CROSS INDUSTRY SPECIAL REPORT

GB

Process Colour Standardisation

connection of competence

PrintCity

FUJIFILM

gmg color

HAMMESFAHR PrintPerfection

manroland

sappi The art of adding value

SunChemical a member of the DIC group

TRELLEBORG

The Biofore Company UPM

Bibliography, contacts and recommended reading

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"Testing and Selecting Paper" *UPM*

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Some useful contacts

Altona Test Suite Application Kit
www.altonatestsuite.com

Altona Test Suite (online version download)
www.eci.org

ECI (characterisation data, profiles, etc.) www.eci.org

Fogra (characterisation data etc.) www.fogra.org

ICC (characterisation data, register etc.)
www.color.org

IDEAlliance® www.idealliance.org

ISO (TC 130 Graphic Technology) www.iso.org

MediaStandard Print
www.point-online.de/download/pdf/free/86035.pdf

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Process Standard Offset www.psoinsider.de

roman16 bvdm reference images www.roman16.com

Design and page make-up: **ID-industry, Paris**
Printing: **Hammesfahr**
Inks: **Sun Chemical**
Paper: **Sappi and UPM**

Foreword

The purpose of this PrintCity guide is to promote the better understanding and use of process standardisation and workflow optimisation. This guide is not intended to be a manual or a specification and is complementary to the work of ISO, PSO, Fogra, IDEAlliance®, ECI, ICC, and other organisations.

The PrintCity project members have share their combined competences to help implement standardisation to improve quality, consistency and productivity. An important part of this project was the case study PSO implementation and certification with the printer Hammesfahr in Germany.

Successful implementation of a printing standard normally provides printers with the benefits of improved cost, quality and time performance, with better sustainability and reduced waste.

The use and certification of a standard is an increasingly important business requirement for customers who require demonstrable quality control. To understand better print buyer motivation, PrintCity worked with f:mp to survey the views of over 50 German print users and designers. They identified their top three top benefits from working with standardised printing companies as improved quality, consistency and reduced errors. However, in 2010 less than 1000 printers were operating with a certified process — only a small proportion of the world's printers equipped with 4-colour production facilities. Printing without certification to a standard is probably higher, for example around 3500 PSO implementation manuals have been sold (up to early 2011).

Correct colour setting depends significantly on how humans see, understand and communicate colour. It is also important to share reasonable expectations of 4-colour printing, which, due to the limits of pigment, paper and the process, can reproduce only around 10,000 colour shades. This means that good results requires all participants in the graphic chain to work with colour as a system. Standards with specific colour targets and specifications are a systematic tool to help achieve this. The trend to 'print by numbers' is driven by customer requirements for verifiable quality control, globalisation and remote site printing using prepress data transmitted with numeric control values.

Some of the primary elements for improved performance include:

- Adequate planning, specification and job preparation by the customer and the printer.
- The selection, use and maintenance of a standard and its specifications because colour management cannot fulfil its objectives without standardisation and process control.
- Certification of a standard or specification helps maintain process discipline and offers demonstrable business differentiation.
- An integrated industrial manufacturing strategy that combines standardisation, process control and defined procedures is essential to achieve higher quality and productivity benefits.
- Complete and coherent control of the printing workflow. Each output step needs to be controlled with measuring techniques and methods that achieve a predictable outcome. Success requires that within this approach the customer, prepress supplier and printer work together.
- The use of colour measurement tools with an appropriate on press approval method. Human factors are often overlooked in the colour approval process. These include subjective and varying perceptions of colour, communication and expectations, and also different viewing environments amongst customer, agency and printer.
- Effective maintenance and standard operating procedures are key success factors to ensure rapid start-up, optimum quality, productivity and on-time delivery.

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Frequently Asked Questions ...

What is a printing quality standard? *See page 12*

Standards establish a common language across the entire value chain. Standardisation has a positive impact not only on internal workflows but also on communications between printer, print buyer and designer. Colour approval and acceptance of the printed job is influenced by the quality of prepress, press specifications and the working relationship between printer and customer. Standards are the base for predictable and comparable results independent of output device or location.

What is the printers' benefit from standardisation? *See page 6*

Standards provide accountable quality control, increased reliability and efficiency leading to reduce costs, improved profitability, competitive differentiation and business sustainability.

Do print buyers value standardisation? *See page 7*

Yes. A survey of German print users and designers identified the top three benefits identified for them as improved quality, consistency and reduced errors.

What is ISO 12647-2? *See page 12*

This printing standard address 4-colour process control of halftone colour separations, proof and production prints for sheetfed and heatset web offset. It defines incoming data and how this is converted onto the plate and the outcome of ink-on-paper. www.iso.org

What is a printing specification? *See page 12*

Print specifications provide the guideline and framework for working with standards. The two most important specifications are Process Standard Offset (PSO) from bvdm/Fogra Germany, and GRACoL® from IDEAlliance®. USA.

What is PSO?

PSO stands for Process Standard Offset. It is a manual that provides guidelines and best practices on standardisation of offset processes, it was first published by bvdm in 1980. It fully supports ISO 12647 and other ISO standards used in the complete graphic workflow.

What is certification? *See page 14*

Certification is the written confirmation by a credible organisation that a company's services, production processes or products have been tested to be in conformance with a relevant standard(s).

Who makes a certification? *See page 14*

The current ISO 12647 has no defined method of certification within the standard. As a result, current ISO 12647 certifications are private, and are more or less recognised by the international community. There are important differences between them in their requirements, criteria, testing, auditing etc. ISO has commissioned Working Group 13 to develop a print certification standard.

How can standardisation benefits be measured? *See page 7*

Key Performance Indicators (KPIs) can quantify standardisation benefits: they help diagnose current performance and monitor process workflow improvements.

Why should we care about process control? *See page 6*

The more we control the printing process, the less waste in time and materials. Every step in the printing process is influenced by variables that may create colour deviations. Effective process control measures defined variables and monitors their output in comparison to a standard definition – any deviations from optimal values can then be corrected.

What are the key influences on quality? *See page 18*

There are many variables that influence colour, even in a standardised process. Primary process parameters with a direct bearing on visual characteristics of the image include printing sequence, press, ink, substrate, screening, and plate. Secondary parameters that can indirectly influence the image include: speed, dampening solutions, additives, cylinder packaging and blankets, ink/water balance, roller setting, ink film thickness, trapping, temperature and humidity.

... and Some Answers

What is profiling? *See page 10*

A standardised colour managed workflow requires all input sources (cameras and scanner) and output devices (monitor, proofer, press) to be individually colour characterised and profiled.

Why is the printing press profile the fixed point from which all other devices are set? *See page 10*

The printing press has the smallest colour gamut and the most variables of all devices in the workflow. Therefore, it is the fixed point from which all other devices are set, working backwards up the process flow. Ideally a single printing profile for all presses in a plant should be used, providing that all presses are printing within a common tolerance range.

How important is using a standard for incoming digital data? *See page 20*

ISO 15930 defines how applications to create and read PDF/X files should behave for reliable prepress data interchange. The aim for designers is to supply a digital content file that will be printed predictably, while printers and publishers receive robust files, avoiding reworking or errors. PDF/X is designed to be easy and cheap to create.

Does my proofing system need to be calibrated? *See page 22*

Yes. The contract proof is the visual constant in the process because it is produced with tighter tolerances than offset printing. Proofing systems must be able to calibrate the complete colour gamut to archive high quality results on a regular basis – only this can ensure a constant reproducible quality.

Why are plates so important? *See page 24*

Reliable printing requires stable plate and plate making that comes from the right combination of platesetter, plate, processor and developer for the technology selected. The plate has a major influence in print colour approval because the stability of dot reproduction within specified tolerances is critical.

Why is blanket performance critical? *See page 27*

The blanket is central to good offset printing and requires careful selection, packing, tensioning and cleaning to ensure printing quality, durability and minimum press down time. Excellent print quality requires a blanket that combines good registration and an accurate dot reproduction.

How important are maintenance and consumables? *See page 28*

Effective and systematic operating and maintenance procedures are fundamental to process stability and standardised materials are required to achieve the best possible results. All consumable materials should be optimised as a system (ink, pressroom chemicals, blankets, paper and plates).

What is the influence of paper? *See page 30*

Paper has the single largest impact on print quality. Paper has visual (gloss, brightness, opacity) and tactile properties (stiffness, roughness,) that affect its quality perception. Equally as important is the combined effect of paper and ink on colour reproduction. The paper surface and shade impact on the reachable colour gamut and the colour reproduction is influenced by the paper surface effect on TVI.

Is there an environmental impact from ISO 12647-2?

Any manufacturing efficiency improvement from using standards not only reduces costs but also provides environmental benefits from reduced waste of paper, ink, consumables, energy, and carbon footprint.

Is it possible to apply the ISO 12647-2 to digital printing?

Some digital printing presses may be able to reproduce the colorimetric aim and simulate the TVI of ISO12647-2 standard, and at least one digital printer has applied for certification. However, the standard was created for offset printing and certification is only for this process. The ISO TC 130 WG3 is currently working on a specific standard for digital printing that will address issues like data handling, substrates, achievable colour gamut, colour stability during the print run and visual comparison to 12647-2. The new standard series will probably be available under ISO 15311 in 2012/13. (For more information see Fogra Extra issues 23 and 25 on Process Standard Digital Printing, download from www.fogra.org.

Glossary & colour basics

Brightness: Method developed to monitor the bleaching of pulp. Measures reflectivity at bluish wavelengths (400-500nm). Different brightness measures used include ISO (C-illumination), D65-illumination, UV-cut, Tappi.

Characterisation tables: Compare the measured colour values of an original with the colour values of the data file.

Control strip: An array of control patches for measurement purposes.

Colour difference ΔE: Method to compare colours measured with CIELAB. In ISO 12647-2 it is defined as the difference in colour of the primary solid tones compared with the colorimetric aims should not differ more than ΔE 5. It is a 3-dimensional scale that includes the distance between two colours but excludes the direction of the deviation. The higher the value is, the larger the difference between two measured colours.

CMYK: Process colours **C**yan, **M**agenta, **Y**ellow and Blac**K**.

Dampening solution (fountain or font): Mixture of chemicals and water to prevent image acceptance on non-image areas of a printing plate.

Density (paper): Indicates how compact the paper is (the inverse of its bulk).

Device link profiles: A profile format that directly links two colour spaces. *See page 11.*

Dot gain: See Tone Value Increase (TVI).

ECI: European Colour Initiative – a group working on device-independent data processing in digital publication systems.

GRACoL®: General Requirements for Applications in Commercial Offset Lithography is a US colour reproduction specification for sheetfed offset using ISO defined inks and paper.

Gloss: The perceived appearance of the paper surface that makes it appear more or less shiny.

Grey balance: Used to objectively assess colour as the eye easily detects any shift in neutrality when neutral areas are compared side-by-side and if there is any colour cast in the neutral area. 'Grey' is a visual sensation of an object with distinct lightness, but with no distinct hue or chroma. 'Balance' refers to using some combinations of CMY values that produce a grey sensation under a specific printing condition.

Grey reproduction (ISO 12647-1/2010 definition): Grey balance is a parameter in the device space, and grey reproduction is a parameter in the device-independent CIELAB colour space. Grey reproduction assesses the degree of neutrality of pre-defined CMY triplets colorimetrically.

Grey Component Replacement (GCR): A technique that uses the greying effect of black ink to replace process colour inks. GCR identifies the combined effect of the three inks and replaces them with a single black. If the black ink cannot reach a sufficiently high density then some CMY can be brought back to support very dark shadows (see UCA).

ICC (International Color Consortium): International forum to define process-wide profiles for prepress file formats, paper and press for colour management systems.

International Standardisation Organisation: ISO is a network of the national standards institutes of 163 countries.

L*a*b*-values: The chromaticity coordinates for any measured colour are described with three points – L* for the lightness, a* for the red/green axis, and b* for the yellow/blue axis.

OBAs: Optical Brightening Agents. Added to paper, they give a higher brightness impression to the paper than it originally has. OBAs are stimulated by UV light, and by the UV content of daylight. OBAs are not effective under light conditions with a low UV content, e.g. 2856 K.

OK print/sheet: Production print selected as reference for the print run with a permissible tolerance.

Opacity: The ability of a paper to obstruct the passage of light (the opposite of transparency); linked to "show through" but should not be confused with "print-through", which includes ink oil penetration that reduces the sheet opacity.

Optical density: Optical ink density of a solid colour.

Paperdam: Organisation of paper suppliers to support paper in context of printing standardisation.

Print contrast: Calculation that compares density readings of a 75% tint area to the density of a 100% solid area of the same colour. Good print contrast indicates a printing system's ability to hold open the shadow areas while still maintaining high solid saturation (density).

Production print tolerance: Permissible difference between OK print from a production run and the reference value.

RIP (Raster Image Processor): Translates electronic file data into an array of dots and lines that can be printed.

Roughness or Smoothness: Describes the paper surface being even (smooth) or uneven (rough) and is linked to its gloss. It depends also on the measuring method, Roughness Bendtsen in ml/min or Smoothness PPS in µm. (A paper measured in PPS is rough, it is still Smoothness PPS and not Roughness PPS, also vice versa with Bendtsen.)

Screen: lpi (lines per inch) or l/cm (lines per centimetre). The number of lines of dot cells per linear length in a halftone screen. There is an optimum screen size for each paper grade.

Separation curve: Tone reproduction represents the cumulative effect of each step of the process on the overall contrast of the final reproduction. It is these interrelationships and their effect that reproduce the grey scale with the proper shades of grey.

SID (Solid Ink Density): A measure of how much complementary light (major filter) is absorbed by a solid patch in a colour bar as measured by a reflection densitometer.

SOP: Standard Operating Procedures.

SWOP®: Specifications for Web Offset Publications is a US colour reproduction specification using ISO defined inks and paper.

TAC (Total Area Coverage): Defines by % the combined CMYK dot area (tonal value) by adding the values of each colour in the darkest area of the separation. Maximum TAC is influenced by the substrate.

Tack: The relative measurement of the cohesion of an ink film that is responsible for its resistance to splitting between two rapidly separating surfaces.

Trapping: The efficiency of a wet ink film layer being accepted by an underlying wet ink layer.

Tone Value: Percentage of surface that appears to be covered by a single colour.

TVI (Tone Value Increase): Also known as dot gain. The physical enlargement of halftone dots during image creation, the printing process and absorption of ink by the paper (mechanical TVI), and light scatter around and under dots (optical TVI). Their combination results in tone value for total apparent TVI during the print process.

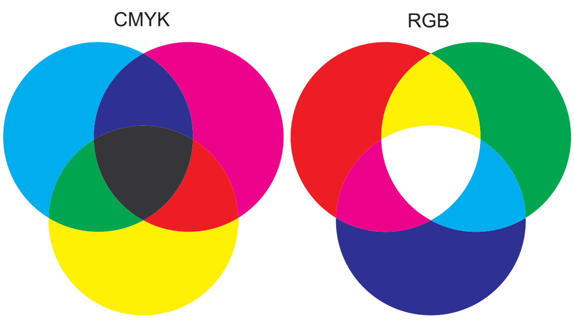
UCA (Under Colour Addition): Addition of chromatic colours to ensure TAC in shadow areas.

UCR (Under Colour Removal): Reduces process colour content in dark, neutral areas of the reproduction and replaces them with extra black. UCR may be only made in dark, neutral portions of the picture.

Colour principals

Additive colour RGB (Red, Green, Blue): Used in digital cameras, scanners and computer screens. RGB lights are combined to create white and by varying their relative intensities generate a wide variety of different colours.

Subtractive colour CMY + K (Cyan, Magenta, Yellow + BlacK): Used in printing when colour perception is dependent on a pigment to absorb (subtract) various portions of visible light to produce a desired colour. Theoretically, black is produced when the three primary colours overlap but, because pigments are imperfect, a separate black ink (K) has been added to the process. The overlaid (trapped) colours produce secondary colours.



Subtractive CMY + K (Cyan, Magenta, Yellow, Black) and Additive RGB (Red, Green, Blue). Source: Sappi

Colour description: Sensing of colour requires a light source, an object and an observer. If any one of these three components is changed, the perception of colour may also change. All three components have been measured and standardised to describe and calculate colour attributes in the 1976 CIE L*a*b* (or CIE Lab).

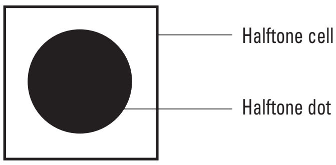
Digital tonal reproduction process steps

1. The PDF digital file contains all tints that have been assigned a continuous tone percentage value between 0 and 100% that corresponds to a specific halftone structure.

2. The file is then converted into a bitmap by the screening engine of the RIP. The RIP converts the file by reading the percentage values defined in the file and creating a screen of halftone dots, each with a tint percentage value. For example, 50% means that 50% of the halftone cell area is covered by a halftone dot or dots scattered in a random pattern (FM).

3. The bitmap is output to plates, and proofs where each halftone dot is typically imaged using with inkjet devices.

4. The press transfers the ink to the dot on the plate, which is then transferred to the blanket and finally onto the paper.



Executive summary

Why standardise?

Process colour standardisation improves cost, time and quality performance. Standards establish a common language between the related parties in the business. Standardisation has a positive impact not only on internal workflows but also on communications between printer, print buyer and designer. Standards, measuring devices, quality procedures and standard operating practices are tools that provide accountable quality control, increased reliability and efficiency leading to lower total production costs. Standards are also the base for predictable and comparable results independent of output device or location.

Effective process control measures defined variables and monitors their output in comparison to a standard definition – any deviations from optimal values can then be corrected. Every step in the printing process is influenced by variables that may create colour deviations.

Colour approval and acceptance of the printed job is influenced by the quality of press, prepress, specifications and the working relationship between printer and customer. Applying a standardised best practice production workflow provides benefits across the entire value chain.

Business benefits from standardisation

Studies show that standardisation generally improves business performance in different areas.

- Increased customer satisfaction. Fewer complaints and related costs (reprints, rebates, refusal to pay).
- Improved customer perception of printers' brand value 'quality'. Standardisation helps retain existing customers and attract new clients.
- Improved file quality and order processing efficiency with customers.
- Prepress has a clearer target of how to create the right profiles for printing.
- Standardised proofs can more easily be matched on press to reduce makeready time and waste.
- Lower total cost of production (less time, materials and energy waste).
- Shorter time on press. Fewer unscheduled press stops. Avoids the cost of shutting the press down when colour cannot be matched, plus possibly the need to re-make plates and/or produce more expensive proofs.
- Higher consistency in the run, from job to job, and between different press crews and sites. Improved process control reduces dependence on personal judgement and variations of individual printers.
- A clear view of the total process (and its deviations) that increases internal and external competence and confidence. Tools to analyse quality problems more quickly and prevent their repetition.
- Any lean manufacturing improvement resulting from using standards provides environmental benefits – any improvement in production efficiency has an environmental benefit. For example, ink minimisation not only saves cost of ink but will also lower the carbon footprint.
- Improved understanding of process and how materials affect results.

The location and extent of improved performance can be variable, and it is recommended that prior to introducing any changes that KPI measurements of current performance are established so that improvements become clearly visible.

Key Performance Indicators (KPIs)

	KPI	Definition
General Workflow	Delivery time	% of jobs delivered on time
+ Economical Benefit	Cost estimate	% of job delivered at or below cost estimate
	Quality	% of jobs delivered with zero faults
	Customer claims	Number of customer claims per month
	Reprint	Number of jobs reprinted per month (quality claims)
	Proofing Quality	Average number of proofs out of tolerance
Prepress	Re-Plates	Number of re-plates per month caused by prepress or client
	Proofing Quality	Average number of proofs out of tolerance
Press	Re-Plates	Number of re-plates per month
	Makeready waste	Average waste in sheets/job
	Makeready time	Average time in minutes/job
	Production waste	Average sheets/job
	Production time	Average production time per 1000 sheets
Postpress	Good copy ratio	Number of good copies over quantity ordered
	Reprint	Number of jobs where postpress makeready waste too low and a section required reprinting

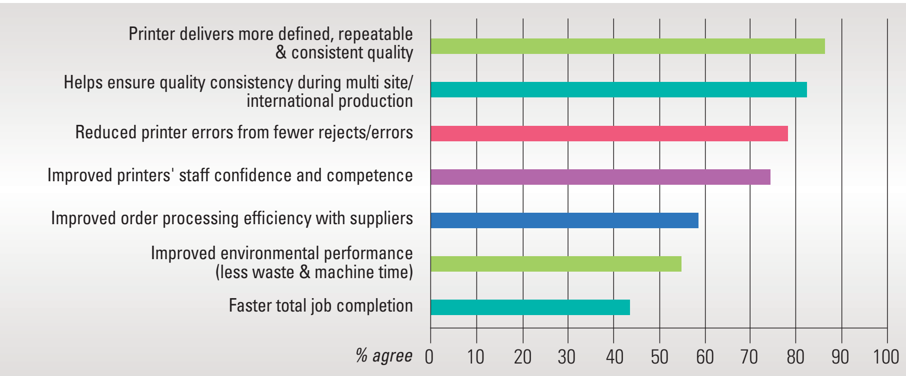
PrintCity definition of Key Performance Indicators (KPIs) to quantify standardisation benefits: they help diagnose current performance and monitor process workflow improvements.

Source: PrintCity

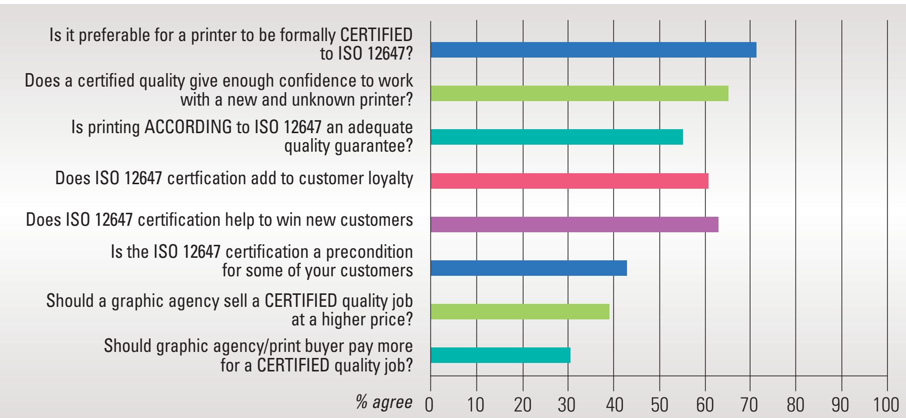
Do print buyers value standardisation?

PrintCity and f:mp made an assessment with German print users and designers to identify the perceived benefits from working with certified printing companies. The responses from over 50 respondents are positive in this respect:

Standardisation benefits



The top three benefits identified by print buyers are improved quality, consistency and reduced errors.
PrintCity/f:mp survey 2011



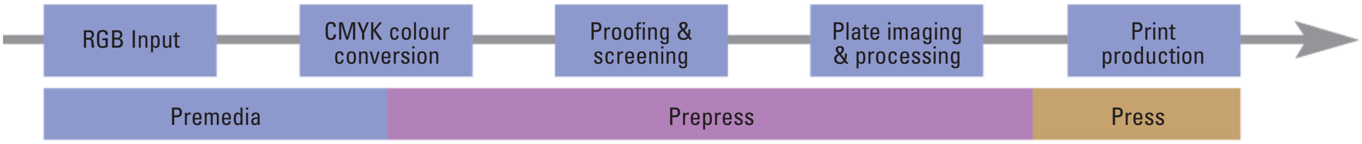
Most surveyed print buyers prefer printers to be certified, and the label provides a credible guarantee to the quality of new printers.
PrintCity/f:mp survey 2011

Standards, Specifications and Certification

A standard is a document established by consensus and approved by a recognised body that provides for common and repeated use, rules, guidelines in a given context. The ISO 12647-2 standard for printing 4-colour process was introduced in 1996 to address process control of halftone colour separations, proof and production prints for sheetfed and heatset web offset. It defines incoming data and how this is converted onto the plate and the outcome of ink-on-paper.

Print specifications, are not standards, they provide the guideline and framework for working with standards. The two most important printing specifications are Fogra 39 from Germany (used in PSO), and GRACoL® from IDEAlliance®, USA. They both consist of characterisation data sets based on interpretations of the ISO 12647-2 standard along with documentation, tools, and requirements for specification compliance, but each takes a different approach to press calibration and metrics. Certification is the written accreditation by a credible organisation that a company's services, production processes or products have been tested to be in conformance with a relevant standard(s).

Certification is becoming an important requirement of some print buyers who want more formal and accountable quality control and consistency. However, the current ISO 12647 has no defined method of certification. As a result, current ISO 12647 certifications are private, often national, and are more or less recognised by the international community. There are important differences between them in their requirements, criteria, testing, auditing etc.



Digital workflows have simplified and increased the speed of offset workflows. However, the digital printing process workflow chain also has multiple potential sources of colour and other deviations. Digital technologies require stricter discipline to correctly implement and maintain workflows if they are to deliver consistent results to higher expectations. Source: WOCG

Key control parameters of a printing standard

1: Colour/grey balance: Relationship between the four process colours and is the key factor for a good production match. Human perception is highly sensitive to technical deviations affecting the colour balance – particularly in midtones. Divergent TVI in the CMY process inks are the main reason for a shift of balance in printing.

2: TVI (Tone Value Increase): Expressed as the difference in ink coverage between a theoretical value (prepress) and the print. TVI has a mechanical and an optical component. Mechanical TVI is when the size of the printing dots tends to increase during transfer from plate to blanket and from blanket to paper. Influencing factors can include CTP platemaking, ink and dampening solution. Optical TVI is due to the refraction of light at the interface between the ink and the paper surface. TVI is the difference of the tonal value of the digital data to the printed tonal value, e.g. a 50% field will appear on the print as 65%. Achieving a similar TVI of the 4 process colours is the key for a good production match on press. If the spread is too large between the colours the difference needs to be compensated on the plate.

3: SID (Solid Ink Density): SID affects the total contrast of a picture and, to a lesser extent, its shadow balance. In ISO 12647-2 the target values for solid CMYK are expressed in L*a*b*-values. Therefore, it is necessary to translate the standard shade targets into press density targets.

Measuring devices & Software tools

Densitometry measurement is directly linked to the ink layer thickness and it allows a precise and realistic control of the ink thickness zone by zone. Currently, there is no alternative to density for controlling the ink. A spectrophotometer measures light reflection over the whole range of visible wavelengths to provide an accurate definition and analysis of colour — their use is mandatory in standardisation process. They can be used to produce ICC profiles for monitors and printing, measure control strips, and colour deviations between a digital proof and printed sheet; they can also be used as a densitometer because measurements can be recalculated to density values. Printers measures wet print while quality control measures dry print. While differences are small, they can be significant enough to lead to complaints.

Key influences on quality

Multiple variables influence colour even in a standardised process. Colour rendition from print run to print run, or during production printing, is subject to fluctuations in relation to solid inking, TVI and trapping, from a changed ink/water balance or different substrates. Even under standard conditions with minimal variations it is practically impossible to exactly conform to a given set of primary parameters. This is due to typical production tolerances and unavoidable differences in press, ink, paper that have to be accepted. Primary process parameters with a direct bearing on visual characteristics of the image include printing sequence, press, ink, substrate, screening, and plate. Secondary parameters that can indirectly influence the image include: speed, dampening solutions, additives, cylinder packaging and blankets, ink/water balance, roller setting, ink film thickness, trapping, temperature and humidity.

Some of the major influences include:

Incoming data PDF/X: ISO 15930 defines how applications to create and read PDF/X files should behave for reliable prepress data interchange. The aim for designers is to supply a digital content file that will be printed predictably, while printers and publishers receive robust files, avoiding reworking or errors. PDF/X is designed to be easy and cheap to create.

Proofing: The role of the proof is to simulate the print output to make the right adjustments to the pictures. The contract proof is the visual constant in the process because it is produced with tolerances comparable with offset printing. Proofing systems must be able to calibrate the complete colour gamut to achieve high quality results on a regular basis – only this can ensure a constant reproducible quality.

Plates and processing: Reliable printing requires stable plate and plate making that comes from the right combination of platesetter, plate, processor and developer for the technology selected. The plate has a major influence in print colour approval because the stability of dot reproduction within specified tolerances is critical.

Press: Needs to be correctly set up and maintained, and periodically measured to ensure that they are within tolerance. The printing press has to be calibrated to match the standard. Calibration must take into account all variables influencing final output. The goal is to enable consistent printing to a given standard and tolerances by producing certain target values when printed. Ideally, a single printing profile for all presses in a plant should be used, providing that all presses are printing within a common tolerance range.

Blankets: The blanket is central to good offset printing and requires careful selection, packing, tensioning and cleaning to ensure printing quality, durability and minimum press down time. Excellent print quality requires a blanket that combines good registration and an accurate dot reproduction.

Paper: Paper has the single largest impact on print quality. Paper has visual (gloss, brightness, opacity) and tactile properties (stiffness, roughness,) that affect its quality perception. Equally as important is the combined effect of paper and ink on colour reproduction. The paper surface and shade impact on the reachable colour gamut and the colour reproduction is influenced by the paper surface effect on TVI.

Inks & Dampening: For best results, ISO 2846-1 compatible inks are recommended to assure compliance with colour, transparency and ink film thickness as defined in the standard. The standard provides colour (L*a*b*) and transparency specifications for 4-colour printing inks. Ensure the right combination of ink and dampening solution to match the press, papers, IPA level and water quality.

Maintenance and consumables: Key quality parameters. Effective and systematic operating and maintenance procedures are fundamental to process stability. Standardised consumable materials achieve the best possible results and should be optimised as a system (ink, dampening solution, blankets, paper, plates).

Case study and Implementation

To better understand the practicalities of process optimisation, standardisation, and certification, a case study implementation was made by the PrintCity project team with the sheetfed printer Hammesfahr. The implementation was a 3-part process:

1: Workflow audit and improvement actions: Includes procedures to inspect incoming data; profile and calibrate proofing system and colour display monitors to ISO 12646; ensure CTP system is correctly maintained and set; test printing press quality performance; evaluate measuring devices and their calibration; assess if staff are adequately trained and informed to use all software and hardware tools correctly; and that workflow procedures are clear and communicated.

2: Test printing evaluation steps: Test print of linear output plates are the basis for print characteristic curve evaluation, measure printed results both wet and dry; adjust plate calibration and reprint with new print characteristic curve; re-measure to check if SID and TVI curves conforms to ISO 12647-2. Several test-correction loops may be needed until curve is OK.

3: Certification printing: Repeats previous step but as specified by certification organisation being used.

More efficient press OKs and makeready

While not necessarily part of standardisation, more efficient press OKs and makeready are important for all printers. Obtaining rapid colour approval is a team effort for which the essential key to success is the preparation of the job before it arrives on press. The use of colour measurement tools with an appropriate on press approval method. Human factors are often overlooked in the colour approval process. These include subjective and varying perceptions of colour, communication and expectations, and also different viewing environments amongst customer, agency and printer. The use of standard operating procedures during makeready can significantly improve performance.

Some key success factors

1. The starting point is an effective audit of the current workflow. External expertise is recommended.

2. Establish an integrated industrial manufacturing strategy that combines standardisation, process control and defined procedures across the complete workflow chain.

3. Put into place Key Performance Indicators (KPIs) to measure current performance and monitor process workflow improvements from standardisation.

4. Ensure staff are adequately motivated, trained and informed to use all software and hardware tools correctly; and that workflow procedures are clear and communicated.

5. Implement appropriate measurement solutions to maintain consistency in each process step. Measuring instruments can only produce accurate values if they are regularly calibrated to the supplier's recommendations.

6. Effective maintenance and correct settings help ensure all production equipment is operating to specification, and is fundamental to process stability.

7. Understanding the influence of consumables (ink, paper, blanket, etc) and selecting the optimum material combinations to achieve the standard. It is important to recalibrate press settings if consumables are changed. Standardised consumable materials achieve the best possible results and should be optimised as a system.

8. Only implement new plate curves based on controlled data and qualified printing conditions. Do not adjust plate curves to compensate for a press in poor condition.

9. The key to quality conformance and sustained productivity is regular evaluation of the process. Press and platesetter characterisation should be made regularly to monitor stability, and, after maintenance or changes of consumables that can impact reproduction.

10. A change to one press variable may affect colour and/or productivity. Only change a single variable at a time. It is much more difficult to regain process control if several items are changed simultaneously.

1: Introduction

Colour management

Standardisation and process control are core elements of effective colour management. Without them, colour management cannot fulfil its objectives.

Profiles

Colour space characterisation and profiling: A standardised colour managed workflow requires all input sources (cameras and scanner) and output devices (monitor, proofer, press) to be individually colour characterised and profiled. Reliable colour management requires defined uniform colour management settings in all software applications used at all points of the production chain. This includes using profiles in Photoshop applications and embedding the profiles into the created images and PDF files.

RGB workflows: All images are kept in the original profiled RGB colour space and are converted into the press colour space before printing. To ensure predictable quality it is recommended to use colour servers based on device link profiles. These convert the entire final PDF files into the required colour spaces, and the device link profile technology ensures the quality is uniform and predictable.

Colour conversions: Automated colour servers convert incoming PDF files to the required printing standard while harmonising the separation of the data for uniform printability and TAC.

Ink optimisation: An intelligent GCR separation can stabilise the printing process while saving ink. The GCR should be applied automatically in the PDF file before going on the press.

Press characterisation and profiling: The printing press has the smallest colour gamut and the most variables of all devices in the workflow. Therefore, it is the fixed point from which all other devices are set, working backwards up the process flow. Official standard profiles should always be used for standard printing conditions, as these are the targets for proofing as well as for print production. The use of standard profiles for separation and proofing during both prepress and printing is a precondition for a standardised print workflow that delivers shorter makeready times and less complaints.

Presses need to be correctly set up and maintained, and periodically measured to ensure that they are within tolerance. The printing press has to be calibrated to match the standard (using methods like PSO). Calibration must take into account all variables influencing final output. The goal is to enable consistent printing to a given standard and tolerances by producing certain target values when printed. Normally, a single printing profile for all presses in a plant should be used, providing that all presses are printing within a common tolerance range.

A house standard may be considered when standard profiles do not meet the customer needs (paper or ink specification, etc.) and when standard printing conditions cannot be applied. In this case, an individual press profile is the starting point to create a profile using the required paper and ink – the choice of paper determines the amount of ink that can be used. An individual press profile should be done only for printing conditions where no official standard is available, e.g. when using highly pigmented inks.

Standard Printing Conditions

Standard printing conditions are available for offset and gavure printing with different paper categories. They exist both as pure measurement data (characterisation-data) and as ICC profiles calculated from this data. The ICC acts as a worldwide registry for characterisation data of standard printing conditions. The most commonly used standard printing conditions data is provided by Fogra and CGATS. ICC profiles calculated from Fogra and CGATS characterisation data are available free of charge from ECI (www.eci.org) and IDEAlliance® www.idealliance.org.

Some standard printing conditions represent printing processes and paper categories as defined in ISO 12647-2 and ISO 12647-3. Other standard printing conditions represent paper categories currently not defined in ISO 12647-2, but which are widely used in the printing industry.

Source: GMG

Using ICC standard profiles or device link technology

ICC colour management technology became increasingly important with the growth of inkjet proofing in the 1990s. ICC is often regarded as the standard for colour management. However, it does not always lead to a uniform and maximum quality for producing CMYK-to-CMYK conversions, or for contract proofs. The aim of ICC technology was to create a standard format for colour profiles to permit simple colour conversion between different devices and give an accurate description of how profiles must be structured and used. However, it did not contain a detailed description of workflows for colour accurate publishing, nor did it ensure that ICC compatible application programmes function reliably; the ICC specification lacks references for quality assurance. These issues can lead to problems in the colour management including:

1. No standardised Colour Management Module (CMM): An ICC colour profile describes the relationship between a device and an independent L*a*b* or XYZ colour space – the Profile Connection Space (PCS). The CMM handles conversion from the source colour space to the target colour space with the help of the colour profiles. ICC conversion always involves the transformation of device colour space A converted into the PCS and subsequently into device colour space B. ICC compliant CMMs are available from several manufacturers, but because they use different algorithms they can have different colour outcomes. Some CMMs offer their own Gamut Mapping methods that are not defined in the ICC specification.

2. Gamut Mapping: Used when converting from a large colour space to a smaller one. Every manufacturer of profiling tools applies its own Gamut Mapping strategies, particularly with the perceptual rendering intent used for conversion from RGB to CMYK, resulting in clear visual differences in converted files.

3. Profile quality: The ICC technology does not define a standardised calculation for profiling. Data processed using different tools will lead to different results. The quality of an ICC profile is not defined and is highly dependent on the expertise of the software developers. Any breaks and reversals occurring in the separations can have a negative impact when printing.

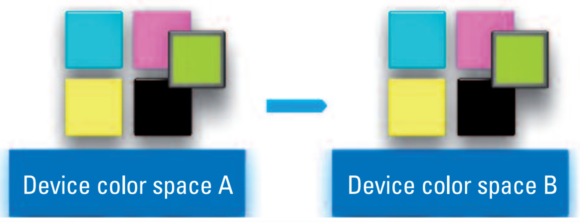
4. Private tags: The ICC defines individual remarks as 'private tags' that can be attached to a profile. These tags are rarely understood by other programmes, leading to their being ignored or incorrectly interpreted.

5. Black channel problems: ICC profiles do not generally lead to the desired result in colour space transformation as the CMYK data of the target colour space are computed via the PCS conversion colour space. The black composition characteristics – long or short black and first printable dot – are lost in the process. Black texts and greyscale images are composed in CMYK. During printing, texts and greyscale images composed in four colours would lead to colour shifts in the event of a slight misregister.

6. Variables in the ICC workflow: The quality of ICC colour conversion is highly dependent on the expertise of the software developer. It can be assumed that when using identical starting data, profiles generated using different profiling tools and interpreted with different CMMs will lead to unpredictable results. This contradicts the standardisation approach and makes communication difficult.

Device link profile technology

Device link technology is specified in the ICC methodology as an optional profile format that directly links two colour spaces without taking the detour via the PCS (unlike ICC). Because the method of calculation is stored in the device link profile it eliminates the variable parameters of the ICC workflow (e.g. CMM and Gamut Mapping). Using the same device link profile in different workflows guarantees identical colour rendition. Suitable software can calculate colour transformations as device link profiles and optimise them if necessary.



Source: GMG

The advantages of device link profiles for proofing and colour conversion include:

1. Proofing: A device link profile converts incoming CMYK data into the colour space of the proofing printer so that the colour impression corresponds to the reference printing conditions. The device link profile should always be based on a calibration that enables constant colour rendition on proofing printers at different sites to ensure that a proof can be reproduced identically at different locations. There are no variables in the profile quality and the conversion strategy, attributes that are fundamental for remote proofing.

2. Colour conversion with device link profiles: Device link profiles have two colour spaces directly linked to each other that can have different functions in colour conversion: separation-preserving colour conversion, e.g. from an industry standard to an in-house standard; separation-preserving colour conversion with reduction of total ink application; re-separating colour conversion with preservation of pure black, e.g. for harmonising different separations in the data; re-separating colour conversion without black preservation. Device link profiles have advantages compared to ICC when performing CMYK-to-CMYK and RGB-to-CMYK colour conversion.

3. Automatic colour conversion: Fully automatic colour conversions can rapidly prepare print production sources from different colour spaces and output them for a variety of printing processes.

4. Data conversion: CMYK conversion optimally transforms printing data from one standard or process to another to maintain the same colour result. CMYK re-separation standardises the colour composition of the data to ensure that data from different sources behave identically on the press (grey balance is harmonised, the total amount of colour standardised). This reduces makeready time and waste.

5. Gamut mapping: This technique ensures that colours are ideally converted between different colour spaces to maintain the harmonious composition of vignettes, and that images retain their contrast and definition in the shadows. Optimum use is made of the printing colour space and colours are not flattened. The files can be simultaneously scaled and appropriately sharpened during processing.

Standards and implementation

In 2011 there were 69 ISO standards under Graphic Technology (TC 130) these include:

ISO 2846 Defines the colorimetric characteristics of 4-colour process ink set when printed on reference papers. However, variations in ink film thickness and substrate properties make meaningful control difficult outside of a laboratory.

ISO 3664 Viewing conditions.

ISO 12218 Offset plate making available in 1997.

ISO 12635 Plates for offset printing – dimensions (2008) is under review for CTP system requirements.

ISO 12640 Prepress digital data exchange – the 1997 standard is film based.

ISO 12642 Input data for characterisation of 4-colour process printing.

ISO 12646 Displays for colour proofing; characteristics and viewing conditions.

ISO 12647 Printing process control. Parts:
1 Process control and measurement methods
2 Offset, sheetfed and heatset web
3 Coldset offset newspaper
4 Gravure
5 Screen printing
6 Flexography
7 Hard-copy contract proof digital proofs
8 Validation print – in process.

ISO 13655 Spectral measurement and colorimetric computation.

ISO 15076 ICC colour management.

ISO 15930 Digital prepress file exchange using PDF/X. Part 7 is complete data for printing (PDF/X-4) describes what a file needs to conform to for print. Part 8: Partial exchange of printing data using PDF 1.6 (PDF/X-5).
The Ghent PDF Workgroup publishes PDF/X-Plus specifications built on ISO 15930 but with more restrictions (X-1, X-3 available, working on X-4).

ISO/CD 15311-1 Draft new standard "Requirements for printed matter utilizing digital printing technologies for commercial and industrial production – Part 1: Parameters and measurement methods".

A standard is a document established by consensus and approved by a recognised body that provides for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. International Organisation for Standardisation (ISO) definition.
A standard is a formal process that is reviewed and accepted by a governing body. The ISO is the world's largest developer and publisher of International Standards. It is a network of national standards institutes of 163 countries that forms a bridge between the public and private sectors.
A printing standard is the definition of optimal process target values and tolerances for the technology and production conditions. These should provide an optimal average result related to a guideline that avoids extremes – they cannot reflect every variable.
To work in a standardised manner does not only mean that the results meet the requirements defined by the standard, but also that all processes have been brought under control, are measurable, and repeatable. A tight control process to assure the best possible quality in the print production is not dependent upon only one calibration test run. To achieve the best possible quality it is necessary to verify the print result frequently.

ISO 12647-2 printing 4-colour process

This standard was introduced in 1995 to address process control of halftone colour separations, proof and production prints for sheetfed and heatset web offset. It defines incoming data and how this is converted onto the plate and the outcome of ink-on-paper. The target of this standard is NOT the standardisation of materials such as paper, ink, press, blankets; it is the differentiation between defined (e.g. print process) and undefined (printing ink) variables.

What's specified in ISO 12647-2:
- Five different paper classes with CIELAB coordinates
- Primary colour (CMYK) CIELAB coordinates and tolerance for the five paper types
- Secondary (RGB) coordinates for the five paper types
- Tone value references and tolerances for the five paper types
- Definition of midtone spread
- CMYK values for use in grey balance patches
- Primary colour and TVI variation tolerance during the print run.

What's not specified in ISO 12647-2:
- Optimal densities for different paper classes
- CIELAB values for grey balance
- Paper values from specific suppliers
- Ink values from specific suppliers
- Plate specifications from specific suppliers
- Any kind of specific additives or other print related material.

This standard defines the measurable results to be achieved but not the specifications or methods to attain them.

Specifications, Calibration & Implementation

A specification is not a standard. Print specifications provide the guideline and framework for working with standards.
The two most important printing specifications are Fogra 39 from Germany (used in PSO), and GRACoL® from IDEAlliance®, USA. They both consist of characterisation data sets based on interpretations of the ISO 12647-2 standard.
Fogra/bvdm and IDEAlliance provide documentation, tools, and requirements for specification compliance, but each takes a different approach to press calibration and metrics.
Some organisations and user groups make printing trials to help create characterisation charts with colour gamut, such as Fogra 39, to achieve ISO 12647:2specified colorimetric aims.

Process Standard Offset (PSO)
PSO is an implementation system (not a specification) that was originally developed in 1980 by Fogra for bvdm (German printers association). It is now sourced from ISO 12647:2 and is an interpretation of the standard that overcomes some of its shortcomings and provides a practical guide to its application. After a printer has successfully implemented PSO they can apply for ISO 12647:2 certification. PSO uses the principle of TVI correction to ensure an even tone gradation. It also makes use of several sets of characterisation data based on test prints on the principal types of paper.

The largest gamut can be achieved on coated wood free paper by using the Fogra 39 Characterisation data. The primary colours fully comply with the ISO 12647-2 AMD 2007, and while secondary colours are slightly different to the standard they are more practical to achieve.

What's recommended to match Fogra 39 (used in PSO)

Matching the CIELAB values and gloss values of paper types within tolerances
Matching tone value increase on 40%, 70% and 80% fulcrum
Matching maximum spread of CMY on 40% mid tone patch
Control variation during the press run
All other values in ISO 12647-2 are only informative and have no influence on pass/ fail criteria for standard compliance.
In real life printing, density measurements are taken during the press run for process control. Density aim values are taken from the OK-sheet which needs to be checked for correct CIELAB CMYK values according to ISO 12647-2.

GRACoL®

The US non-profit industry association IDEAlliance® provides a route to achieve ISO compliant printing with GRACoL® specifications for sheetfed and Specifications for Web Offset Publications (SWOP) along with the G7® calibration method and definition of greyscale appearance.
The seventh edition of the GRACoL specification (GRACoL 7) consists of a characterisation data set based upon an early beta version of the Fogra 39 data set, adjusted to fit the Neutral Print Density Curve (NPDC) and grey balance definition defined by G7. Although closely tied to ISO 12647-2, GRACoL 7's NPDC curves are not part of the ISO standard but are based on the device-independent G7® specification. The NPDC is the heart of G7 and was derived by analysing the neutral tonality of typical ISO Standard commercial offset printing using CTP-based plates as opposed to film-based plates. G7 defines greyscale appearance and a calibration method to adjust any CMYK imaging device to simulate the G7 greyscale definition. It uses four one-dimensional curves to provide a visual neutral match between different imaging systems and enables shared neutral appearance between different printing devices or specifications when additional colour management is not available. It can be thought of as an implementation of the new ISO 10128 Technical Specification for "Near Neutral Calibration" but with a number of advantages not mentioned in ISO 10128, specifically shared neutral appearance, paper relative grey balance, automatic dynamic range adaptation and device-independent tonality. A key advantage of G7 compared to the Near Neutral Calibration definition described in ISO 10128 is that the NPDC, grey balance definition and calibration methodology are the same for any imaging technology, regardless of substrate, pigments, screening technologies, etc. This means that G7 can be applied to any imaging system without alteration, and will result in similar print appearance (at least in neutral grey image areas), given similar substrate colour and similar maximum neutral density
G7 is widely used in North America, Asia, Latin America and elsewhere, and was carefully designed to comply with the ISO 12647-2 standard when applied to commercial offset printing. The G7 calibration and process control method replaces separate TVI values with a single grey balance and NPDC aims. CTP curves are adjusted to achieve a predefined NPDC for CMY balanced grey scale and a K-only scale. IDEAlliance no longer specifies TVI, solid ink density [SID], or print contrast targets.
IDEAlliance has always recognised the value of TVI as a process control tool and recommends a combination of standardised G7 aim points and custom (user-determined) TVI aim points as the ideal total process control approach.

What's specified in GRACoL:
- Primary colour (CMYK) CIELAB coordinates according to paper type
- Secondary (RGB) CIELAB coordinates according to paper type
- G7 NPDC (see below)
- G7 Grey Balance (see below)

What's specified in G7:
- Near neutral print density curve for combined CMY grey scale
- Near neutral print density curve for K black ink scale
- Paper-relative CIELAB grey balance target values

What's not specified in the G7 calibration method:
- Tone value increase tolerances
- Optimal densities for different paper classes to reach ISO CIELAB values for CMYK

The Process Standard Offset (PSO) manual was first published in 1980 by bvdm. This manual is a comprehensive practical guide on how to organise and optimise print production to conform to ISO 12647. A new revised edition in English and German will be available in 2012 covering all offset processes. www.pso-insider.de

"Guidelines & Specifications 2007" IDEAlliance®

"HOW TO — A step by Step Guide to Calibrating, Printing & Proofing by the G7 Method" IDEAlliance®

www.idealliance.org

Certification of a Standard?

Certification is the written accreditation by a credible organisation that a company's services, production processes or products have been tested to be in conformance with a relevant standard(s).

An ISO TC 130 survey of printers certified to a standard worldwide reported in 2010 that only 661 printers were operating with a certified process (60% Fogra, 15% UGRA and 25% other). This is less than 0.002% of the world's printers. Printing without certification to a standard is probably much higher, for example around 3,500 PSO manuals have been sold up until 2010, but only around 10% of the manuals have led to certification. Certification is becoming an important requirement of some print buyers who want more formal and accountable quality control and consistency.

Normally ISO audits and certifications can only be conducted and delivered by companies and organisations that are themselves authorised and accredited by their national ISO body representative. However, the current ISO 12647 has no defined method of certification within the standard and for this reason an ISO/TC 130 group is working on recommendations for a single international certification method.

As a result, current ISO 12647 certifications are private, and are more or less recognised by the international community. There are important differences between them in their requirements, criteria, testing, auditing etc. A key issue is the accreditation, competence, consistency and impartiality of the certifying organisation and their independence of related consulting activities. The costs, requirements, and frequency of private certifications are also variable.

The most widely used certification (about 60%) is Germany's Fogra/bvdm's PSO (Process Standard Offset); Switzerland's UGRA is also long established and accounts for around 15% of certifications. A more recent approach in the UK, Sweden, and USA combines parts of ISO 9001 printing quality management system certification and the ISO 17021 general audit requirement as a vehicle to certify ISO 12647 (this includes documented procedures for customer complaints and corrective actions).

Some of the principal national approaches with data correct to March 2011, include:

China: 48 printers have G7 Master Printer certification from IDEAlliance and their partner APTEC in Hong Kong. There are 2 EUGRA and 2 Fogra certifications.

France: Around 20 printers have UGRA certification. France-PSO is a non-profit organisation to promote and help implement ISO 12647-2, and guide printers to UGRA certification.

Germany: Since 2002, Fogra and bvdm have acted together as certifier or co-certifier, and certified over 400 companies worldwide with around 300 in Germany (see www.psoinsider.de). The SID in Leipzig also has a certification service.

Italy: CertiCarGraf from Italian Printing Association but with no certified companies to 2010. UGRA has certified some.

Netherlands and Belgium, SCGM: The Stichting Certificatie Grafimedia Branche (SCGM) is the independent certification institute for the printing, media and packaging industry in the Netherlands and Belgium and provides ISO certification accredited by the Royal KVGO and the Kartoflex. www.scgm.nl

Spain: Around 100 certified printers. Multiple certification services from local partners of UGRA and Fogra (RCC Consultants); AIDO, the Technological Institute for Optics, Colour and Imaging, has developed its own certification supported by the National Entity of Accreditation in Spain.

Sweden: Printing Federation (GFF) recently introduced Certified Graphic Production (CGP) that incorporates ISO 9001 Quality Management System.

Switzerland: The UGRA printing technology institute provides international certification of materials, persons and companies to different standards or specifications, including ISO. www.ugra.ch

UK: About 100 printers have used multiple certification choices. A new scheme, Print and Media Certification (PMC), launched by the British Printers Industry Federation (BPIF) includes core parts of the ISO 9001 Quality Management principles, with accredited certification from UKAS. BPIF, as a part of ISO/TC130 WG13, is participating in the development of the printing quality management system standard. BPIF has stated it intends to replace its current Colour Quality Management Scheme with this new standard once development is completed.

USA: Rochester Institute of Technology (RIT) launched Printing Standards Audit℠ (PSA) Certification in May 2011. This certification is designed to be compatible with all recognised printing standards, and will certify both ISO 12647-2 and G7 Targeted compliant workflows. Two certification levels are: (1) PSA℠ Certified: Organisations technically capable of operating a standards compliant workflow. PSA℠ Certification will be extended to include the proposed Process Independent Standard (ISO 15339) as soon as this standard is approved by ISO/TC 130; and (2) PSA℠ Certified with HonorsHonours: Organisations routinely practicing and continuously improving a standards compliant workflow (under development as a part of ISO/TC130 WG13 activities).

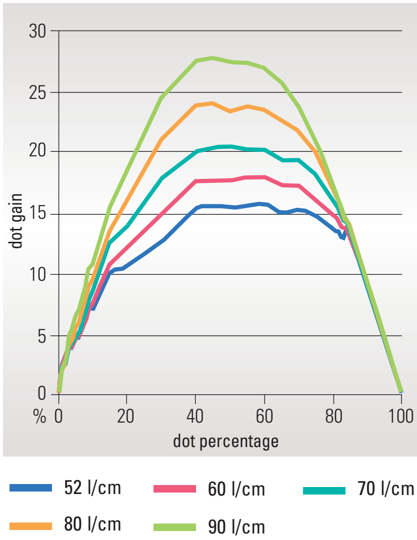
Key control parameters

1. Colour/grey balance

Colour balance in printing is the relationship between the four process colours and is the key factor for a good production match. Human perception is highly sensitive to technical deviations affecting the colour balance – particularly in midtones. Divergent TVI in the CMY process inks are the main reason for a shift of balance in printing.
To obtain visually consistent results for images with low contrast, or mainly grey areas, the deviations in midtone balance should ideally not be larger than +/-2% in TVI between the highest and lowest values. However, large printing variations often allow a tolerance of +/- 4% TVI spread in midtones and improving process consistency is the major prerequisite to achieve narrow tolerances. The gap between perception of colour deviations and the technical limits can be reduced with grey stabilisation. It is better to keep the neutral balance on a higher or lower level of TVI because human perception is less sensitive to changes in gradation (darker or lighter) than it is to colour balance shifts.
A midtone grey balance patch is an effective visual control method.

2. TVI (Tone Value Increase)

An important element in colour reproduction is TVI (also called dot gain). TVI is expressed as the difference in ink coverage between a theoretical value (prepress) and the print. TVI has a mechanical and an optical component.
Mechanical TVI is when the size of the printing dots tends to increase during transfer from plate to blanket and from blanket to paper. CTP platemaking can increase or decrease dot size if the devices are not correctly calibrated. Other influencing factors can include the ink and dampening solution.
Optical TVI is due to the refraction of light at the interface between the ink and the paper surface (which is by definition uneven).
A standard spectrophotometer using the Murray-Davis formula measures both the mechanical and optical components. TVI is measured in the midtones, where it has the highest impact and the largest variations. There is a 6-8% difference in TVI between analogue positive and negative plates. With CTP plate, this systematic difference can be corrected by a different transfer curve on the RIP, making TVI closer to the results of analogue positive plates. However, for many other reasons CTP plate has more variations and the process has to be closely monitored. Screen ruling and paper grade have a high influence on TVI and need to be specified with the customer.
The relationship between the four process colours is the key factor for a good production match on press. It is better to keep the neutral balance on a higher or lower level of TVI because human perception is less sensitive to changes in gradation (darker or lighter) than to colour balance shifts



A sheetfed example on the effect of screening on TVI. Source: Sappi

3. SID (Solid Ink Density)

SID affects the total contrast (saturation) of a picture and, to a lesser extent, its shadow balance (if SIDs in the CMY inks have divergent variations). The SID value changes with the type of density measurement, e.g. ISO Status E or Status T — mainly used in North America — Status T shows a lower SID value than Status E for yellow. Polarisation filters are often used when measuring print density in sheetfed offset. A polarisation filter reduces the amount of white light caused by surface scattering reaching the detector. In this way it mimics the situation when measuring wet ink film where surface scattering is reduced by the high gloss of wet ink film. The idea is to have similar print density values regardless of the status of ink film drying. For this reason the values with a polarisation filter are higher than corresponding values without the filter. In ISO 12647-2 the target values for solid CMYK are expressed in L*a*b*-values. Therefore, it is necessary to translate the standard shade targets into press density targets. One of the most accurate ways to do this is to print solids in all process colours and black on the chosen substrate, with the chosen ink. The prints are made at different densities – for example, increasing – and for each print, the shade on the print is measured and compared to the target. The colour difference ΔE can be calculated and the optimum density is found at the smallest ΔE.

Measuring and control

Equipment required includes image analyser to control dot size on plate, densitometer, spectrophotometer, and software for control and visualisation. Source: Sun Chemical

It is important to understand the purpose, intention and relative performance of densitometric and colorimetric measurement systems to use these tools correctly in offset printing.

Densitometry

Densitometry measurement is directly linked to the ink layer thickness and it allows a precise and realistic control of the ink thickness zone by zone. Currently, there is no alternative to density for controlling the ink.

A reflection densitometer measures absorbed light and will calculate the screen density, TVI, ink film thickness density in solids, grey balance, print contrast and trapping. However, this device is colour-blind and relies on filters and software to identify and measure colours. Densitometers are not recommended ISO measurement devices because ISO uses L*a*b*-values. Some printers continue to use densitometers as a control device once correctly adjusted to spectrophotometer values,

Spectrophotometry

Colour values are usually calculated by spectral data measured by a spectrophotometer. Colour values specify the visual properties of a colour and are a physical approximation of human colour vision. Colour values are used to define a target colour if the reproduction of a colour is acceptable. There are several ways to define these target colour coordinates. Either a reference sample can be measured (i.e. proof, OK sheet) and taken as target colour or it can be defined as numbers (i.e. CIELAB colour values). The distance between two colours in a perceptual colour space is defined as colour difference (Delta E).

A spectrophotometer measures light reflection over the whole range of visible wavelengths to provide an accurate definition and analysis of colour. They can be used to produce ICC profiles for monitors and printing, measure control strips, and colour deviations between a digital proof and printed sheet; they can also be used as a densitometer because measurements can be recalculated to density values. Some printers use spectrophotometers to measure any variations in new batches of ink and plates on delivery to avoid surprises during production. Some CTP systems automate this measuring.

Wet or dry measurements?

Standards recommend measuring colour values only on dry sheets because colour values shift as the ink dries. The intensity of this change rapidly decreases within seconds of printing and is only a minor problem for offline measuring systems. A polarisation filter on a densitometer provides a comparable density measurement on wet and dry ink to accurately control press ink zones. The polarisation filter eliminates surface scattering, making the dry ink film look like wet ink. A polarisation filter is essential for inline on press devices that measure totally wet ink directly after printing.

Spectrophotometer colour measurement values approximate human colour vision and a polarisation filter cannot be used because it influences colour values in an unacceptable manner. Inline measuring is therefore not recommended, as polarisation filters cannot be used to eliminate the colour shifting effect due to drying.

Online density measurement with a closed loop system is recommended because it provides instant and precise control. It should be combined with offline spectrophotometer measurement of colour values.

White or black backing?

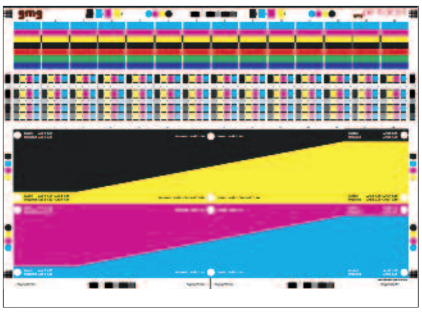
Paper opacity can make measurement problematic, e.g. if the control strips on both sides of the sheet face each other then a dark area on the reverse side of the paper may influence the result. Although white backing is usually used when measuring production prints, black backing is used to decrease the effect of reverse side. For this reason the black backing values in ISO 12647-2 are normative and white backing values are only informative.

Standardisation according to ISO 12647-2

Within ISO 12647-2, target values of colour (CIELAB) and TVI are defined. There is no definition of density values because the same density printed with different inks and/or paper results in different colour appearance.

A first step to realise process standardisation is to evaluate the correct density value for a particular combination of ink and paper. Using this density, the target colour values according to ISO 12647-2 have to be reached by a tolerance of Delta E ≤ 5. As the target colour values defined by ISO are meant for dry sheets, the wet densities have to be matched with respective dry colour values. Using the densities a test print run for print curve evaluation has to be conducted. If the results are stable within given colour tolerances, print characteristic curves can be adjusted until they are also within given ISO TVI and spreading tolerances. This procedure has to be conducted for different combinations of ink and paper. Mostly, it is adequate to conduct this only once for a number of similar combinations.

A test form to calibrate the press to ISO 12647-2 (TVI), or the G7 (grey balance) method using GMG PrintControl 2.0 or similar. Source: GMG



Grey balance control

Ink control based on solid ink density only partly matches the requirements of quality printing. Grey balance measurement and control gives significantly better process stability for 4-colour-printing (screen images), particularly for print jobs with difficult images.

TAC (Total Area Coverage)

Defines by % the combined CMYK dot area (tonal value) by adding the values of each colour in the darkest area of the separation. Theoretically, laying down 100% solids of each colour (TAC of 400%) would achieve the best black area but this causes colour variability. TAC is measured on the original file and controlled during image preparation. TAC should be checked in the darkest area of the film or electronic file and read in the same spot for each colour on final film or CTP file. Maximum TAC is influenced by the substrate.

Assessing plate evenness. Photo: UPM

Other devices

Colorimeter: Low cost device using filters and software; reads and expresses CIELab value to verify colour gamut (preferred in ISO 12647 standards and for measuring ICC profiles); also used to calibrate and characterise monitors.

Plate reader: Special device to measure screen density on printing plates to ensure that they are correctly exposed and processed and are within correct tolerances; essential to calibrate and linearise a CTP device.

Processless plates do not always allow the measurement of the image on plates directly after exposure, as the image contrast between exposed and non-exposed area is less than that on traditional processed plates. Processless plates can be measured by some plate readers like other CTP plates after manual removal of the non-image area using a cloth soaked with dampening solution.

Measuring instruments can only produce accurate values if they are regularly calibrated to the supplier's recommendations. Be cautious when selecting devices to ensure that their calibration does not require an external technician or factory calibration. Similarly, lamps and filters need periodic replacement.

Calibration: All measurement devices need to be serviced and calibrated on a regular basis, usually once a year. For density meters, check and adjust using the density calibration card that is shipped with the device. Check with your provider for more information.

Status E/Status T filter choice: Set the correct density filter settings. USA is usually Status T (or ANSI T); rest of the world Status E (or ANSI E). The colour most affected by the choice of filter is yellow, and can show differences of up to 0.3 density between Status E and Status T.

Measurement conditions: Verify that the measuring conditions for the device are always D50 illuminant; 2° observer; 0/45° or 45/0° geometry; absolute white for colorimetric measurements; relative or absolute white for densitometric measurements; a polarisation filter is recommended for density measurements (if supported in device) but NOT for colorimetric.

Backing: Gives a more brilliant look to work. White backing is preferred by prepress, and is always used when judging/measuring contract proofs (the white backing must conform to ISO). However, black backing is required by printers to avoid show through of ink printed on first side (black backing or a stack of at least 5 sheets of the paper used).

Viewing conditions: Lighting conditions should comply with ISO 3664. A measurement device can be used to check the quality of the light to the CRI (Colour Rendering Index). Check the lighting system counter (if present) for required tube change.

Test Forms: Altona Test Suite, a joint industry development that includes:

1. Altona Test Suite – Application Kit: Reference prints, colour specimens (Process Colour Solids), test suite files, characterisation data, ICC profiles, documentation (available from bvdm).
2. Altona Measure: ECI 2002 , characterisation target, pattern for print definition characterisation, pattern for solid tone measurement, Altona Visual, form for visual judgement, elements to control right settings in prepress workflow (free of charge download from www.eci.org).
3. Altona Test Suite: Purpose form for visual judgement, elements to control right settings in prepress workflow. Testing of ISO 12647 compatibility of output devices: proofer, printer (computer), monitors, presses, test of the compliance to an PDF X3 workflow ISO standard (free of charge download from www.eci.org).

A completely new Altona Test Suite 2.0 Application Kit will be published in 2011 (bvdm) able to test all PDF/X-4 specifications (15930-7).

The Altona test suite includes a test form to visually compare print quality in reference to the standard.
Source: www.eci.org

2: Key influences on quality

There are many variables that influence colour, even in a standardised process. Colour rendition from print run to print run, or during production printing, is subject to fluctuations in relation to solid inking, TVI and trapping, from a changed ink/water balance, or from different substrates. Even under standard conditions with minimal variations, it is practically impossible to conform exactly to a given set of primary parameters. This is due to typical production tolerances and unavoidable differences in press, ink and paper that have to be accepted.

- Primary process parameters with a direct bearing on visual characteristics of the image include printing sequence, press, ink, substrate, screening, and plate.
- Secondary parameters that can indirectly influence the image (by changing the values of the primary parameters) include: speed, dampening solutions, additives, cylinder packaging and blankets, ink/water balance, roller setting, ink film thickness, trapping, temperature and humidity.

Print job preparation & design

Obtaining reliable printed results is a team effort to plan and prepare a print job correctly before it arrives on press. The print buyer/designer should:

- Define clear specifications including paper and bindery.
- Determine the quality expectation and industry standard to be used.
- Type of files to be supplied.
- Identify the type of proof required and viewing conditions.

Many printing problems can be avoided or minimised in the design stage by working within the process limitations and the reproduction qualities of the paper. Printers and paper suppliers can provide valuable advice in these areas. Ideally, these issues should be discussed with the printer at the concept stage when modification of the design layout can be made to align with printing constraints.

Most prepress work and proofing is made before the printing data and proofs are send to the printer. It is important to agree in advance the printing standard to be used by prepress, proofing and printing. This will ensure the separation of RGB images and proofing fit to the standard of the printer. Printers should be supplied with prepress adjusted to paper grade with specifications for SID, TVI and contrast; colour control bars and patches on all forms; and, ideally, proofs that are compatible to the process. Applying GCR, UCA, or UCR techniques can improve printing quality, run performance and reduce ink consumption. *See page 19.*

During job preparation use PSO, GRACoL and SWOP ICC profiles for the general paper category selected. It is recommended to use the standard profiles from ECI or IDEAlliance for the separation of RGB images and for proofing the print ready data before delivery to the printer. This ensures the separation of RGB images is optimal for the chosen paper category and that the proof can be matched by the printer with a short makeready time.

It is the content originator's responsibility to calibrate their monitors, scanners and cameras. Good communication, workflow process understanding and submission of sample files prior to the start of production are a good practice.

Correct software avoids colour management errors when moving from RGB to CMYK colour space for proofing and printing. The large RGB colour gamut needs to be compressed to the smaller CMYK gamut without compromising the colours in the image. Colours outside the CMYK gamut are replaced with colours that come closest to the printing device being used.

10 common problems with digital premedia files *(Source GRACoL)*

- Wrong or missing fonts.
- Banding.
- Incomplete or corrupt files.
- Excessive sizing/rotating of image files in the page layout programme.
- Spot colours not converted to process colours or vice versa.
- Wrong page size.
- Low-resolution images.
- Inadequate bleeds.
- Improper or incorrect trapping.
- Improperly reformatted files.

GCR for process stabilisation in offset printing

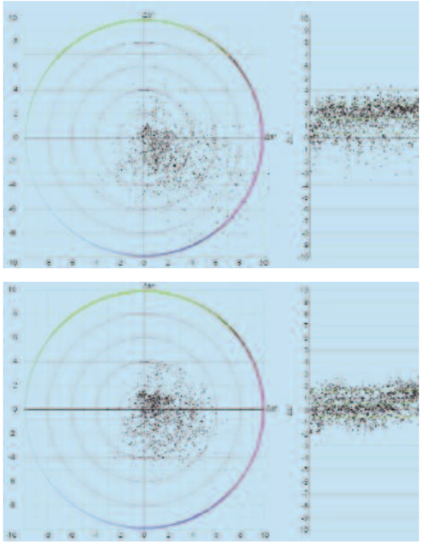
Grey Colour Replacement (GCR) helps stabilise the printing process and improves the contrast and the definition in the shadows. Separations are harmonised by the optimisation process, allowing images from different data sources to behave identically on press. Ink savings of up to 20% are possible because GCR increases the achromatic component. The lower level of inking leads to easier control, tighter tolerances, faster makeready with less waste, and better drying properties. The stability, colorimetric and visual match between production print and reference proof are improved by using GCR to replace the chromatic grey components in grey and tertiary areas. This overcomes the alternating colour shift of the grey balance that can be attributed to the separation having too high a chromatic component in the quarter, middle and three-quartertones.

To reduce the chromatic ink, the black component has to be increased in the tertiary areas, and the chromatic component harmoniously reduced. The black channel must be calculated correctly to ensure the CMY separations are homogeneous; if not, breaks occur in the colour separations and consequent printing. It is in this process that the quality of GCR software is demonstrated.

The starting point for black describes the tonal value in combined printing (CMY) where black starts replacing chromatic colours. A very early starting point can lead to the black screen structure being visible in the highlights, even when using fine screens. A starting point for black in the region of 8% is normally recommended and should be implemented in the optimisation profiles. The maximum tonal value for black determines the tonal value up to which black is added to the separations. Different printing processes and paper classes require different maximum tonal values for black.
To avoid problems in printing and finishing, the total ink coverage has to be taken into account. Printing data are usually optimised before plate making, and generally include a limitation of the total ink application. The optimisation profiles should allow an automatic reduction of the total ink application and avoid problems from excessive ink coverage. Optimisation profiles with a very high level of GCR can be used in offset. Profiles should have different GCR intensities that can be selected to match the press, printer, job and reproducibility.
The grey balance values for a given set of inks, paper and tone transfer characteristics describe the relationships of the three colours to each other necessary to maintain a grey throughout the tone scale.

Printing tests

A series of sheetfed and web offset printing tests confirms this process stabilisation. The sheetfed offset example (graphic) is printed to ISO 12647-2:2002 on a Class 1 paper. The test data were images and test charts were prepared using ECI's ISOcoated ICC profile. The data were additionally optimised with GMG InkOptimizer software with the option to maximise ink savings. The two data records were printed next to each other on the same sheet and subsequently evaluated as described below.
Grey balance/tertiary colours: Optimisation significantly improves the rendition of the grey balance. Errors in the ratio of the TVIs to each other are compensated because the grey balance is primarily composed of black ink. This makes it easier for the printer to adjust grey balance simply by over- or under-inking black. The printer can regulate CMY density to optimise the colours on the press relative to the proof without the grey balance changing. Tertiary colours are stabilised because the total ink application is reduced from the higher black component, optimising the overprinting properties of the individual inks.
Scatter diagrams: The improved quality of the tertiary colours and the grey balance from GCR optimisation was colorimetric tested using an ECI 2002r chart. The scatter diagrams illustrate the local distribution of the differences between the colorimetric target and actual values (the ISO coated characterisation data and the test print). The scatter diagrams are divided into chroma and brightness. The more the values are scattered, the greater the deviations between the characterisation data and the measurements obtained on the print. The improvement achieved by using GCR is also illustrated on the basis of colorimetric figures (see Table).



The top scatter diagram shows the print with non-optimised data and the comparison with ISO-coated. A marked shift in the grey balance towards violet can be seen, and the brightness distribution indicates a tendency towards excessively bright colour rendition in print. The same print with optimised data (bottom scatter diagram) does not display this tendency. The grey balance is far more neutral, and the brightness deviations are also visibly smaller.
Source: Based on report from David Radtke, GMG Color, originally published in Deutscher Drucker in 2007.

Tertiary colors								Gray balance							
GCR/UCR separation Mean				GCR/UCR separation Standard deviation				GCR/UCR separation Mean				GCR/UCR separation Standard deviation			
ΔE*	ΔL*	Δa*	Δb*	ΔE*	ΔL*	Δa*	Δb*	ΔE*	ΔL*	Δa*	Δb*	ΔE*	ΔL*	Δa*	Δb*
0,82	0,58	0,55	0,16	3,75	1,73	1,52	2,96	0,56	0,24	0,26	0,43	1,83	1,35	0,38	1,18
ISOcoated separation Mean				ISOcoated separation Standard deviation				ISOcoated separation Mean				ISOcoated separation Standard deviation			
ΔE*	ΔL*	Δa*	Δb*	ΔE*	ΔL*	Δa*	Δb*	ΔE*	ΔL*	Δa*	Δb*	ΔE*	ΔL*	Δa*	Δb*
2,81	0,49	2,46	1,25	5,03	1,71	2,11	4,23	2,10	-0,89	-1,39	1,30	4,22	1,80	2,54	2,85

! Available GCR optimisation solutions have a wide variation in quality; testing is recommended prior to selection. The test form should include critical images in the grey balance range and vignettes with tertiary colour ranges. Complete solutions for ink reduction should include an automated PDF colour server and profiles for ISO standards. These products work with Device Link Profiles that adapt (but also preserve) the separation of the data without changing the result colorimetric.

PDF/X digital data standard and workflow

The goals of PDF/X are to improve colour and content matches from proof-to-proof, proof-to-press, and press-to-press; reduce processing errors; enable effective preflighting of files; and enable use of multi-vendor systems at single or multiple sites. Poor files, errors in prepress and untrustworthy proofs lead to a waste of time and materials that increases costs, errors and delays to a print job. ISO 15930 defines how applications to create and read PDF/X files should behave for reliable prepress data interchange. The aim for designers is to supply a digital content file that will be printed predictably, while printers and publishers receive robust files, avoiding reworking or errors. PDF/X is designed to be easy and cheap to create. The key term is "process control". Reliable content file delivery is every bit as important as waste management and is a prerequisite for automation.

CMYK vs. device independent

Two issues are treated separately in the standard. CMYK data exchange is used if the file originator wants complete control over the final appearance of printed image. Alternatively, device independent colour spaces (usually CIELab or RGB tagged with an ICC profile) give printers more flexibility to re-purpose content between multiple print formats, and to reduce file size.

Open vs. blind exchange

Users have different needs that require more (open) or less (blind) requirements for exchange of additional technical information. This led to the creation of several PDF/X standards; each is a superset of the preceding one and restrictions are removed in a staged manner.

PDF/X-1a for CMYK-only blind exchange: Files are delivered in CMYK and their values do not specify a particular colour until the printing device is defined. The same values for printed gravure, flexo, offset, or inkjet will usually look different. Groups such as GRACoL, CGATS SC3, Fogra, and ECI are working on characterisations and associated ICC profiles.

PDF/X-3 for colour-managed blind exchange: Files transfer data in colour spaces like CIELab or RGB with a profile attached. Different prepress software may handle embedded ICC profiles in colour managed jobs, which means care is needed that a proof of device independent colours will accurately predict the final printing.

PDF/X Plus: Defines requirements specific to a sector, e.g. image resolution, type size, bleeds, etc. Each is a superset of a specified PDF/X standard.

PDF/X-4: Becoming the standard for colour managed blind exchange, based on PDF 1.6, with live transparencies. Files transfer data in colour spaces like CIELab, RGB or CMYK with a profile attached. Different prepress software may handle embedded ICC profiles in colour managed jobs, and live transparencies flattening, which means care is needed that a proof of device independent colours will accurately predict the final printing.

Application

PDF/X should be used by anyone generating files to send to a print service provider and it is important to check specific requirements with printer or publisher. Making PDF/X files is a useful creative discipline to construct workflows with appropriate pre-transmission validation steps.

A PDF/X file is always labelled with the name of the characterised printing condition that was assumed when the file was created. It provides an early warning to the printer if a customer sends a file that is not suitable for their presses. It also ensures that the supplier and the receiver can set up their proofing in a compatible way to see the same results. It is important to ensure that the label applied to the PDF matches how the file was made. If the file includes CMYK images separated from RGB or L*a*b*, the label in the resulting PDF/X file must match the profile used for the separation. It is extremely difficult for preflight software to validate the selection of a label. Other information required includes:

'OutputConditionIdentifier', this field must be exactly completed to allow automated preflighting. Some software will default to using 'Custom' for this field, and many printers will treat this as suspect because the file may need adjustment.

'OutputCondition' or 'Info' requires a more complete description of the print condition, e.g. embedded profile (if there is one), maximum total ink coverage, or if there are high- or low-key images. Caution: the printer's prepress workflow may not display this data, so if it is important it should also be included as a comment on the order.

Other key data includes the 'TrimBox' that indicates the position and size of the page surface; and 'BleedBox' that adds the area needed for the bleed trim.

Prepress workflows with PDF/X

The complete prepress workflow (trapping, compositing partial page submissions, imposition and RIPing) must be PDF/X compliant for proofing and final output. There are only a few key issues to ensure that PDF/X files process reliably and predictably, and that the final printed piece can match the proof generated by the customer before submission.

When files are delivered they should be preflighted to ensure:
- Compliant with the appropriate version of PDF/X.
- Created for the correct characterised printing condition.
- Appropriate resolution of images (possibly apply extra tests, or use a PDF/X Plus specification designed for the purpose).
- Trim and bleed appropriate for the job. In some print sectors it is difficult for an automated preflight tool to check this and a manual visual inspection is recommended.

For the rest of the workflow, follow the designer's intent:
- If the file is already trapped do not re-trap it.
- Fonts embedded within the file must be used when rendering the file (missing fonts or fonts without authorisation are common problems).
- Overprinting should be applied as defined in the PDF when rendering the file (note that RIP default settings may not produce the required output).
- Proof files using a system set up to match the characterised printing condition for the file. Use the ICC profile embedded within the supplied PDF/X-3 to ensure that the gamut and tone scale compression and black generation match what was intended by the designer.
- The ICC profile embedded in the file should be used to ensure correct output when making plates from individual PDF/X-3 files that contain device independent colour data.
- In many proofing cases, the file will have been reconstructed as it passes through trapping or imposition tools, or aggregated with other files. When processing PDF/X-3 files, these steps must be able to maintain the information about the intended printing condition and any embedded ICC profiles so that the data is acted on appropriately. It may be necessary to apply the embedded colour management to individual files, effectively converting them all to CMYK early in the workflow.

There may be application data sheets available for the components of the prepress workflow to make configuration for reliable PDF/X handling much simpler. A number of free tools are available to assist in evaluation and application.

Proof

Originator: The graphic agency should proof the PDF/X file before dispatch (rather than proofs from the design application) to make visible any unexpected alterations that occur during conversion to PDF/X. If the file contains an embedded ICC colour profile, then the proof should use that profile as the emulation target.

Recipient: Printers and publishers have a variety of policies for proofing customer files. Some proof all files and retain them in case of a dispute. It is useful to store the preflight report with the proof. For others, proofing all jobs may be too expensive or too slow. There are two ways in which the proof can be performed. Both can be useful in different ways:

A. If the PDF/X file contains an embedded ICC colour profile, a proof may be generated using that profile as the emulation target. This gives a representation of what the customer produced in any proof that they created immediately before dispatching the job. First compare it with any hard copy proof from the customer; any significant differences will show that at least one of the two proofing systems is not correctly configured. Next compare the appearance of any device independent colour data on this proof with what appeared on the press. If they do not match, but the appearance of page elements in CMYK does match, then it is probable that the prepress workflow did not honour the embedded profile within the PDF/X file.

B. Create a proof using the usual profile for press print characterisation as the emulation target, ignoring any embedded profile within the PDF/X file. The colour of any CMYK data in the file should match what appeared on the press; if it does not, then either the press is not running to the characterisation intended or the proofing system is not configured correctly.

Influence of proofing system

Proof	Proof use	Proofing system
Creative proof/ concept proof	Design discussion stage	Inkjet or laser printer (non-Postscript 300 – 600 dpi)
Validation print ISO CD 12647-8 *Draft published 06/2010*	Imposition, typeface, text breaks, text overflow, layout and style, type fonts	Inkjet or laser printer (8PS capability) Colour from this type can be acceptable in meeting some production proofing requirements
Contract proof ISO CD 12647-7 *Published 12/2007*	Guide for on press colour approval	Contone and halftone digital colour proofing system

Contract proofs

The contract proof is the visual constant in the process because it is produced with tighter tolerances than offset printing. It is essential that proofs are produced identically with the tightest tolerances irrespective of the output inkjet printer used.

Proofing systems must be able to calibrate the complete colour gamut to archive high quality results on a regular basis – only this can ensure a constant reproducible quality. The achieved quality for contract proofs is a combination of output printer, proofing system, ink and toner used, proofing media, and proofing profiles used. A proof produced on the same output printer but created with different proofing software will vary in quality.

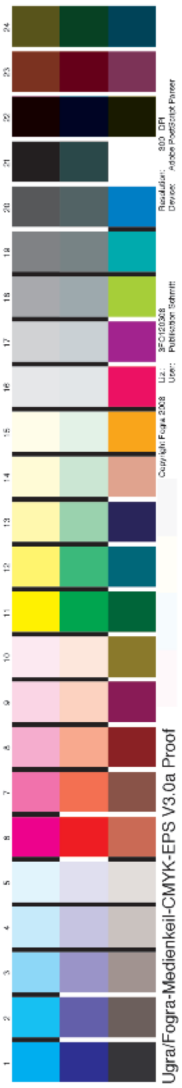
Some proofing systems are certified for industry specifications of standard applications like Fogra, SWOP and GRACoL. If these systems work on a calibration base they can be used immediately without individual profiling. Only a post-calibration is needed on a regular basis according to the supplier's specification.

Proof systems that work without a calibration require a periodic system profiling: 1, Linearisation according to the software RIP aiming at optimal ink amounts and grey balance with the paper used on the proofer; 2, Characterisation of the proofer by printing and measuring a test chart (e.g. ECI 2002 Random and IT8.7/4 Random) with a spectrophotometer and creating a proofer profile.

The success of a contract proof depends on that the production is standardised — both the process and the press that the job is to printed on.

Characteristics of a contract proof: Produced on basis of the PDF file or the 1-bit data that is used for the final print run. Use of the media wedge on the proof to check if the proof is produced in tight tolerances (some suppliers give the option to measure the proof inline with a spectral photometer, but this device must meet ISO 13655). Information required on the proof by ISO 12647-7 includes: Description of the proof system (software and output device), file name, ink and proof media, simulated print condition, source and target profile, date and time of proof creation, and declaration of spot colours.

The Ugra/Fogra Media Wedge CMYK is recognised globally as the control medium for digital contract proofs. Media Standard Print requires a designated contract proof must contain an Ugra/Fogra Media Wedge CMYK. Its colour values must correspond to the reference values of the printing conditions (as ISO 12647) and the tolerances for the proofing process for digital data (as ISO 12647-7).



Media Wedge is a proofing control bar developed by Fogra, compliant with 12647-7 requirements. It is one of the most important control elements in daily use. Source: Fogra

Creative & intermediate proofs

Creative proofs are used between designer and customer to check creative prepress. These proofs are usually inadequate for printing and often cause significant production problems. They may also create unrealistic expectations due to the potential gap between the proof and finished job (variations in proof type and consistency) and non-standard viewing conditions at the customer and/or agency premises. The intermediate production content proof is used to communicate data for imposition, typeface, text breaks, text overflow, layout and style. Both the creative proof and intermediate production content proof are described in the ISO CD 12647-8 as a "Validation Print" to prevent any confusion with a contract proof.

Optimal proof conditions

Climate: Keep a constant and even temperature and maintain relative humidity according to the vendor specification. Storage conditions for proof media and inks should be between 15-20°C and 30-40% relative humidity.
Proofing media: It is recommended to use approved and certified proofing media of the proof system vendor. Some proofing media is approved and certified by Fogra according to ISO 12647-7.
Proofing inks: It is recommended to use the original ink provided by the printer manufacturer. Colour stability of the ink must allow the highest proof quality.
Measurement conditions: The exchange of colour measurement results requires constant conditions as described in ISO 13655: measurement geometry 0/45 or 45/0; viewing conditions 2° according to ISO 3664 (no matter which patch size is used); light source D50 (5000K); CIE-Lab colour space (L*a*b*); white backing (for process control during print runs black backing is used); no polarisation filter; DeltaE according to ISO 13655.
Storage of proofing papers and proofs: Papers brightened by OBAs should be stored in a lightproof folder or bag. Even though OBAs are converting invisible UV light into visible blue light they are sensitive to higher UV light exposure. Lightproof storage ensures that the OBAs are not degrading or losing their ability to convert UV light into visible bluish light. The same applies to all prepared proofs and OK sheets, especially if a reprint is likely.

Remote proofing

Remote proofing saves time and money, now with confidence that proofs at remote locations fully satisfy the stringent demands on a contract proof.
To print a file identically on multiple proofing systems requires strictly separated calibration and profiling. The objective is to achieve identical colour rendering at all times for a given combination of proofing systems and media. Separated calibration enables the systems to reliably achieve the targets for an industry standard within the defined tolerances.
Current proof systems allow a specialist to create an optimised colour profile once; then with the help of a simple calibration routine it can be reliably achieved with close tolerances at any time. The optimised colour profiles supplied by the proof system vendor for the various standards do not require external assistance to implement. Closed-loop printer calibration ensures that the printer always corresponds to the colour space on which profile creation was based. This is the prerequisite for ensuring that proofing results obtained within a printer family and using identical paper can be reproduced at any time and at any location. This eliminates the need for printer linearisation and renewed profile creation.
Fully automatic calibration of inkjet printers allows simple handling at all locations to ensure identical results. The remote site has only to make sure that the output device is operating within the specified tolerances – any deviation is automatically corrected on most new-generation proofing printers. The perfect remote proofing of spot colours is also now possible.

Certification of Proofing Systems

Both Fogra and IDEAlliance offeri certifications of proofing systems according ISO 12647-7. Certifications are given to a defined combination of proofing device, proofing software and proofing media. Selecting a certified proofing systems is a good starting point for producing proofs according ISO 12647-7, PSO, GRACoL or SWOP.

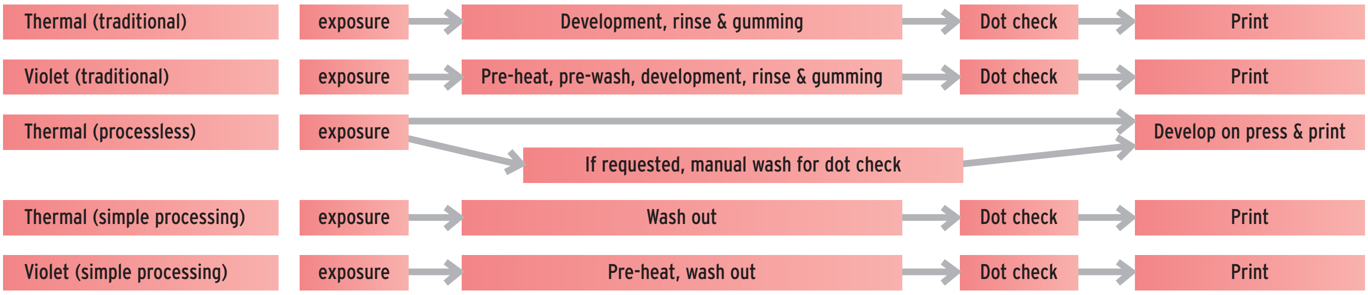
Certification of Proof Production

Fogra and IDEAlliance certify production of proofs according ISO 12647-7. After selecting a proofing system and its installation, the certification of proof production demonstrates that proofing conforms to ISO 12647-7, PSO, GRACoL or SWOP.

Criteria to select a proofing system:

- Proof-to-proof consistency.
- Adequate colour gamut.
- Appropriate proofing substrate.
- Adjustable colour set-up to meet the requirements of different printing applications.
- Calibration system for proofer-to-proofer consistency.
- Incorporated colour control bars.
- Ideally, use the same manufacture's RIP technology that will generate the printing plates. Alternatively, some systems can proof 1-bit TIFF files that are typically produced by a CTP device.
- The selected system should match the desired quality level; include measurable control wedges.
- Simulate the paper shade in inkjet proofing by adding the correct combination of ink.
- The proofing system must be able to correct visual differences that are not covered by measurement nor affected by metamerism or optical brighteners.

Influence of plates and processing



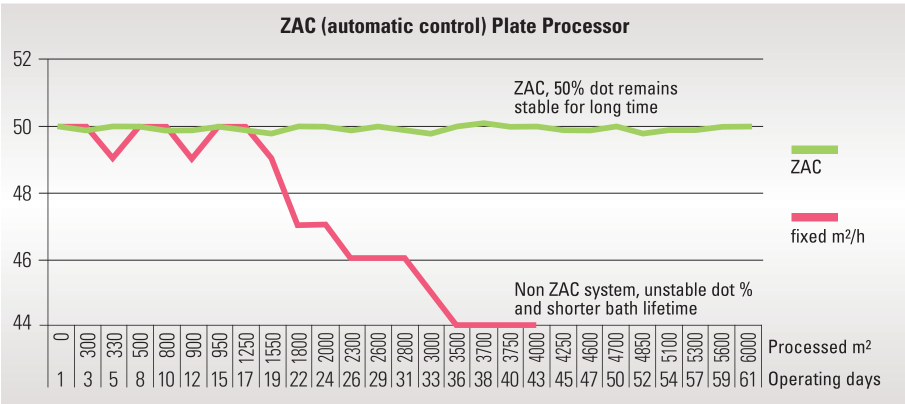
The relationship between different plate types and their processing requirements. Source: Fujifilm

The plate transports to the press the desired image with its upstream calibration, specification and colour profiles. On press it must provide good lithographic qualities and consistency throughout the press run. Plates that are not within specified tolerances can affect colour. The plate must provide a clear baseline for colour approval but only begins to influence colour once it is on the press. There should be no factor from the prepress and/or plate production that requires over correction of inking or dampening on the press. Areas where CTP plate imaging and processing parameters can affect colour and consistency are:

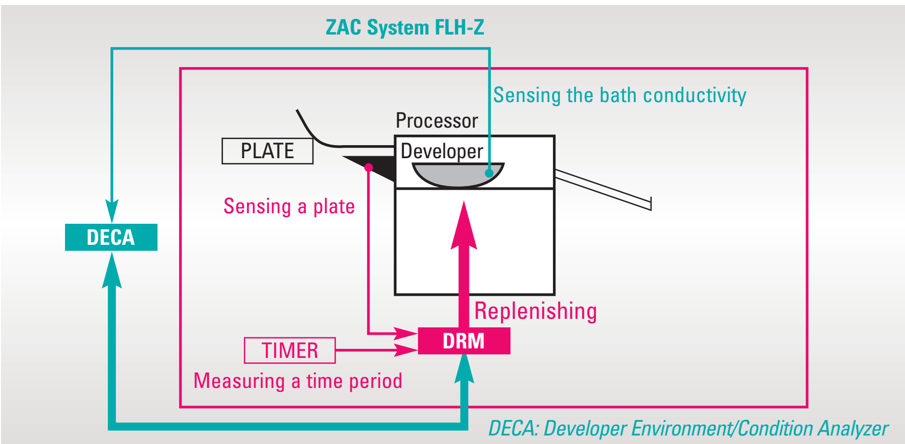
- Picture contrast.
- Density control.
- Colour balance – plate exposure and plate processing tolerance.
- Image gradation – plate exposure and plate processing tolerance.

Reliable printing requires stable plate and plate making that comes from the right combination of platesetter, plate, processor and developer for the technology selected, thermal, violet or UV plates; traditional, low chemistry or processless.

The plate has a major influence in print colour approval because the stability of dot reproduction within specified tolerances is critical. Conditions in the developer bath can change the dot size that may cause a colour variation. The chart shows the impact of the developer bath against the dot size, comparison of a standard processor with fixed values for repl/m² and repl/h against a processor with intelligent measurement and automatic control (Fujifilm ZAC). Target during this trail was to maintain 50% tone value. Source: Fujifilm



The activity of a developer bath is always fluctuating and needs to be permanently monitored. Simple fixed values do not permit a constant 100% stable activity and bath condition and leads to variable dot size and a short bath lifetime. Intelligent Automatic Control (ZAC) uses sensors, timers and DECA (Developer Environmental Condition Analyzer) to analyze the cause of any small change within the bath condition (e.g. by CO_2 or dissolved coating) and if required a dedicated amount of replenishment is made. The DRM (Developer Replenisher Manager) adjust the right replenishment value based on DECA information. Source: Fujifilm



Printing plates have a major influence on colour

Measurement, control and ability to track in the platemaking process are vital to deliver consistency on press. Process stability requires best practice techniques, including:

- Correct storage of plates to manufacture's recommendations for temperature and relative humidity.
- The use of correct development temperatures and processing speeds.
- The use of correct recommendations for developer life m^2/litre.
- The use of correct developer replenishment to maintain development activity.
- Replacement of processing chemicals at the recommended intervals.
- Cleaning and maintenance of the plate processor.

Platesetter laser beam needs to be stable and precise to expose an even image and to minimise the effect of scattered energy/light. A poorly focussed laser beam, or dirty optics cause uneven dot reproduction and weak printing stability. Regular power output monitoring of the platesetter and preventive maintenance are important. Use only qualified media with the CTP unit.

Plates should only be cleaned with an approved developer.

Monitor frequently the stability of the bath and development process; unless an automatic monitoring and control systems is used.

Check the plate thickness with a micrometer because a thicker or thinner plate causes more or less pressure to the blanket that can affect TVI (this can be compensated by adjusting the packing when mounting on to the cylinder).

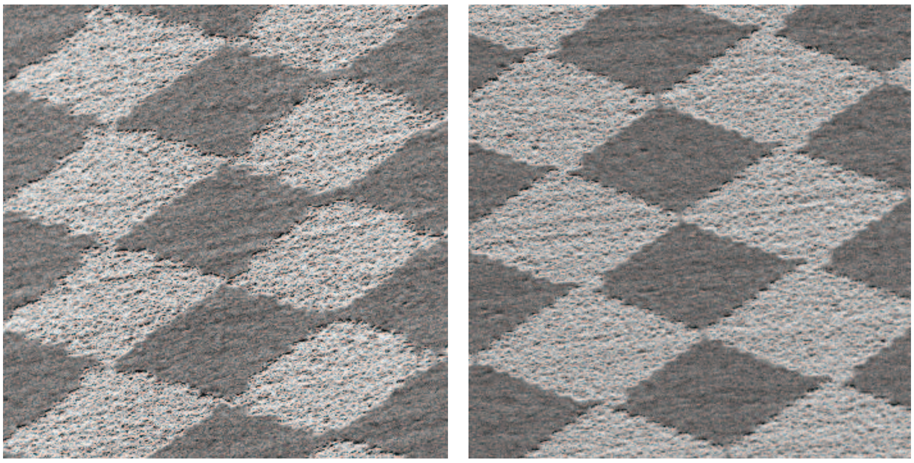
Dot reproduction on plates should be checked to assure consistency.

The plates/curves module in PrintControl can verify the platesetter calibration by measuring the exposed plates.

Plates should be linear for the inking test.

The plates for the second (verification) test run are exposed with new, compensated curves.

Importance of Correct platesetter adjustment



Stable dot reproduction requires accurate adjustment of the exposure unit, because only a small variation in focus will visibly impact dot reproduction. These enlarged photos show the impact of poor laser beam focus. The left photo is out of focus showing an increased tone value increase and non-sharp dot edge, that will not ensure stable printing. The right photo has perfect setting. Source: Fujifilm

Processless plates

An important advantage of processless plate is that the "variable factor" of processing is eliminated. For example, in the DoP process (Develop on Press) only ink and dampening solution are used, which means there is no chemical reaction that can effect the dot size on the plate. The lower image contrast on these plates means that older dot meters cannot measure TVI directly. Suppliers now offer digital plate readers with extra features to read TVI. Manual plate cleaning is needed for these tools which slightly increases the effort to inspect TVI.

Image visibility of processless plates

To measure TVI of processless plates (like Fujifilm Brillia HD PRO-T) requires simply hand washing using dampening solution to remove the non-exposed coating. These photos show a processless PRO-T plate before and after manual cleaning in comparison with a conventional thermal plate.

a)

b)

c)

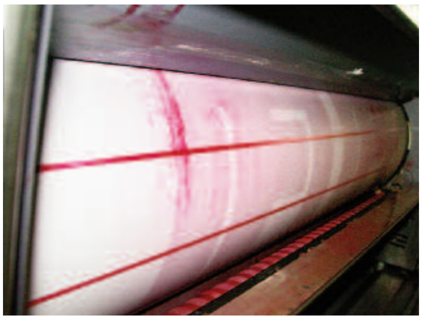
a) An exposed PRO-T plate, image identification and inspection is possible.

b) A PRO-T processless plate with its non-exposed area manually cleaned with dampening solution to allow dot reading measurement.

c) An exposed and processed LH-PJE standard thermal plate.

Source: Fujifilm

Influence of printing press



Check the roller stripes and adjust the ink and dampening rollers as needed. Photo: manroland

A printing press is a moving target with a tendency to change pressures, densities, register and other variables – it is essential to control key variables if the press is to be capable of consistent reproduction.

- Assess the printing performance by running a test form (Altona Test Suite, PIA, etc). Determine the minimum size of dot reproducible on all presses. Any anomaly on the press needs to be fixed.
- Choose and use consumables that optimise reproduction quality. Only change one consumable at a time. Re-run the test form to check impact on the press profile where appropriate.
- Make a profile only when press is warm and in a steady state because this will determine process accuracy and what tolerances can be consistently achieved. Do not adjust plate curves to compensate for poor press condition.

Maintenance

Printing machines are complex electrical and mechanical systems. It is essential to bring the press into an optimum and stable condition and maintain them on a regular basis.

- The surfaces of all cylinders should be free of paper, dust, and ink. Check that grippers are working correctly with no slippage that can cause slurring and doubling.
- Check blanket and plate cylinder packing.
- Check adjustment of the ink train rollers and the dampening unit.
- Optimal condition and adjustment of the ink train and dampening unit rollers must be ensured. Check the roller stripes and adjust the ink and dampening rollers and check the condition of the roller surface visually.
- Adjust the inking unit temperature control device (if fitted) to a suitable temperature.
- Check relevant parameters of the dampening solution (IPA percentage, temperature, pH value, conductivity).
- Check ink preset systems are functioning correctly to achieve uniform target density across the printed image.

Print run consistency considerations

A constant ink and dampening unit temperature is important; a 2°C rise in temperature can produce a noticeable change in colour (TAGA research 1996).

Constant conductivity of dampening solution, and dosage of dampening additives.

Balanced filling of ink and dampening solution.

Regularly clean blankets according to paper characteristics.

Maintain constant production speed.

Offset presses have a cyclic copy-to-copy variation. Although imperceptible in solid colours they can become a visible variation when CMY are combined in neutral colours. This is caused by roller oscillation in the ink train and can be minimised by making the correct phase relationship of these rollers; GCR also minimises the effect.

Register dependent colour variations. If screen angles are correct, small register shifts should not affect colour.

Presses are complex electrical and mechanical systems that needed to be correctly maintained. Photo: manroland

Influence of blankets

The blanket is central to good offset printing and requires careful selection, packing, tensioning and cleaning to ensure printing quality, durability and minimum press down time. Excellent print quality requires a blanket that combines good registration and an accurate dot reproduction.
Accurate transfer of the ink/water emulsion at each cylinder revolution reduces ink piling, and is influenced by the surface roughness of the blanket. Correct morphology helps keep a film of water on the blanket surface to optimise ink/water balance consistency. Using fine screens may cause piling from negative ink build-up that can adversely affect blanket life.

Some blanket best practices:

- Re-profile the press if the blanket type or manufacturer is changed because this may have an impact on reproduction characteristics.
- Blankets need to be stored, installed and maintained correctly.
- Use a gauge to ensure blankets are mounted with correct packing. Adjust the pressure between the blanket and the plate, as well as pressure between the blanket and substrate. Increase pressure slightly up to one-tenth of a millimetre between blanket/plate/substrate.
- Verify the blanket tension with a torque wrench according to the supplier's recommendation.
- Regularly check blankets for any damage.

Check blanket packing and tension to ensure printing quality. Photo: GMG

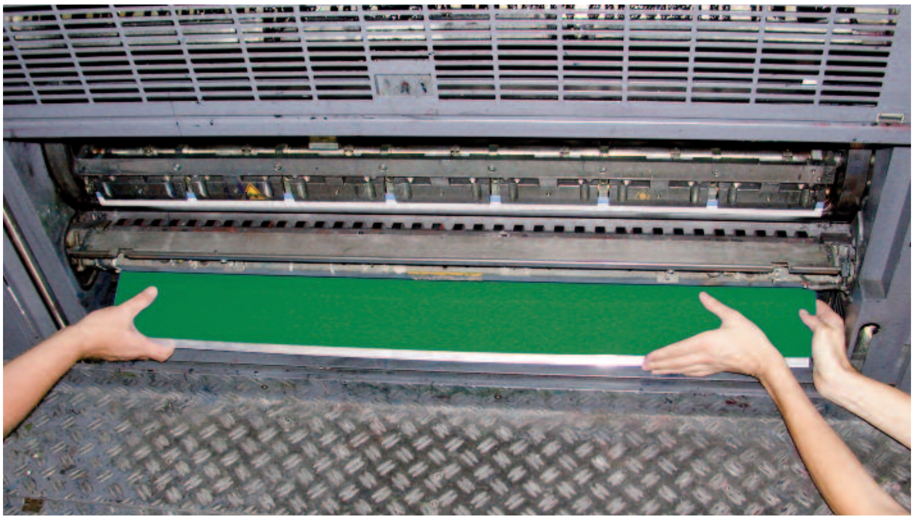
Blanket selection:
With the help of the press manufacturer and blanket supplier(s), select the blanket best suited to the specific production requirements. Considerations include:

Paper release: Poor release affects paper transport and print quality (slurring, mechanical ghosting smudging and even doubling); it can also be related to print-through. Paper release involves a number of factors (paper, ink, water dampening solution and blanket) and its improvement may require adjusting several of them. The blanket can help reduce release through a selected roughness, hardness or top chemistry.

Paper versatility: A single blanket type can be a good compromise for a variety of papers (quality, weight, thickness), but a specific design may be required to address a particular paper and colour registration issue.

Ink & water transport: A high performing printing process requires an optimised combination of blanket + ink + dampening solution appropriate to the paper grades used and target quality levels. A blanket's top surface chemistry and its roughness and hardness play a major role in rapidly achieving ink/water balance and emulsification on the blanket surface.

Stability: Mechanical and chemical stability are essential. Dynamically unstable blankets (nip, surface, blanket cylinder) may cause poor ink transfer (blanket behaves like a sponge) and generate heat that changes ink/water balance (more evaporation on blanket surface) and creates loss of print and streaks.



The press manufacturer and blanket supplier can help select the blanket best suited to the specific production requirements.
Photo: manroland

Maintenance key quality parameters

The chart highlights the relationship between maintenance and quality (and related issues). Maintenance intervals depend on process, devices and intensity of usage (printed sheets).
Source: WOCG/PrintCity

Effective and systematic operating and maintenance procedures are fundamental to process stability. Standardised materials are required to achieve the best possible results. All consumable materials should be optimised as a system (ink, dampening solution, blankets, paper, plates). A change to any one of these may require a new RIP curve. A new inking and verification test run should be made for any new combination of ink and paper.

	Frequency							Related problems		
	Daily	Weekly	1 month	3 months	6 months	12 months	Quality	Slow	Stop	Safety
Prepress										
Check platesetter calibration			✔				●		●	
Check platesetter image quality	✔						●		●	
Platesetter maintenance		✔					●		●	
Check rollers	✔						●		●	
Clean rollers			✔							
Change air filters			✔				●		●	
Plate production line										
Check & Clean plate punch dies				✔			●		●	
Check chemistry activity	✔						●		●	
Change developer depends on system consumption		✔					●		●	
Check finisher	✔						●		●	
Clean processor rollers	✔						●		●	
Replace processor filters			✔				●		●	
Check processor chiller			✔				●		●	
Check baking oven			✔				●		●	●
Ink and Dampening systems										
Check incoming water quality		✔					●			
Check blade of ink train washing device			✔				●			
Clean dampening system, change filters		✔					●	●	●	
Refresh dampening water		✔					●	●	●	
Inking and damping rollers										
Hardness and visual surface check				✔			●			
Roller setting check			✔				●			
Roller cleaning	✔						●			
Roller decalcifying		✔					●			
Roller deep cleaning		✔					●			
Bearing check				✔			●		●	
Blankets										
Clean blankets at end of run and inspect	✔						●		●	
Use correct washing solvents							●			
Check blanket-packing thickness on press			✔				●			●
Replace blanket and packing correctly				✔			●			●
Tension correctly							●			●
Printing units										
Clean blanket cylinder	✔						●			
Clean impression cylinder	✔						●			
Guard grids, clean and check safety	✔						●			●
Check strip width inking rollers			✔				●			
Check strip width dampening rollers			✔				●			
Clean plate clamp bar			✔				●			●
Clean and lubricate bearer rings	✔						●			●
Check bearer ring pre-tension					✔		●			●
Cooling systems										
Clean water filters		✔					●		●	
Compare temperature with setpoints		✔					●	●		
Vent system & refill						✔	●		●	
Complete system service						✔	●	●	●	●
Machine										
Check electrical and mechanical guards	✔									●
Clean sheet guiding tracks			✔				●		●	
Clean ventilator tracks			✔				●		●	
Check and clean sensors		✔					●		●	●
Lubricate side guides		✔					●		●	
Lubricate bearings, shafts etc.	variable, keep to maintenance manual						●			●
Check cylinders for wear & damage					✔		●		●	●

Influence of Inks

For best results, ISO 2846-1 compatible inks are recommended to assure compliance with colour, transparency at the appropriate ink film thickness as defined in the standard. The standard provides colour (L*a*b*) and transparency specifications for 4-colour printing inks. The colorimetric portion of the standard requires that each colour be within a specified Delta E tolerance at within the ink film thickness range provided in the standard. The transparency portion of the standard involves printing over a black substrate at varying ink film thicknesses and measuring the ability of the ink film to transmit light. This ink property is extremely important to trapping and overprint ability (source: PIA/GATF).
The ink system needs good all-round printability with a consistent wet ink transfer to keep blankets clean throughout the run and to reduce piling and plate build-up. The increased surface area of water-to-ink on the plate requires effective control of the emulsion with good water holdout. Even if the "working" ink contains some emulsified dampening solution, it must still retain a correct rheology and tack to provide good transfer and trap. The wet-ink/water balance is a result of the controlled emulsion and is crucial to keeping printing clean, avoiding piling and assuring even reproduction of the image (SID, TVI, ink trapping). Optimum results can be achieved by using an ink with a good balance between pigment, resins and varnish to provide good ink transfer and water balance. This avoids overloading the ink with too much pigment. The process colours require well balanced strengths to avoid one colour excessively carrying too much, or too little, ink.
It may be necessary to recalibrate the process. Even small variations of the solid colour shade and of the sharpness of the screen dots may result in a detectable and measureable difference.
Ink film thickness has a major impact and it is critical to monitor and control ink density so that the TVI remains consistent. There is no direct correlation between SID and TVI; changing SID is an indirect way to manipulate TVI.
Sheetfed printing sequence is normally KCMY. It is important to check the trapping properties of the inks as this is a very important factor for the visual impression of the images and the proof-to-print match. In some cases it is necessary to change sequence to KMCY, e.g. when a blue cannot be achieved with the overprint sequence of C+M, the printer may use M+C.
The addition of press auxiliaries may affect the rheology of the printing inks and the dot reproduction and therefore should be avoided.

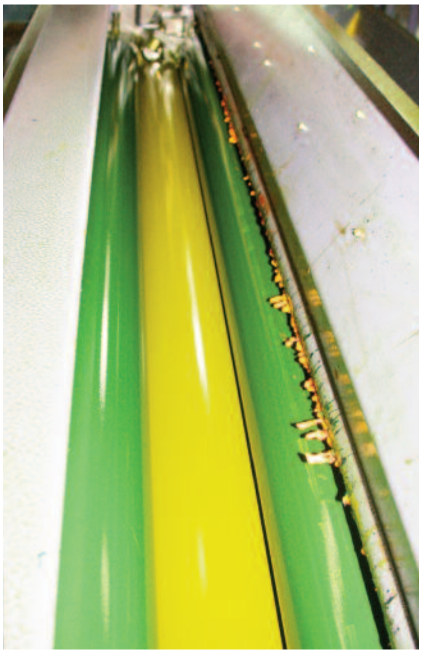
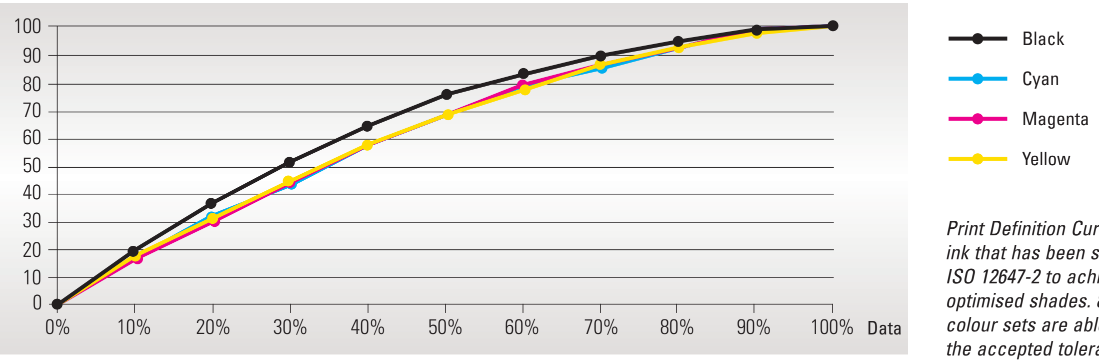


Photo: manroland

Dampening solution

Check the pH and conductivity daily because it influences the printing process; ensure good routine maintenance practices are used.
The pH-values of the dampening solution should be at a level of 4,8–5,5. The percentage of the additive in the dampening solution should be at the level specified by the manufacturer.
Dampening systems are continually contaminated from paper and ink particles, organic pollution and blanket washing solvents. A poor quality solution causes difficult ink/water balance, higher chemistry costs, environmental problems, debris build-up on rollers, plate and blanket cylinders.
Ensure the right combination of ink and dampening solution to match the press, papers, IPA level and water quality.



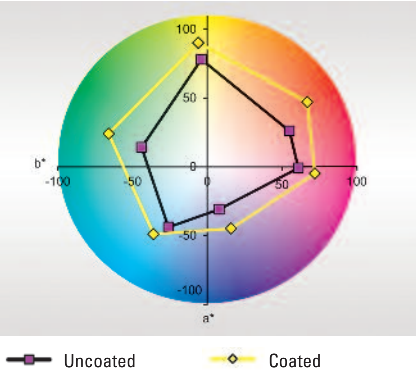
Print Definition Curve of SunLit™ Exact PSO™ ink that has been specifically formulated for ISO 12647-2 to achieve required TVI and optimised shades. 80% of all available process colour sets are able to fulfil ISO 12647-2 within the accepted tolerances. Source: Sun Chemical

Coatings

Water and oil-based overprint coatings change colour reproduction and, therefore, only uncoated printed sheets should be used for calibration.

Influence of Paper

Paper has the single largest impact on print quality. Paper has visual (gloss, brightness, opacity) and tactile properties (stiffness, roughness,) that affect its quality perception. Equally as important is the combined effect of paper and ink on colour reproduction.
The paper surface and shade impact on the reachable colour gamut and the colour reproduction is influenced by the paper surface effect on TVI.



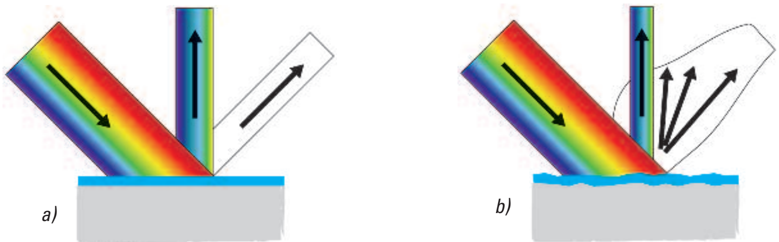
The reachable colour gamut depends on the roughness and porosity of the paper. Part of the white light striking the paper surface is reflected away and part is absorbed by the ink layer. A very rough paper will scatter the white light in all directions to decrease the chromaticity of the colour; ink penetrates more deeply into very porous paper and its effect decreases. Paper coating increases smoothness and decreases porosity. Source: Sappi

Effect of paper on colour gamut

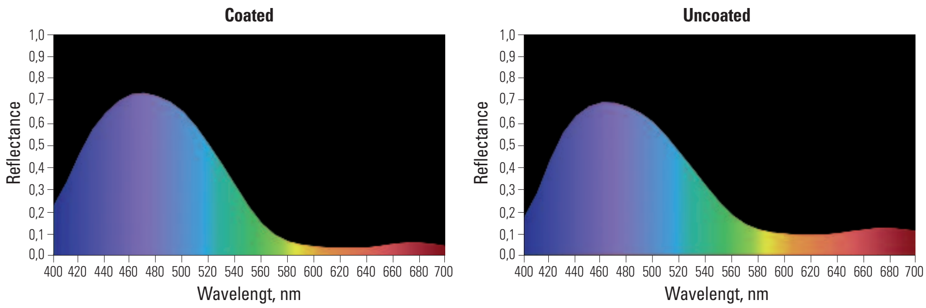
Colour gamut and solid ink density (SID) have a direct correlation. A high SID is needed to achieve a larger colour gamut. There is an optimal level for each paper/ink combination to ensure good runability and printability (even if very different SIDs can be reached on different papers). This is defined by ink demand, because smoother and less porous papers have lower ink demand and need less ink on paper to reach the same SID.
Paper shade acts as fifth colour in printing and affects the colour gamut. Near-white objects in pictures are defined by paper shade and it can be very difficult or nearly impossible to adjust those colours in printing.
The achievable colour gamut on uncoated paper is about half that of coated grades.

a) Cyan ink on smooth and dense surface has higher chromaticity as ink has not penetrated into the paper and white light is reflected away. Below is shown the reflection.

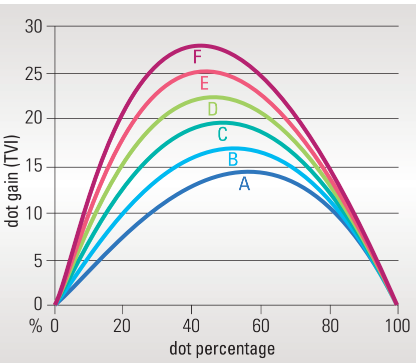
b) Cyan ink on rough and porous surface has lower chromaticity as ink penetrates into the the paper and white light is reflected into the direction of reader. Below is shown the reflection.



The reflection curves and the bluish wavelength levels on both coated and uncoated are similar but there is much more reflection in yellow and red wavelengths with uncoated, indicating there is more surface reflection of white light towards the measuring device (reader). Source: Sappi



Curves A to E are generally used for different types of papers with conventional AM screening and curve F is generally used for non-periodic screening (NP). Source: Sappi



Effect of paper on TVI

TVI is an important element in colour reproduction; it is expressed as the difference in ink coverage between a theoretical value (prepress) and the print. TVI has a mechanical and an optical component. From a mechanical point of view, the size of printing dots tends to increase in transfer from plate to blanket and from blanket to paper. Optical TVI is due to the refraction of light at the interface between the ink and the paper surface (which is by definition uneven). Standard spectrophotometers calculating TVI with the Murray-Davis formula take into account both the mechanical and optical components.
TVI is dependent on press conditions as well as on paper and ink used. However, TVI changes caused by different materials and press conditions can be compensated in platemaking order to stabilise the TVI below a certain level.
Standard ICC profiles now target TVI curves expressed in ISO 12647-2:2004.
Ink demand also influences TVI. A thicker ink film on paper will result in higher TVI. Ink demand is determined by paper roughness and porosity, the same as SID. Generally, the higher print densities (larger colour gamut) that can be achieved with a certain paper, the lower will be the TVI. Paper thickness can influence TVI depending on how nip pressure is adjusted.

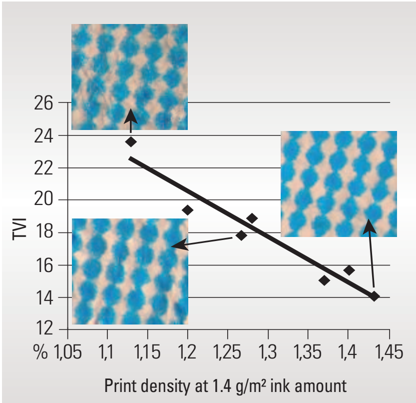
Paper categorisation

ECI ISO profile	Fogra N°	Paper type ISO 12647-2	Paper grades, general terms
ISOcoated v.2, ISOcoated v.2 300	39	PT 1,2	WFC & High quality MWC
PSO LWC Improved	45	Does not exist in 12647-2	MWC and high brightness LWC
PSO LWC Standard	46	PT 3	Standard LWC
PSO Uncoated_ISO12647	47	PT 4	UWF
SC paper	40	Does not exist in 12647-2	SC
PSO MFC Paper	41	Does not exist in 12647-2	MFC (matt LWC)
PSO SNP Paper	42	Does not exist in 12647-2	Newsprint for heatset

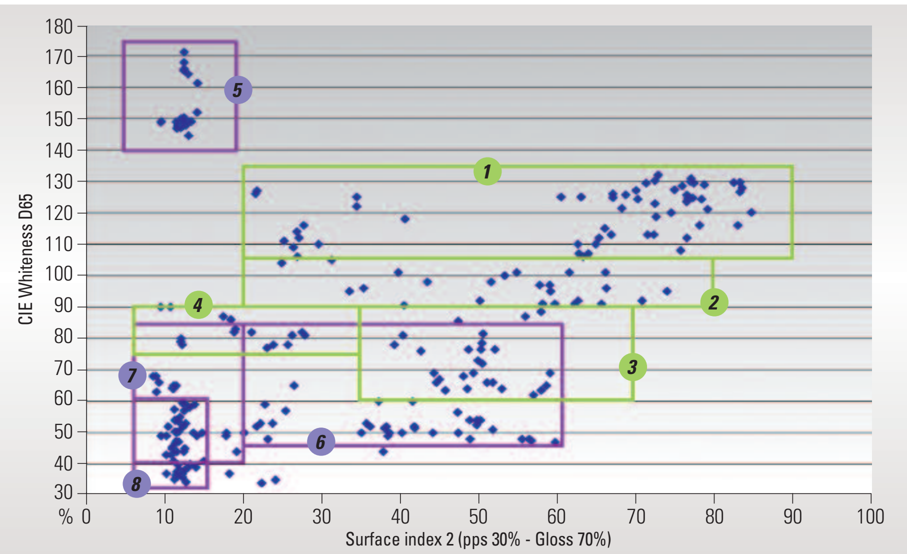
The table shows currently available standard ICC profiles created by European Color Initiative (ECI). WFC (Wood Free Coated), MWC (Medium Weight Coated), LWC (Light Weight Coated), UWF (Uncoated Woodfree), MFC (Machine Finished Coated, SC (Super Calendered uncoated paper). Download from www.eci.org

Paper is generally selected on the combination of suitability for use and cost. However, categorising is the key paper question for colour management and standardised printing, i.e. what ICC profiles, what prepress workflow and CTP compensation should be used with a paper?
The idea of paper categorisation in ISO 12647-2 was to give guidelines to substrate colour in proofing, but it has been misleadingly used as target and tolerance to reach ISO 12647-2 printing. The five sheetfed paper types chosen in ISO reflect the quality of papers in the early 1990s. Little has changed in paper categorisation in spite of the 2004 revision and the 2007 amendment. The shade for a large number of papers does not correspond to these ISO types.
Coated papers often have a bluer/redder shade, which is appreciated by the market because this corresponds to the brightest papers, but also more yellowish papers exist than the standard dictates. The main issue in paper categorising should not be purely paper shade with strict tolerances, but rather what kind of colour gamut the paper can provide.
Most paper manufacturers make prepress recommendations for their paper grades, including the appropriate ICC profile and printing conditions. Following these recommendations allows the full potential of the paper to be utilised with minimal problems in proof-to-print match and achieving colour target.
The colour gamut of the printing press is much smaller than the human visible gamut and generally smaller than hard copy proofs and monitor proofs. To maximise offset printing colour gamut:

1. Select the smoothest substrate available within the context of the job type and its budget.
2. Print to recommended standard L*a*b*-values for the paper grade.
3. Use the specified printing colour sequence to achieve the correct trapping.
4. Ensure that press settings and consumables are correct so that a uniform ink film and correct trapping can be achieved.



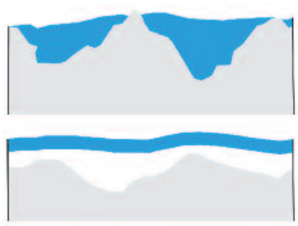
Effect of paper on TVI. Source: Sappi



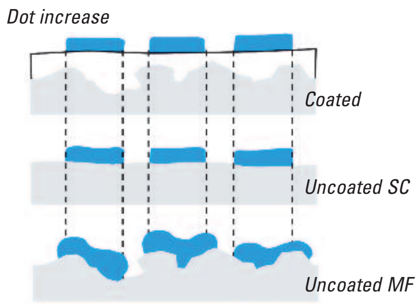
Paper and its relation to printing conditions. Source: Paperdam

Coated Papers
PS1 Premium Coated – Fogra 39
PS2 Improved Coated – Fogra 45
PS3 Magazine gloss – Fogra 46
PS4 Magazine matt – Fogra 41

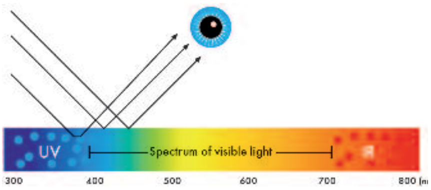
Uncoated Papers
PS5 Woodfree uncoated – Fogra 47
PS6 SC paper – Fogra 40
PS7 Improved Newsprint – Fogra xx (t.b.a.)
PS8 Standard Newsprint – Fogra 42



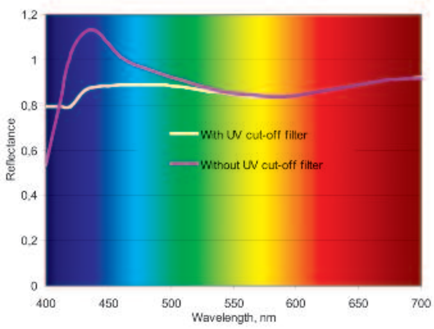
Target print densities for solid covered printing area.
Source: UPM



The more even and dense the surface, the better the dot coherence. Source: UPM



Optical brighteners (OBA or FWA) convert ultraviolet light in the blue sector into visible light.
Source: "Testing and Selecting Paper" UPM



Reflectance spectrum of uncoated offset paper with and without UV cut-off filter. Source: Sappi

OBAs and colour management

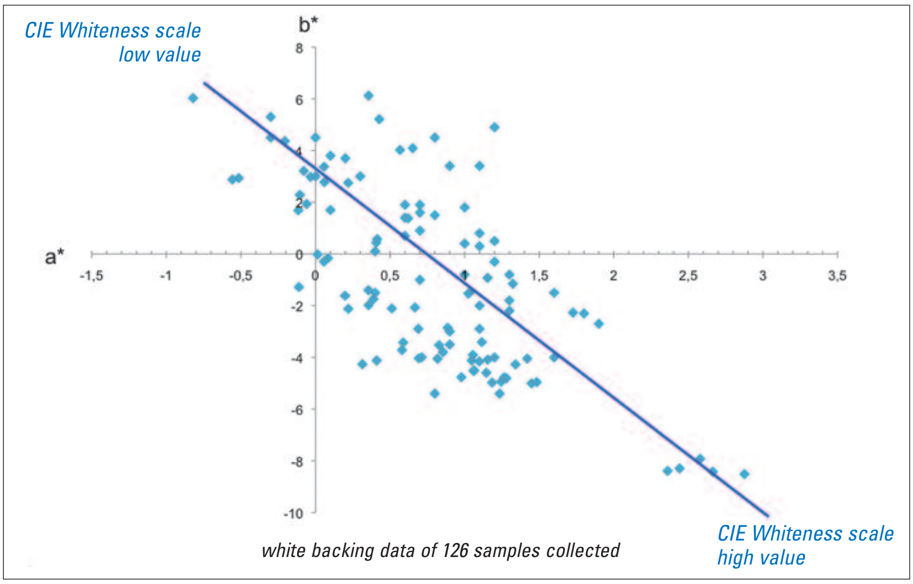
Paper has a natural slightly yellow tint and Optical Brightening Agents (OBAs) are used to increase paper whiteness and brightness. OBA dyes absorb UV light and re-emit it into the blue area of the reflected spectrum; the yellowness is compensated by the blueness, resulting in an overall whiter shade with a crisper and fresher look.

OBAs are often perceived in colour management as being responsible for difficulties in matching colours between the print and proof. To obtain the best match between proof and final printed product, it is necessary that the appearance of the proofing paper is as close as possible to that of the printing substrate. This can be achieved by
- Using the same paper for proofing and printing (as recommended in ISO 12647-2)
- Using a proofing paper similar in paper shade (and amount of OBAs) to the printing paper
- Simulating the paper shade in inkjet proofing by adding the correct combination of ink.

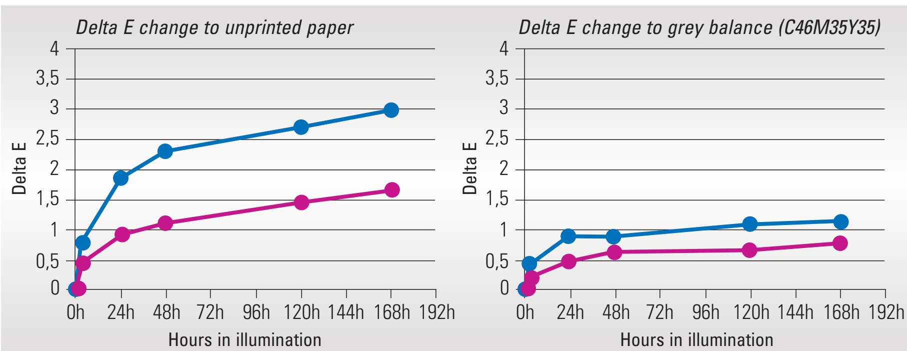
Proofing paper brightened by OBAs should be stored in a black lightproof folder or plastic bag to ensures that the OBAs do not degrade. The same applies to all prepared proofs and OK sheets, especially when there is the demand to use them again later for a re-print.
Paper shade simulation is widely used because proofing papers have minimal amounts of OBAs due to archiving requirements. However, simulating very bluish paper with a near-neutral shade of inkjet proofing paper can be difficult.

Light fastness of printing and proofing papers

The shade and brightness of the paper will change over time when exposed to light because of degradation of OBAs in paper, and yellowing of lignin in mechanical paper grades. There is no reliable standardised light fastness test available.



The whiter the papers are, the more bluish they become. OBA has also an effect on the blue shade of the paper.
Source: Paperdam



Paper with mechanical fibres
Woodfree coated paper

This study results show significant changes in paper shade to a normal wood-free coated paper over several days under direct 5000 Kelvin illumination used in printing houses. The effect on printed colour is much smaller as can be seen from the other figure showing how grey balance shade has changed during time.
Source: Sappi

Colour Perception

Human colour perception is subjective and varies with age, fatigue, heredity and even mood. Inherited colour blindness affects about one man in 12 but only one woman in 200. Even people with 'normal' vision can have variable perception because:

- Physical and intellectual fatigue reduces ability to accurately match colour.
- The eye has a poor colour memory and can only be precise for direct comparisons.
- Ageing affects colour vision as a yellow filter forms on the eye.
- A colour's visual appearance is influenced by the colour adjacent to it.
- Perceived colour is significantly changed when viewed under different light sources.

Many people may be unaware that they have a deficiency in colour perception and some printers test their staff and customers to try and match similar perceptions together to better manage colour OKs. Tests should only be applied and interpreted by a qualified person using the correct materials to give reliable results. These include Ishihara's Tests for Colour Deficiency, Pilot Colour Tolerance Exercise, GATF/Rhem Light Indicator and Farnsworth-Munsell 100 Hue Test.

Fruit collection under daylight illumination.
Source: Sappi

Fruit collection under incandescent illumination.
Source: Sappi

Viewing conditions — light changes perception

We can only see the colours of an object when it is illuminated by a light source. An illuminant is defined by a given power spectrum, which is the intensity of light emitted as a function of the wavelength. White light is a mixture of all of the colours of the spectrum. Colour temperature describes how 'red' or 'blue' the light will be and this will influence the perception of colour being viewed. A standard light source for viewing has been specified at 5000 Kelvin (CIE, ISO, ANSI) in response to the huge variations in natural and synthetic light. CIE standard illuminants are:

Illuminant A: Represents the typical spectral curve of a standard light bulb (tungsten incandescent light).

Illuminant D50: Represents daylight with a colour temperature of 5000 K, commonly used by print industry.

Illuminant D65: Represents daylight with a colour temperature of 6500 K, commonly used by paper industry.

Standard illuminants are used in calculations to allow comparable results because the actual light sources may differ from each other.

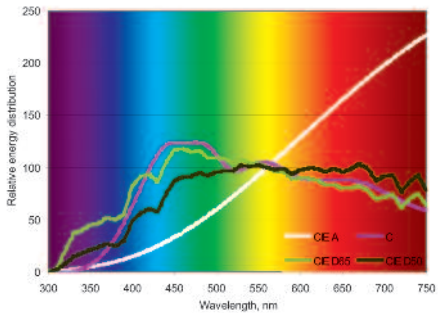
D50 and D65 differ mainly in their power distributions, with less UV light in the D50 than the D65.

Note that printed matter can look very different under the so-called "same light" but with a different amount of UV light. This happens on papers with a high amount of OBAs (Optical Brightening Agents) that are only stimulated by UV light. They give a brighter visual impression to the paper so that the paper seems to have a higher whiteness than it actually has. OBAs under UV light direct the visual colour impression into the bluish instead of just a neutral white. This can be a problem with light shades, such as a neutral grey, viewed by different people in different light booths with different D50 lamps.

✔ Effective viewing conditions require a dedicated physical environment with lamps that conform to an international standard (CIE, ISO, ANSI).

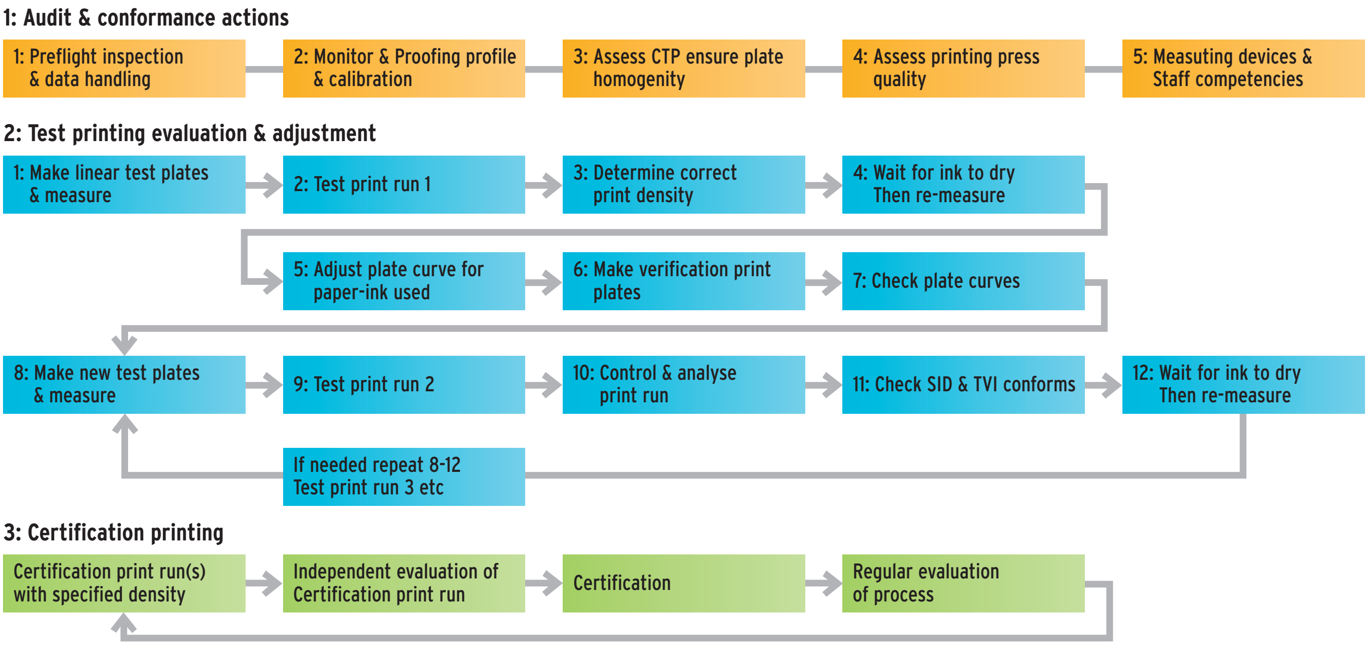
✔ Ensure that the lamps are clean and within their specified life. Many lamps require 45 minutes to warm up to their target colour temperature.

	Printing industry	Paper industry
Standard	ISO 13655	ISO 5631
Standard illuminant	D50	D65
Physical light source	Tungsten lamp	Xenon lamp
Light emission	Direct light	Diffuse light
Geometry	0°/45° or 45°/0°	d/0°
Observation angle	2°	10°



Spectral curves of standard illuminants. Source: UPM

3: Implementing standardisation



The implementation of process optimisation, standardisation, and certification is a 3-part process.
Source: PrintCity

1: Audit and conformance actions

1. Review of preflight inspection and procedures to inspect incoming data and ensure correct data output (PDF X/3).

2. Profile and calibrate proofing system and colour display monitors to ISO 12647-2.

3. Ensure CTP system is correctly maintained and set to manufacturers specifications, check plates for homogeneity. Controlled CTP imaging and processing is essential to maintain high and repeatable quality in the final printed product. The plate must transport the desired images with the correct tonal compensations curves to the press. Place a digital control strip on every plate (position them in the plate bend if they cannot be put in the image area).

4. Assess printing press quality performance with a test form (e.g. Altona Test Suite). Determine the minimum size of dot reproducible on all presses. Any anomaly on the press needs to be fixed. Regularly repeat test to ensure presses are printing to specification.

5. Evaluate measuring devices and their calibration. Assess if staff are adequately trained and informed to use all software and hardware tools correctly; and that workflow procedures are clear and communicated.

2: Test printing evaluation steps

1. Linear output plates are the basis for print characteristic curve evaluation. Measure dot area on the plate with digital plate control strip and plate dot reader (these tools enable plate linearisation, monitoring, and the implementation of tonal compensation curves). The linear plate calibration allows identification of the printing characteristics of a press for a given set of paper, ink, and blankets.

2. Test print run 1 is used to evaluate the print characteristic curve. Make a profile print only when the press is warm and in a steady state because this will determine process accuracy and what tolerances can be consistently achieved. Print about 3000 sheets of each paper with minimal density variation and no slurring, doubling and smearing.
Run the set of linear plates under standard printing conditions to the L*a*b*-value and print contrast specified in the standard. Measure cross sheet evenness of L*a*b*-value and grey balance and adjust until deviation between ink key intervals is a small as possible. Once densities are stable, print 500 sheets at typical production speed to identify any cyclic effects within the press. It is unlikely that the target TVI of the standard will be achieved because the plates are completely linear.

3. Determine correct print density to reach the ISO L*a*b*-value.

4. Wait 2-6 hours for conventional ink to dry and then re-measure. Analyse the sampled sheets over the whole print run and evaluate correction needed for tone values. Measure density v. L*A*B* and related TVI.
Measure 20 samples (from the beginning, middle and end of the 500 copy run) to identify the print curve required. Measure the 40% dot for CMYK and determine the difference in TVI between the test sheet and the selected standard. (The 40% dot is used because it has the largest perimeter and will exhibit most TVI with highest fluctuation on press.) If the deviations between the TVI from the press and those specified are beyond the tolerance of the standard, then the printing units need corrective maintenance to bring them back into tolerance.
Average the results of the measured tone values: Adjust plate calibration if needed. If there is an anomaly on the press test form (e.g. one colour not coherent) the press should be adjusted — not the profile.
Input correct values in RIP.

5. Create plate correction curves for paper/ink combination(s).

6. Make verification print plates.

7. Check plate curves.

8. Output new set of plates with new print characteristic curve. Measure plates.

9. Control print run 2 to test corrected print curve on plates. Wash blankets between test runs. Print about 3000 sheets of each paper.

10. Analyse print run 2 sample sheets from the whole print run. Evaluate correction recommendations for tone values. Confirm that the tonal compensation curves are correctly applied and TVI curves conform to specifications of the corresponding paper type in ISO 12647-2.

11. Check if solid ink L*a*b*-values are in range of max Delta E 5 compared with L*a*b* target values of the corresponding paper type of ISO 12647-2.

12. Wait 2-6 hours for conventional ink to dry and then re-measure.
Several test-correction loops (6 to 12) may be needed until curve is OK.

3: Certification printing

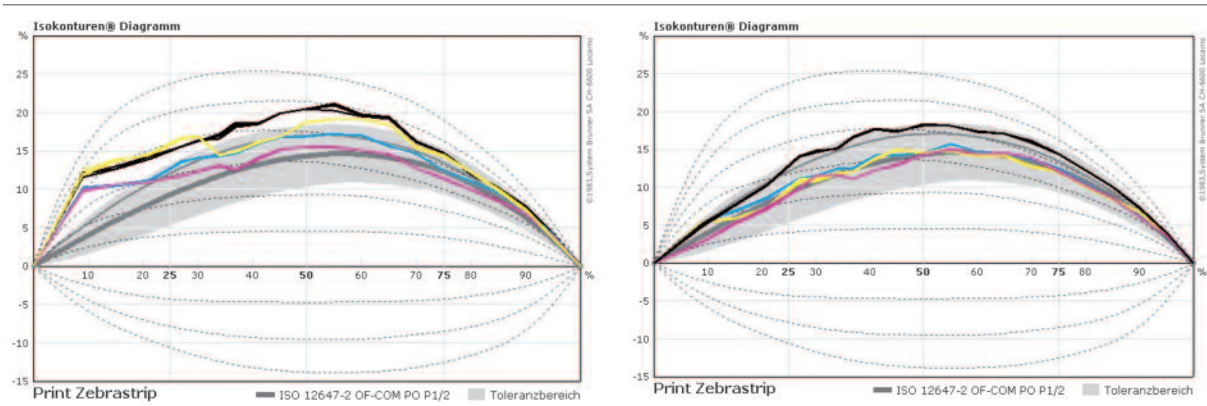
Use steps 8-12 and print around 2000 sheets each paper (or as specified by certification organisation being used).
The key to quality conformance and sustained productivity is regular evaluation of the process.

- Only implement new plate curves based on controlled data and qualified printing conditions. Do not adjust plate curves to compensate for a press in poor condition.
- Press and platesetter characterisation should be made regularly to monitor stability, and, after maintenance or changes of consumables that can impact reproduction.
- A change to one press variable may affect colour and/or productivity. Only change a single variable at a time. It is much more difficult to regain process control if several are changed simultaneously.

Team evaluation of test printing forme at Hammesfahr. Photo: manroland

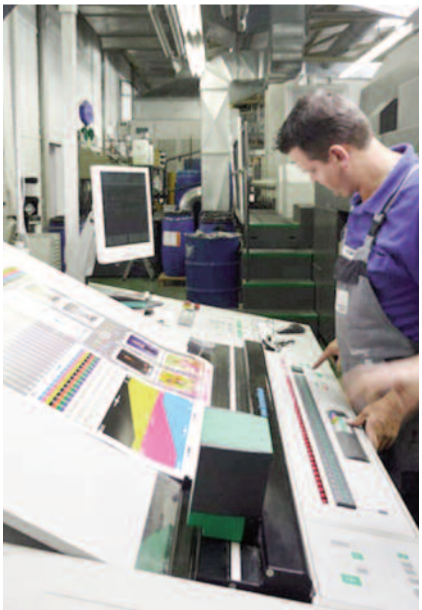
Comments on print characteristic curves

The TVI for each printing colour is examined to characterise the performance of each colour. The overall tonal value (effective dot area) is not considered until later. The target is to bring the curves for each colour as close to the centre of the tolerance as possible and to reduce the spread between TVI of Cyan, Magenta, Yellow as much as possible. The tolerance window is set so that if the TVI deviations are within these limits then the grey balance is not severely affected. This assumes that L*a*b*-values are within specified tolerances.



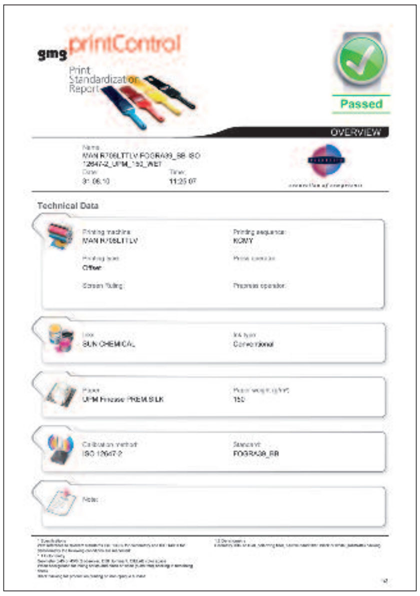
Tone value increase before and after correction. Source: UPM

Hammesfahr case study



Test form printing on the Hammesfahr ROLAND 700 HiPrint. Photo: manroland

Standardisation report. Source: GMG PrintControl



To better understand the practicalities of process optimisation, standardisation, and certification, a case study implementation was made by the PrintCity project team with the sheetfed printer Hammesfahr.

Hammesfahr Print Perfection is a privately owned company established in 1933 that produces publication, packaging and label printing with a focus on value added printing and converting. The company operates out of a modern factory in Haan, Germany, and has 30 employees. Equipment operated includes in prepress: Agfa Apogee X-PDF-Workflow with software from CS Adobe and Quark; Sherpa and Epson 9600 proofing systems; a Fujifilm low chemistry CTP line; a 6-colour ROLAND 700 HiPrint sheetfed press with inline coating and a cold foil system, printing with either conventional or UV inks; labels presses; die-cutting and embossing equipment, and short run laser cutting systems for packaging.

1: Workflow audit

The purpose of the workflow audit is to identify any steps and procedures that can be optimised and have an influence on print job quality and its standardisation. An essential first step is to involve concerned staff to help define targets, requirements, resources and set a time frame.

Preparation and planning — audit status

Hammesfahr's customers define/supply:

- Substrates to be used
- Ink spot colour tone (Pantone or HKS) and sometimes ink set or supplier
- Colour tolerance card (+/-) is occasionally supplied, but no aim standard
- 90% of customer data is created by an external agency
- Contract proof supplied only for some jobs

Hammesfahr's scope of supply:

- Customer is supplied with a PDF and/or a 1:1 imposition proof (created with Sherpa)
- Sometimes customer is on site for press approval, but not for reprints
- Customer is sent print samples but does not receive a report after the job is printed

All job information is placed in a job bag. A weekly print production plan manages job priorities, and provides all information about substrate, ink, coating, print sequence, finishing, etc. The responsible employee for each production step must sign-off the finalised plan.

Prepress — audit status

Incoming files are preflighted by Hammesfahr staff using PITSTOP. Particular attention is given to checking die-cut lines, maximum area coverage, and transparencies. Incorrect incoming files are referred back to originating graphic agency to discuss who and how to corrected data. Packaging construction is delivered by customers or created in house.

Customer proofs were produced to Fogra 39/ISO coated v2. Internal imposition proof 1:1 made on an Agfa Sherpa, and contract proofs on the Sherpa or Epson 9600. After imposition, a PDF is sent to the customer for confirmation. At the time of audit, the in-house contract proof devices were not calibrated, and the calibration method not communicated.

The platesetter was checked regularly, but its status was not documented. Two process calibration curves for exposed plates established at installation of device for (1) conventional inks (2) UV inks. Process curves were not related to ink set or substrates, no defined densities to match ISO/PSO, and no plate process calibration curve available. Plate measurement device is a TECHKON SpectroPlate.

Plates were checked visually, but without rules on what/ when to check. The plates and the job bag are stored together, where appropriate, a die-cut film is provided for the operator to check on press.

Press — audit status

Press operator takes data from the print production plan and the job pouch accompanying the plates. Ink set and paper is prepared in advance.

The press was calibrated only once when set-up one year previously.

Measurement devices: handheld GRETAG DENS device; Grapho Metronic FM 19 scan device; Grey balance control (okBalance) is available but not in use. Training required to use these quality control devices effectively. Press operator checks only DENS on press and tries to match with sample or proof; TVI, Grey balance and CIE-LAB are not checked during production.

Print sheets are checked against customer samples, contract proofs, or prior printing. Often the print tone value looks too saturated compared with the customer sample or contract proof. OK sheet is signed, in some cases by the responsible production manager, and stored for 4-6 weeks along with pull sheets.
No report is made to document the production — and had not been requested by customers.

Audit observations and conclusions:

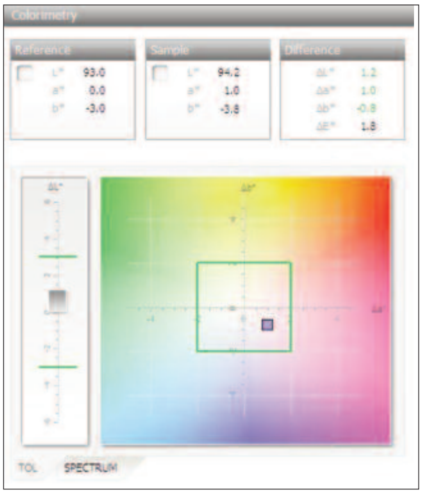
1. The workflow needs improvement to meet PSO certification.
2. The hardware and software to improve the process is available but needs to be calibrated and used correctly. Staff need some training to make full use of these tools.
3. Employees knowledge is limited to their own department and needs to be increased across the complete process chain.
4. Process control is only partly made and not documented. Full control and documentation needed.

Steps to improve workflow and prepare for PSO certification

Prepress:
- Update and recalibrate proofing system.
- Check platesetter output — including consistency from top to bottom and left to right.
- Update process calibration curve on substrates and ink systems used.
- Check calibration of measurement devices.
- Prepress operators need training on process control and PSO certification.

Press:
- Check the machine settings (ink train, rollers, dampening unit, plate packing etc.). Machine found to be in very good condition and only minor adjustments carried out.
- Press operators need additional training on control desk and colour control software; and for PSO certification and process control.
- Review blankets for UV/Conventional inks.

Other:
- Send substrates to ink supplier to help define required ink set.
- Test the substrate samples for PSO conformity.
- Hammesfahr to select its PSO certification organisation.



Comparison of paper tone with reference value.
Source: GMG PrintControl

SID test form for certification print (4 times SID test layout on 70 x 100 cm sheet). Source: Hammesfahr

Overview on standardisation status.
Source: GMG PrintControl

SID test form measurement. Photo: UPM

2: Test printing evaluation for PSO certification

Materials used:
- Substrates: Checked to be within ISO 12647-2 tolerance. Target densities and print characteristic curves were evaluated during the test for: 150 and 300 gsm UPM Finesse Premium Silk gloss coated / 220 gsm GC1 Carton Incada Silk / 350 gsm GD2 Carton JadeBoard / Tauro Offset, uncoated.
- Inks: Sun Chemical Sunlit SKF Process and Sunlit SKF Intense
- Blankets: Trelleborg Rollin Graffity & Vulcan Folio
- Plates: Fujifilm Brillia HD LH-PJE
- Software tools: GMG PrintControl 2.0

A special inking test form was printed with linear RIP settings (no process curve for exposure) to evaluate the optimal densities for the paper, ink and machine combination. The test form has patches and wedges to measure density, colour and TVI. The ink starvation ramps help to achieve a density sweep over the sheet width. The form was measured immediately after pulling it from the press to record wet ink densities; dry colorimetric values of the inks were measured after three hours.
GMG PrintControl software was used to evaluate the optimal patch with the closest match to the given CIE- L*a*b* values for CMYK of ISO 12647-2. The TVI of this linear press run was then measured below the optimal patch of CMYK. The software displayed the current TVI and if these values are within the ISO 12647-2 reference.
As expected, the achieved TVI with linear plates was out of tolerance and a TVI curve compensation was needed to achieve values to conform with ISO. (The GMG PrintControl created these compensation curves in a ready to import file format for the RIP installed.)
The curve corrections were implemented and new plates made. Another test print was made and measured and found the print characteristic curves were within tolerance.
The different measuring devices provided multiple values. For this reason, the master readings were defined as the densities of the manroland FM19 Online Measuring System. These were imported into GMG PrintControl. Target densities were stored within the ColorPilot data bank for further reprints.
After drying, the print characteristic curves and the necessary corrections were evaluated with GMG Print Control.

Test printing observations and actions

1. Machine checked and some minor adjustments made according to manufacturers specification
2. Solid density for paper type 1 (FM19 production device) evaluated and stored within the ColorPilot data base
3. Print characteristic curves for reference material UPM Finesse Premium Silk 150 g/m² gloss coated created
4. Test prints for other materials carried out but no curves evaluated

3: Certification print run

Day 1 — Total time 4 hours

Plate linearity tests
Plate exposure evenness tests
Create test plates with same test form as test printing evaluation (step 2)
Print density and plate curve tests with same paper as test printing
Printed 2 sheets with different blankets

Day 2 — Total time 14 hours

Measure dry printed sheets from previous day. Results showed:
TVI curves very similar to prior test printing (step 2)
Cyan ink shade was outside the standard (closest Delta E was 5.5, far higher than test print run) because the wrong ink type was used and a replacement was immediately ordered.

Order of activities during the certification print run

The project group decided that the final certification run would use a single paper and a single blanket. The density test was reprinted, and a wait of two hours was needed for ink setting before measuring density and TVI.

*Test print 1 with wrong cyan ink. Density vs. L*a*b* evaluation on a Trelleborg blanket.* Source: PrintCity

The TVI (dot gain) curves were corrected in 2 cycles for the final print.
Certification test form printed 1st time — plus waiting time for measurements
Certification test form printed 2nd time — plus waiting time for measurements
Measurements showed that the primaries were within the standard, chromatic TVI curves were very even and close, except black marginally higher. The project group decided that the sheets were OK certification evaluation.
The sheets submitted were evaluated by SID who awarded certification to Hammesfahr.

Observations

- Plate linearity constant over 5 months between test and certification runs.
- Paper quality of different deliveries was constant over 5 months.
- It is essential to control incoming consumables for conformity — the wrong cyan ink type supplied in error for certification and led to an avoidable delay.

Measurement tools:
- CCI densitometer was 0.2 D higher than Gretag Densitometer
- Gretag Spectroeye vs. Techkon RS800 showed that CMK had almost identical Delta E measurements to standard (max 1DE); however Y had a high difference in Delta E measurements to standard (max 2,5 DE), if both equipments are to be used they require a density/ L*a*b* compromise to be established.

Printed sheets measurements
- Blankets have an influence on the density vs. L*a*b* ratio (especially M+Y)
- Comparison of fresh vs. dry printed sheets show that TVI curves are stable with only minor changes. Most density changes occur in first hour and afterwards is nearly stable, after 2 hours Delta E drifts to higher value.

The Sächsisches Institut für die Druckindustrie certification awarded to Hammesfahr. The SID was founded in Leipzig as a research and service competence centre to provide services for the graphic arts industry. The SID offers tests and expertise for printing machines, product quality, material analyses and inspections based on the bvdm Handbook, along with certification to Process Standard Offset (PSO).

Business benefits of optimisation and standardisation

Satisfaction level	Low	Moderate	High	Very high
Internal benefits to print company				
Improved order processing efficiency with customers			●	
Improved PDF file quality supplied from customer	●			
Fewer re-plates				●
Reduced makeready waste & time			●	
Reduced running waste & time			●	
Reduced customer claims/credits from fewer rejects/errors		●		
Increased overall production efficiency & lower costs			●	
ISO/PSO part of programme to improve manufacturing & workflow			●	
Improved understanding of process & how materials effect results			●	
Improved staff confidence and competence			●	
External business & customer marketing benefits				
Deliver more defined, repeatable & consistent quality			●	
Faster total job completion			●	
Improved customer perception of printer 'quality brand' value			●	
Certifications helps retain & extend existing customers sales		●		
Certifications helped attract new customers to grow business		●		
Improved environmental performance (less waste & machine time)			●	

The internal and external business benefits of optimisation and standardisation to Hammesfahr from its standardisation process. "Our benefit has clearly been the rationalisation of the workflow and especially to increase the capacity of our staff," adds Klaus Valet, production director of Hammesfahr.

4: More efficient press OK

"Obtaining rapid colour approval is a team effort for which the essential key to success is the preparation of the job before it arrives on press. Efficient colour approval then requires effective working between the print buyer and the printer". *'9 Steps to Effective and Efficient Press OKs' by Diane J. Biegert, PIA/GATF*

What is a press OK?

The colour OK is an objective comparison of the printed job with its proofs to help ensure it meets the order specification. The customer or design agency may be present to approve the colour. In some cases, specific targets may be specified using a reference to a standard or specification.

On Press Approval — the customer's role

The print buyer/designer prepares for the press OK by:

- Determining the quality expectation of the printed product (preferably with an objective standard).
- Identifying the surface and shade of the paper.
- Identifying pages/images that are potentially difficult to print due to the design.
- Identifying the type of colour proof to be used.
- Determining the degree to which these factors can match the printed job.

At the printing plant

- Be well rested before making a colour OK as fatigue impairs colour perception. Allow your eyes time to adjust if you have come from a bright sunlit area (45 minutes).
- Ensure that your proofs are made from the digital data used to make the plates, and on the same (or simulated) substrate, otherwise they will have poor comparative validity.
- If you view the job in the pressroom, ask where you should stand in order to avoid being in the way of the press crew. Don't comment on the job until you are given a printed sheet to review.
- The printer is your ally to achieve the optimal result from the materials supplied.

When comparing proof to printing

- The sheet should be free of ghosting with no tinting or scumming in non-printing areas.
- Look at the overall print impression. Stand at arm's length from the sheet and look at it for about 10 seconds, then look away. Are there any images or colours that appear incorrect?
- From the general impression identify the areas that require some adjustment and examine them closely.
- Are all of the graphic elements present (less of a problem in complete CTP plate workflows)?
- Clearly and rapidly communicate the end result of any adjustment requested (not how to achieve it).
- The limits of the process may mean that not all changes can be made. Work with the printer to find the best compromise and clearly communicate your priorities to help him.
- Work to the quality parameters established at the time of order.
- Register tolerance of around half a dot is relatively normal on dark colours. Yellow can be up to two dots out without visual impairment in many cases. The importance is the printing effect to the naked eye. There is generally less visual register tolerance on borders, reverse type and overlay tints than on photographs.
- Exercise caution when requesting increased ink film density because the human eye evaluates optical stimuli on a logarithmic scale, e.g. a perceived 5% increase in a colour may require 25% more ink – which may be beyond the paper's ink density limit.
- A Spectral Photometer should be used. L*a*b*-values and TVI should be according to ISO specifications, within certain tolerances. When these values are right, measure the SID for better control of the ink film thickness. Alternatively use the GRACoL/G7 method.
- When satisfied with the result, sign off two OK sheets and keep one for your records. The other is the printer's reference to maintain continuity during the print run.
- There will always be some SID variations during printing; these need to be within an agreed tolerance.

Test fold: Some expensive and time consuming postpress problems can be prevented by folding the sheet to ensure that printing is correctly positioned on the pages, and back up correctly from front to reverse sides.

Check colour vision

Human colour perception is subjective and varies with age, fatigue, heredity and even mood. Inherited colour blindness affects about one man in 12 but only one woman in 200. RCC Spain reports that around 7% of over 1000 printers tested could not read colour correctly with Ishihara tests. Even people with 'normal' vision can have variable perception because:

- Physical and intellectual fatigue.
- The eye has poor colour memory.
- Ageing affects colour vision.
- A colour's visual appearance is influenced by the colour adjacent to it.
- Perceived colour is significantly changed when viewed under different light sources.

Some printers test their staff and customers to try and match similar perceptions together to better manage colour OKs. Tests should only be applied and interpreted by a qualified person using the correct materials to give reliable results. These include Ishihara's Tests for Colour Deficiency, Pilot Colour Tolerance Exercise, GATF/Rhem Light Indicator and Farnsworth-Munsell 100 Hue Test.

Makeready — some best practices

Makeready steps	Printer's task	Customer's task
Pre-set ink keys via cip3, tension, press settings, density target values		Check that all graphic elements are on printed copy
Start-up press makeready	Achieve ink-water-balance and colour register	
Adjust settings with customer to achieve colour OK	Achieve colour (i.e. based on ISO target Lab values or proof or customers wishes)	Identify where colour adjustment is needed
Start production print run	If colour is OK, start good OK copy count	Sign off 2 sheets, keep 1
Monitor samples to colour ok, check print quality visually and via measuring device	Adjust press to maintain printing to ok. Collect print samples and protocol of run	

Makeready steps and key tasks for Printers and Customers. Source: manroland

Productivity maintenance is a prerequisite for efficient production. There is a clear relationship between effective maintenance and print quality, productivity, and reliability.

Prior to start-up

- Ensure all specifications and special instructions are clearly communicated to all staff. Define proof types and viewing conditions for each process step. Understand the issues of human perception and mutually define an objective colour approval approach.
- Ensure plates have been measured.
- Ensure that proofs are available at the press. Ideally make imposed colour proofs (profiled to press) that have been approved by the customer.
- Make sure that all measuring devices are calibrated.
- Always check blanket surface visually before starting a new job and avoid an unplanned press stop to change the blankets after start-up.
- Check viewing conditions – are the lamps clean and within their specified life? Many lamps require 45 minutes to warm up to their target colour temperature.

Priorities during makeready (and running)

1. Colour/grey balance: The effective use of the grey bar is a powerful tool for colour control and consistency. Monitor midtone grey balance patches to get rapid overall colour balance. Intelligent regulation algorithms (i.e. okBalance®) facilitate keeping the grey balance, and with it the visual impression, very stable.

2. TVI (dot gain): Can vary between 6-35% depending on the screen size, press, process, paper, ink film thickness.

- Measure the midtones where TVI has the highest impact and the largest variations.
- Control of TVI consistency and balance is much more important than absolute values.
- To maintain grey balance, TVI values between the three colours should not differ by more than ± 4% (traditional procedures) or ± 2% if the right tools and procedures are used (grey balance control).

3. Monitor L*a*b*-values: When reaching the target, measure the SID. Be aware that there is a remarkable colour shift between wet and dry sheets. It is, therefore, important to find out the SID-values for optimal L*a*b-values on the dry sheet.

4. Monitor SID: Measure and control ink film thickness. Many print customers want 'colour punch' and pressmen often please them by overinking. When setting colour it is important to remember that the human eye works in a logarithmic scale, e.g. a perceived 5% increase in a colour may require 25% more ink. However, each paper grade has an optimal ink density limit beyond which little additional perceived difference can be achieved. Use a properly calibrated densitometer as a tool to control ink film weight and avoid overinking and drying problems detrimental to quality. Do not exceed the density specifications appropriate to each paper grade (UCR and UCA during prepress ensure good reproduction of solids without overinking). Overinking is the most frequent cause of a wide variety of process problems; it is an avoidable cost and increases the carbon footprint.
The balance between the values of process colours is more important than their absolute values, e.g. frequent densitometer measurement of the SID solid patch in the colour bar will prevent ink film weight from continuously creeping up during running (and keep job consistency closer to the colour OK sheet).

Use quality control devices: The effective use of correctly calibrated quality control devices is essential to ensure optimal process results. Automatic closed loop colour control systems overcome the issue of manual measuring. The measurement of different attributes (grey balance, TVI, L*a*b*, SID, print contrast, highlight and trap) gives a more effective control of the print process to achieve the best results with the materials available. While measurement assists makeready and output monitoring, some final manual settings adjustment may still be required. Key considerations are:

- There is no single attribute to measure, all must be considered together.
- Quality control tools should be systematically used, calibrated and maintained.
- Printers should be supplied with prepress adjusted to paper grade with specifications for ICC profiles, characterisation data, L*a*b*-values, SID, TVI and contrast, with colour control bars and patches on all formes. Ideally proofs should be compatible to the process and paper surface to be printed.

Remember that between people there is a variable colour perception influenced by their competencies, motivation, and physical condition.

Trouble shooting

Common problems & solutions

Common problem	Platesetter calibration	RIP curve	CTP curves	Lighting conditions	Digital proofing	Plate & Packing	Paper surface	Paper tone	Ink density	Ink composition	Ink colour sequence on press	Dampening & pH value	Ink/Water balance	Press gripper	Ink roller settings	Cylinder settings	Blanket & Packing	Press temperature	Fan-out effect
1: Gamut does not match the standard								●	●	🟢	●		●			●	●		
2: Grey balance out of tolerance		●				●		●	●	🟢		●		🟢		●	●	🟢	
3: Solids do not match reference values								●	●	🟢			●						
4: Midtone spread values out of tolerance		●				●			●	🟢		●		🟢		●	●		
5: Print does not match proof			●	●	●	●		●	●	🟢			●				●	🟢	
6: Slur/Doubling values are out of tolerance						●								🟢	●	●	●		●
7: Trapping is out of tolerance									●	🟢	●		●			●	●	🟢	
8: TVI is out of tolerance	●	●	●			●			●	🟢		●		🟢		●	●	🟢	
9: NPDC values (G7) do not match reference curve		●				●		●	●	🟢		●		🟢		●	●	🟢	

Issues that can be resolved by printer ●
Issues requiring external/expert assistance 🟢

Source: PrintCity/GMG

Some common problems

1. Gamut does not match the standard: The gamut represents the colour space, or colour reproduction capability of a device, and is dependent upon the combination of ink, paper, and printing machine. All printable combinations of CMYK are inside this gamut that is built from the measured solid values of CMY as well as from the overprints Red (M + Y), Green (C + Y), and Blue (C + M).

2. Grey balance is out of tolerance: Grey balance is the ratio between the three process inks (CMY) required to produce a neutral grey. The ratio is different at each halftone value from 0 to 100%, and is predominantly a function of the ink hue. The three grey balance control patches are composed of combinations of CMY. When printed correctly, the resulting tone should be neutral grey. Any incorrect parameter is immediately noticeable because the patches will display a colour other than neutral grey – the colour can vary widely, from reddish to greenish or yellowish, depending upon the cause. In some traditional approaches, grey balance was considered correct if there was minimal visible difference between the CMY and the K patch alongside it, however when printing to simulate today's colorimetric specifications such as Fogra 39 or GRACoL, it may be unwise to judge CMY grey balance by visual comparison to a tint of black ink due to variations in the "colour" of many black inks. The only reliable way to measure grey balance is in units of a* and b*, however the target a*, b* values will vary according to specification or target colour space.

3. Solids do not match reference values: CIELAB is a mathematically derived colour space that can be used for colour comparisons. The chromaticity coordinates for any measured colour are described clearly in this colour space with three points; L* for the lightness, a* for the red/green axis, and b* for the yellow/blue axis. The L*a*b*-values and tolerances for CMYK (primary colours) and RGB (secondary colours) are specified in ISO 12647-2 for each paper class. The Delta-E formula that is used describes the distance between two colours inside the CIELAB colour space. If the dE value is zero, then the two colours are equal. A value of one means the colours are similar but not equal, and the larger the dE value, the greater the distance between the two colours. (DeltaE described in ISO 12647-1: "Difference between two colour stimuli defined as the Euclidean distance between the points representing them in L*, a*, b* space.")

4. Midtone spread values are out of tolerance: Spread is the difference between the highest and the lowest TVI at the same dot percent of CMY. The aim for spread as defined in ISO 12647-2 is the same for production runs as well as for standardisation, i.e. 4% or less at the 40% or 50% midtone patch.

5. Print does not simulate the proof: Once the standardisation process is finished, print the verification test form on the digital proofing system to compare results. There should be a very close visual correspondence between the offset print and the digital contract proof. If not, it may be due to one or more factors.

6. Slur/Doubling values are out of tolerance: Slur is caused by the difference in surface speed of two cylinders (plate/blanket or blanket/impression), and results in a thickening of lines that run across the printing direction, making them appear darker while parallel lines remain unaffected. Doubling is caused by register problems between different printing units and shows as a slightly misregistered overprint of the same image. The visual effect is also that lines of a particular direction become darker. Contrary to slur, however, doubling can occur in any direction. There are patches on the test form for checking slur and doubling. The first allows a visual check without the need for a measuring device. Each of the four sets of concentric circles should appear uniform, with no wavy artefacts. There are also patches that can be measured to give a slur/doubling percentage value, which should be as low as possible.

7. Trapping is out of tolerance: Trapping (ink acceptance) occurs as inks are overprinted and refers to the amount of the second or third ink which is able to print over the previous ink layers. The relative amount is expressed as trapping percent, where 100% corresponds to the quantity of ink transferred to a blank sheet. Trapping values generally differ from wet-on-wet printing to wet-on-dry, or dry-on-dry printing. Trapping values are typically less than 100% in wet-on-wet printing (without any inter-unit drying) and can be less than 70%. The secondary colours are very dependent upon trapping as the tone and saturation of red, green, and blue depend upon how well the second primary colour has been able to print over the first colour. Trapping values are only informative and not specified in any standard or specification and will change with different papers, inks and additives as well as with different printing speeds or types of printing machine construction.

8. Correct compensation curves: Curves are smooth and uniform and CMY are closely matched. Black is often 3-4% higher. Incorrect compensation curves: When the curves are smooth and even, but not within tolerance, it is a matter of using the correct compensation curves. Plates may have been imaged using curves for a different substrate or printing machine, or could also be linear, with no compensation applied. Each colour should have its own compensation curve.

9. NPDC values do not match the reference curve: The G7 specification defines tonality with a Neutral Print Density Curve (NPDC) that specifies the relationship between measured neutral density and original halftone percentages of a printed grey scale. The specification defines two standard NPDCs – one for a combined CMY grey scale and one for a black ink grey scale. The 'natural' NPDC curves of commercial CTP based printing were determined by G7 research analysis of numerous press runs made with ISO conforming ink and paper and a variety of plate types imaged on non-calibrated CTP systems. To define the curves mathematically, the measured data was averaged and smoothed to remove measurement anomalies, then matched by trial and error to a variety of experimental formulae until one was found that fitted the data smoothly and accurately. To fit the neutral dynamic range of any other process, a non-linear dynamic range adaptation formula embodied in the G7 specification compresses or expands the standard NPDCs initially determined for the GRACoL neutral dynamic range.
For the purpose of tolerances, NPDC accuracy is measured in ΔL^* on the K-only and CMY-only grey scales of the standard G7 25-step P2P target. Gray balance accuracy is measured on the CMY-only grey scale in units of "ΔF^*", where ΔF^* is the sum of absolute Δa^* plus absolute Δb^*. (Note that the name "ΔF^* may be changed in future to ∅Ch.) To minimize false errors in unstable shadow areas, a weighting formula reduces ΔF^* and ΔL^* in grey scale areas where the cyan percentage is higher than 50%. Tolerances vary according to process. The strictest tolerances apply to proofing, where the average weighted ΔL^* and ΔF^* values must be 1.5 or less and peak ΔL^* and ΔF^* must be 3.0 or less. Other printing processes are assigned more relaxed tolerances depending on the capabilities of each system.

Some solutions

Platesetter calibration: If all colours show the same anomaly it is probably a platesetter calibration problem. It can also be caused by incorrect development conditions such as bath temperature, speed, or even a defective batch of plates. If only one colour has faulty tone curve, then there is probably a machine problem like slur or doubling.

RIP curve: Measure the printing plates after exposure and check if the tone value curves for CMY are all too high or too low. If yes, then check if the solid printing densities are correct; if they are within tolerance, then check the CTP RIP curves and the exposure process.

Paper tone: Check if the paper tone matches the L*a*b* values to the ISO 12647-2 standard for this paper class. A large colour shift of the paper will influence the overall appearance of the sheet, especially in highlights and greys. Use substrates with the correct paper tone. Use of proofing paper with optical brighteners can have a dramatic effect on the visual match to press – the proof is generally seen as more bluish.

Lighting: Check the lighting conditions. ISO 3664:2000 establishes the correct viewing conditions for graphic technology and photography. Digital proofing systems use different paper and inks than offset systems. Use a standardised lighting system, otherwise the metamerism effect will create a poor proof to press match.

Ink composition: Tack, chromaticity, viscosity, pigment strength – check these with your ink supplier.

Ink colour sequence: Make sure the colour printing sequence is either KCMY or CMYK, as other sequences are not ISO 12647 compliant. Many inks are tack adjusted to print in a certain order. A change in print sequence can lead to undesirable results.

Ink density: Check the densities of the CMYK solids. Adjust the print density to within the optimum range. Variations in density will increase and decrease the TVI, so it is important to keep the density inside the range for all jobs. (Ink film thickness: Has a major impact and it is critical to monitor and control ink density so that the TVI remains consistent. There is no direct correlation between SID and TVI; changing SID is an indirect way to manipulate TVI.)

Ink/water balance: Check the ink/water balance. A good ink/water balance is indicated through a slim scum line on the bend edge of the printing plate. An incorrect ink/water balance can negatively affect trapping, as the amount of dampening solution in the ink influences its splitting behaviour. Ink/water balance affects trapping that affects secondary and tertiary colours. Poor trapping leads to weaker overprinted colours and therefore a smaller gamut. Too much dampening solution can increase the fan-out effect resulting in slur/doubling.

Dampening solution: Take into account pH/conductivity, water hardness, type of dampening system, dampening solution formulation.

Plate packing: Check the packing under the printing plate. Incorrect packing changes the circumference of the printing cylinder, which has a major influence on correct rolling. The result is a print length change and a change of rotational speed.

Plate/blanket squeeze: Check the pressure between blanket and the plate cylinder. Reduce the pressure as much as possible.

Blanket/substrate squeeze: Check the pressure between the blanket and the print substrate, and reduce the pressure as much as possible. Use the "Kiss print" adjustment and increase pressure slightly afterwards.

Blanket packing: Check the packing under the blanket. Too much packing will change the circumference of the blanket cylinder, which has a major influence on correct rolling. The result is a pressure change and flexing effect between the substrate and the blanket.

Ink roller/plate squeeze: Check pressure between the ink roller and the printing plate is uniform with an ink roller stripe test. A different band thickness from one side to the other indicates an incorrect ink roller adjustment.

Gripper bar: Grippers should be clean and well lubricated and the sheet edge perfectly straight in the gripper bite. Improperly adjusted grippers can cause slur and doubling which will affect the spread. If needed, request press manufacturer to check the the sheet gripper adjustment in the printing unit.

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