof prints as well as plate making and print run production.

Source: German Printing and Media Industries Federation (bvdm), ([www.bvdm-online.de](http://www.bvdm-online.de))

### **Print Media Standard 2008**

Technical guidelines for data, films, proof printing and print run production

The Print Media Standard is made up of various modules, and it is the user's own responsibility to ensure that these are organized and implemented correctly. The Print Media Standard contains information on all significant components required for correct application in the individual printing processes.

Source: German Printing and Media Industries Federation (bvdm), ([www.bvdm-online.de](http://www.bvdm-online.de))

### **ECI Gray Control Strip**

Control element for checking tone value increase and gray reproduction for a defined printing condition visually and by measurement.

Source: ECI European Color Initiative ([www.eci.org](http://www.eci.org))

### **G7 Specification**

American specification for the production of prints according to predefined gray balance

Source: IDEAlliance ([www.idealliance.org](http://www.idealliance.org))