TECHNICAL GUIDE

APPLIED COLOUR MANAGEMENT

Second Edition

FESPA
profit for purpose

Applied Colour Management

Colour management is largely a solved problem, at least it is in terms of technologies. The colour science is sound and the tools to control colour data are widespread throughout the graphic arts industry, sometimes visible and sometimes not. The development community has done a great job of providing technology that works and it keeps evolving as new inks, substrates and printing methods emerge across ever increasing markets. And many industry standards are available to provide guidance for implementing colour management processes. There is even broad awareness of the problems a lack of colour control can cause and yet people still find that colour management is a challenge.

They are of course right, but not because much of the development work hasn't been done or the science is flawed. People who believe that printed colours are impossible to control are mistaken, but it is true that applying the technology can seem daunting. The challenges associated with setting up a functioning colour managed workflow can make applied colour management seem out of reach for many companies. But it is not.

Where do you start?

As with all things the objective is the starting point, because once analysed your objective ultimately determines what you must do in order to achieve it. The reason for implementing colour management technology and processes is most commonly to achieve higher profits, faster turnarounds, greater automation and less waste. Cutting down on colour errors improves margins on jobs because it saves operator time and materials waste. Fewer errors in the workflow means production can run automatically and at a higher capacity. And colour control improves the business's use of resources, from customer service and production staff through to ink and energy. Shorter and faster make readies are another benefit commonly experienced when a printer evaluates what has been achieved with improved colour management knowledge and practices in the company.

You may also find that improved colour quality allows you to increase margins, not just protect them. Customers generally are prepared to pay for better quality products delivered fast.

If they don't want to pay a premium, you at least save the cost of losing them or dealing with dissatisfied clients and having to do reprints. Waste reduction is an especially important consideration, particularly if you have to do repeat runs because the colour isn't right. Applied colour management tools can also help you to optimise ink coverage, so that you are not spending more on consumables than you need. All in all improved colour management should increase not only customer satisfaction but also staff satisfaction. People generally appreciate the opportunity to develop their skills and work for a company committed to quality production.

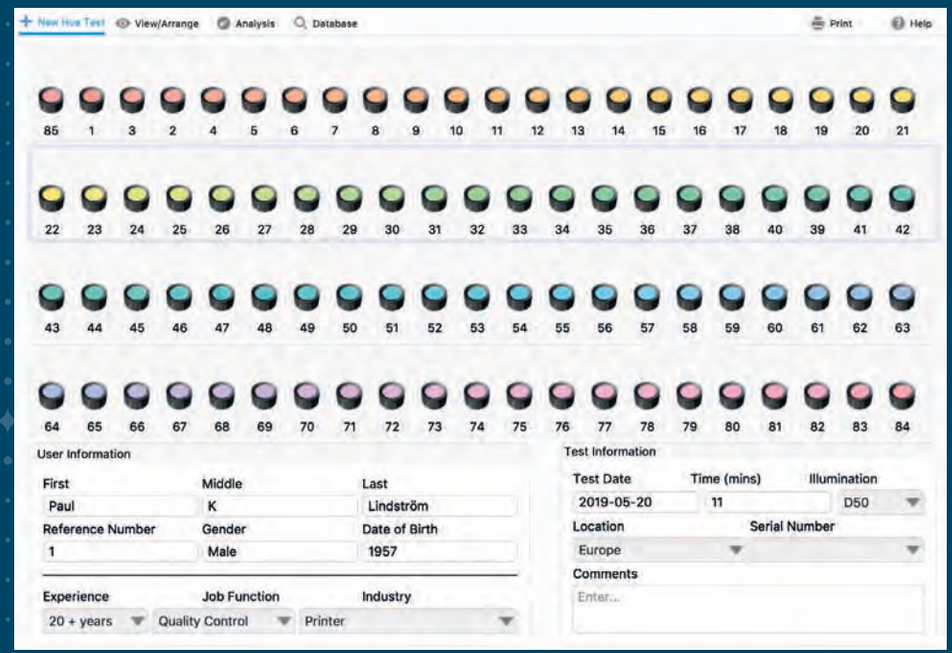
Cost control should be fundamental to how you manage your business and a decent colour management set up will deliver this. It will improve overall workflow performance and provide you with accurate data for responding to Requests for Quotations (RFQs). The business case for applied colour management is clear, so even if it looks complicated and a hassle it's worth doing.

Basic Principles

We have traditionally managed colour during the printing process by fiddling with colours until the printed colours look like the customer artwork. But this approach is inappropriate in the modern digital age where data is king and where computers have replaced many traditional prepress functions. While this has been bad news for colour and graphics production artisans, the digital graphics revolution has been good news for graphics production overall. The deskilling through digitisation of many prepress functions, including very expensive ones such as creating colour separations and proofs, has encouraged investment into print media products and created new opportunities for printers, especially in wide format digital printing. It has also created new opportunities for developers so many companies are now actively developing tools to automate colour management processes. Print runs in all sectors of the graphics industry are generally much shorter than they used to be and they are produced in highly automated environments, and colour management software is a vital component supporting this business model.

Prepress has benefitted from intense investment in software and hardware to improve prepress processes to make them more efficient and inexpensive and colour management has particularly benefited. Digital systems can be configured in completely automated workflows, managing colour at every stage in a job file's development from the original page layout to rendering in HTML on a website.

Colour management starts with the job's design and origination, based on the output intent and can continue at each stage in the job's progress towards the printing press and beyond. These systems are cost effective. They do not get tired, so they are not prone to the intellectual and physical fatigue that plagues humans and which can impede our ability to perceive and match colours. Unlike digital systems humans are vulnerable and inconsistent. Our eyes do not perceive colours accurately all the time and the visual appearance of colours is influenced by adjacent colours. As we age our colour perception changes, none of which is good for applied colour management. Trust better the digital systems and measurement tools that are



The Farnsworth-Munsell colour vison test is commonly used to check if a person really can discriminate accurately between small differences in colour. A series of colour patches needs to be arranged exactly right, or you will be given penalty points in your score.

not vulnerable to any of these limitations. And don't forget to test the colour vision of staff members who make colour critical decisions. This can be done with a simple colour vision test such as the Farnsworth-Munsell 100 Hue test. You can buy this kit for a few hundred Euros and it can save you a lot of money in avoiding errors and correcting them. It's a one off cost, so it can be used for customers as well as employees.

Start your applied colour management planning with what you expect for incoming files and how they are formatted. Specify job set up for your customers, providing them with guidelines that help them to configure colour files correctly, for instance using PDF/X-4 or even PDF/X-6 as your required data format. For example give them a check list of what not to do, such as including RGB images unless they are tagged with an ICC-profile, low quality images or lines that are too thin to hold with your print method. Provide a shortlist of ICC profiles you prefer for the most common substrates used in your plant, and give them some basic colour guidance.

Device Calibration and Profiles

You cannot control anything that you cannot measure, so device calibration and characterisation are absolutely fundamental to your colour management routines. The frequency with which you calibrate devices depends on how much use they get, how old they are and how vulnerable they are to changes over time. For instance your viewing booth lamps generally conform to CIE Illuminant D50, however the performance of light tubes generally deteriorates over time. Check the manufacturers' specifications for how many hours the light tubes or can be expected to produce stable and correct brightness, track usage hours and change the tubes before they are overdue.

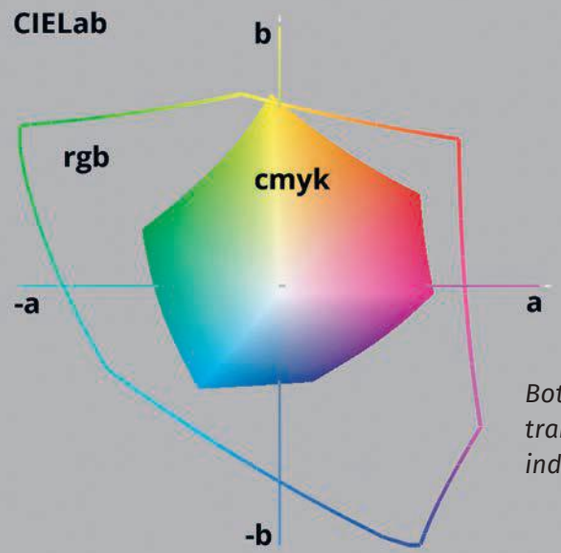
Spectrophotometers are probably the most important device in your colour management armoury. They should be serviced and recalibrated according to the manufacturers' instructions, which is generally once per year. You should also compare values across devices, as inter-instrument agreement is by no means a given. Work is underway within the standards community to try to resolve this problem, but in the meantime you can use the reference technique mentioned above to check that your devices are performing consistently or that, if they are not, you know what the deviation is likely to be from a calculated mean. If you have any inline spectrophotometers make sure to include them in your calculations. Proofers, scanners, digital cameras and presses should all be calibrated on a regular basis.

Device calibration and profiling are the cornerstones of colour management, following the principles laid down by the International Color Consortium (ICC). A device profile is a small data file that has details of a device's characteristics and its ability to match reference colour values. This little data file doesn't have any reference to what a colour ought to be, but only how RGB or CMYK colours appear on the device, expressed in CIELab colour space values; CIELab is the working colour space for ICC colour workflows.

CIELab

CIELab defines mathematical colour values in a three dimensional space according to their luminance value (how light or dark they are) and their degree of redness to greenness along the a axis, and blueness to yellowness along the b axis. Using a device profile the colour management system can, if necessary, adjust the colour data as the file is processed. This improves the likelihood of achieving accurate and consistent colours in proofs and prints. The ICC's standard file format for device profiles has been widely adopted throughout the printing industry and all colour management software and hardware providers include support for ICC processes.

Spectro ready test patches.

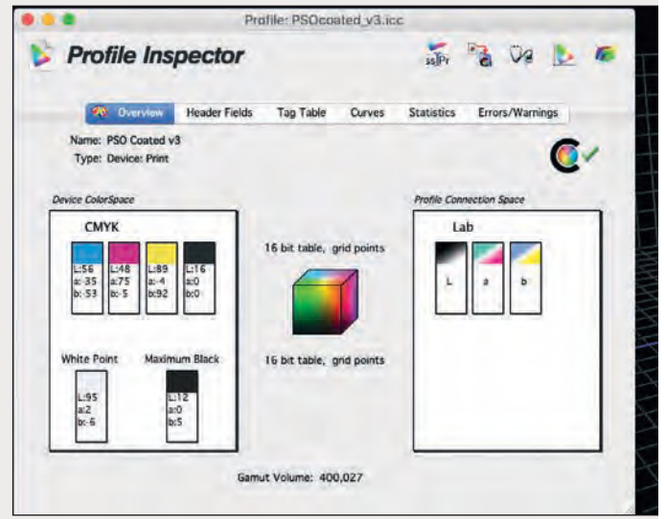


Both RGB and CMYK can be translated to CIE Lab, the device independent colour space.

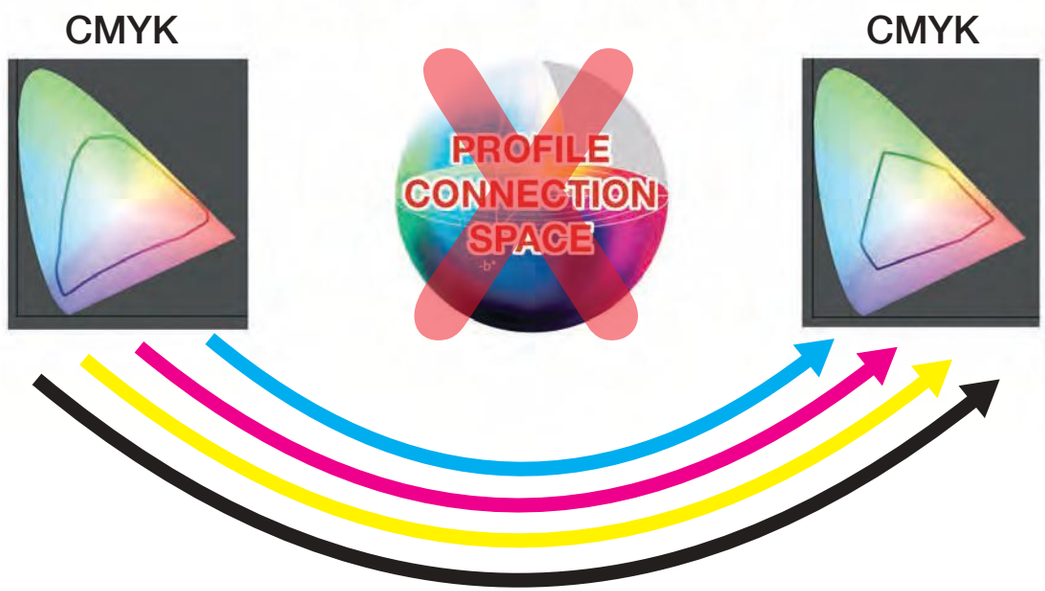
Profiles are created using measuring tools and comparing how a device renders colours relative to absolute CIELab values. You measure colour charts with patches of specific percentages of cyan, magenta, yellow and black, or when calibrating a monitor, different values of RGB, using a spectrophotometer.

You can get away with using a colorimeter for monitor calibration, but you will get better results with a spectrophotometer. Commonly used charts for printing devices are what is commonly called the IT8-series and charts produced by ECI, but they are all included in the latest series of the ISO 12642 suit of test charts. For scanners the ISO 12641 suite of test targets can be used for calibration, since scanners has had something of a revival of late.

Generally speaking you will get a better result from your profile the more patches you measure, because a profile defines the relationship between CIELab and the device's digital values. The profile also instructs the transformation of RGB and CMYK colour values into their CIELab equivalents. A device link profile, is a pre-calculated colour transform between a fixed set of printing devices, to save time when processing the colour data.

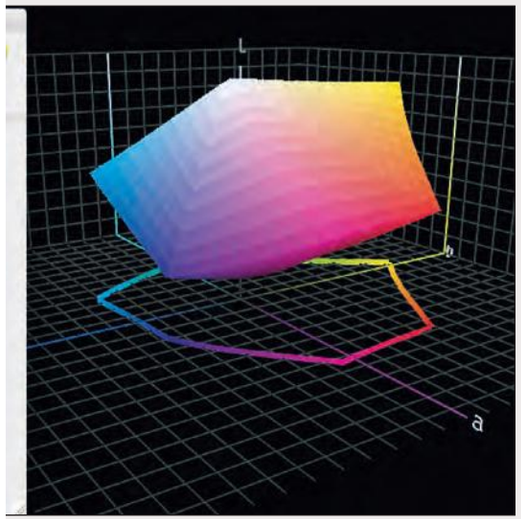


Device link profile



You can use generic profiles for different ink, paper and device combinations, but for professional print you are better off using professional tools and creating your own bespoke profiles. Do make sure you know what you are doing and that you have some controls in place to check the quality of your profiles.

The twin imperatives of device calibration and profiling, including inks and substrates are the foundation of applied colour management. Together they make it possible for you to account for the different characteristics of devices and materials within your printing system. A colour



Colourthink gamut map and profile

managed workflow lets you print jobs with confidence on different substrates and using different printing processes. Colour management technology is sound enough, but you have to be prepared to invest in the knowledge you need to manage processes, so that the colour management procedures and technologies are optimised for your specific production workflows. This is the only way to ensure that colour management works for your business to deliver the results you want. There are plenty of reasons why this makes sense, not least margins and profitability and a foundation for growth.

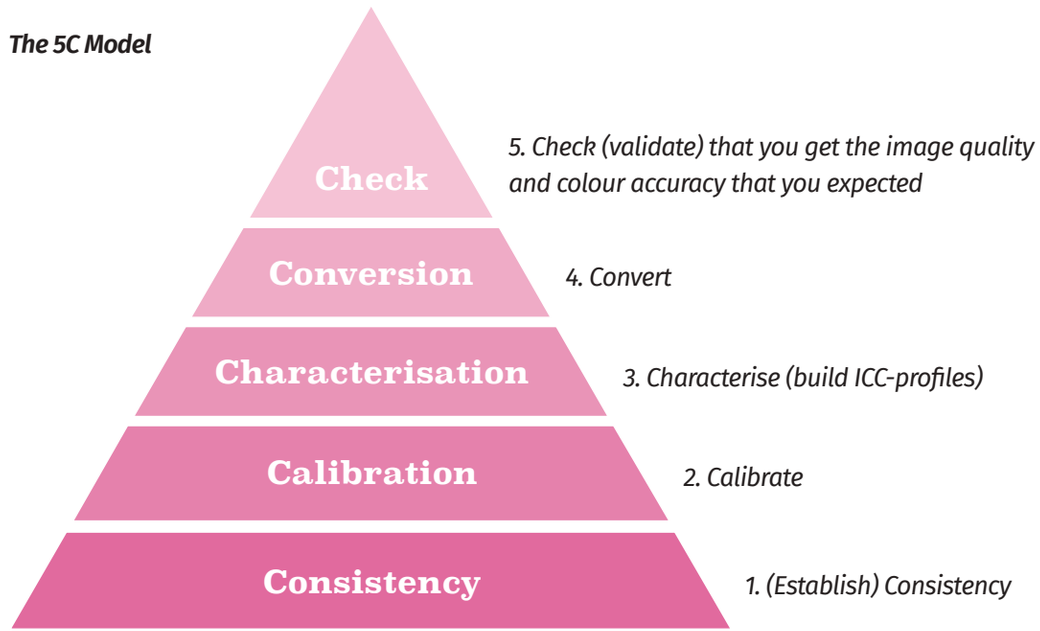
Go Through the 5Cs

When analysing the print production workflow it might be useful to follow a 5C checklist to see if all the components related to colour management are optimised. The 5Cs are Consistency, Calibration, Characterisation, Conversion and finally Checking.

In order to achieve colour consistency both devices and the production environment need to be set to a stable and predictable state. This includes process control and management, plus checking and controlling temperature and humidity, as well as reducing vibration. Check how calibration and validation should be done for each device in the colour production chain.

Characterisation means creating or selecting the best possible ICC profile for a given substrate. Colour conversions should be applied at the appropriate stages in the workflow and in the correct way, according to clear and consistent instructions that both staff and clients can follow. Finally, you must build in regular checks to ensure your processes are quality managed. You may find a centralised colour management solution useful here, where all colour targets are saved in a database together with instructions on how a certain device should be calibrated and how often. This central colour database can also hold your validation data to help evaluate the performance of your colour management system and to track improvements.

The 5C Model



Benefits

Getting the results you want requires that you know what you want! Set clear targets for operators so that they can achieve the desired colour goals. Put the targets in terms they can understand, such as average Delta E error rates per month or sheets, rates of deviations from defined tolerances, waste volumes or remake rates. If you have set up your colour control and management procedures correctly, you and your staff should be able to trust the data to improve colour control with confidence.

It's all about confidence. Once you have trust in the technology and your ability to use it effectively you will be able to create reliable profiles for new substrates. This means you have control over their quality and do not have to depend on supplied profiles of uncertain progeny or accuracy. Reduced errors mean fewer customer complaints or expensive reprints. It can also mean you can automate more processes and keep printing machinery running at full tilt, because you are generating accurate colour data. This could have profound business implications and will certainly influence future investment decisions.

And the total cost of production will be lower in terms of consumables used, operators' time and waste generated. Process control gives you confidence that you know how to get the most out of your production system and this influences what you can promise and reliably deliver to clients.

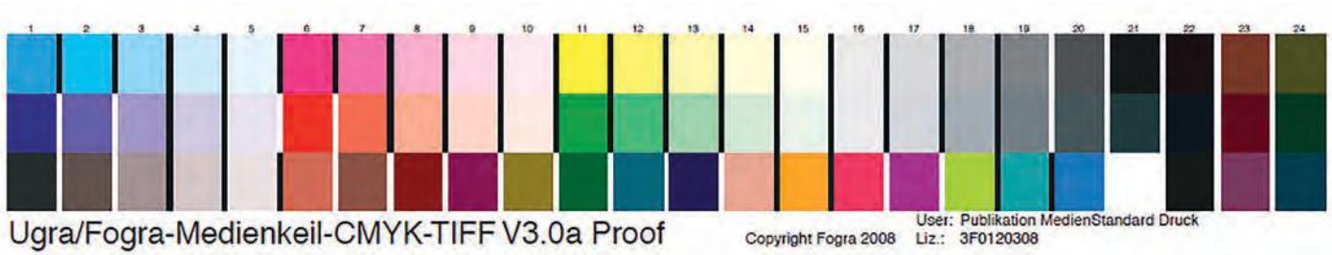
Successfully applied colour management gives you the ability to match output across printing methods and workflows. This can be handy if you want to take on more ambitious projects. It also gives you the knowledge that you can repeat a run at a later date or deliver the data for other output channels without compromising colour appearance and consistency.

Whatever It Takes

You understand why you should colour manage but how you go about it may not be so easy. It starts with your team and their awareness of basic colour science and data management. Most successful printing companies have the required colour knowledge resources inhouse, however it isn't always true that this knowledge is deployed throughout the workflow, so colour management occurs more often as an error correction process. People responsible for getting files into production need to know the basic file requirements for colour control. You should assign a colour management champion to oversee the colour management processes and policies and to keep up to date with the latest developments, for instance in profiles and media options, particularly in wide format digital printing.

Control Procedures

Control is fundamental to all aspects of a business, but too often printers tend to overlook it when it comes to colour production quality. And yet it can be as important to the success of your business as your accounting management. To provide adequate controls audit your workflow, the type of work that is most profitable and the margins you typically expect. Look at the frequency of high and low margin work and do some basic analysis of the factors undermining or enhancing margins. If you can quantify errors and identify their cause, you have a starting point for improving procedures. This will naturally lead to you taking stock of colour expertise amongst your customers and staff. See if you can support them better, perhaps with a guidance document that explains how they can improve colour control when they create and process documents and jobs.



In order to validate your prints you need to measure a control strip and check that the colour deviation doesn't exceed the tolerance you have set up. Here the commonly used Mediawedge from Ugra in cooperation with Fogra.

Measurement Modes

It is vital that you measure colours accurately since this data is the basis on which colour conversions are made. There are several different ways, or modes, in which spectrophotometers measure colour. For many years the de facto standard mode has been M0 which uses the CIE's Illuminant A (a Tungsten or Halogen lamp is used) as its reference light source. The M0 mode should only be used to measure colours where neither the substrate or the colorants fluoresce.

As more new printing and proofing papers that include Optical Brightening Agents (OBAs) come onto the market, reliance on M0 as the default mode is starting to change. M0 does not fully define the measurement illuminant condition it uses, and does not specify the UV light content of the light source. However OBAs work by fluorescence produced when UV light hits the brightening agents contained in the substrate. If a spectrophotometer or light booth does not have a light source which includes UV wavelengths, the device cannot measure the UV content in the paper. This means that any substrate that exhibits fluorescence cannot be accurately measured. M1 has been developed so that the variations in measurements caused

This image shows the difference between two papers without and with OBA under UV light. Both look white under standard lighting.

by fluorescence have been reduced. M1 light sources match D50 which includes UV light, so M1 will work with optically brightened papers. M1 is the mode to use when colorants or the substrates fluoresce. In the latest version of the ISO 12647-series of standards it's assumed that the M1-mode is used by the measurements devices.

There is also a mode referred to as UV cut or UV filtered, which excludes UV light. M2 is used in colour management applications where the final print will not be viewed under lighting that includes UV, for example in a museum. It can be used with fluorescing substrates and colorants and either cuts out the UV in software or by using a UV filter.

The final mode is M3 a measurement condition that adds polarisation so that reflections in the print, for instance caused by wet ink, are removed or substantially reduced. This mode is only really used in situations where surface reflections have to be minimised.

The appearance of print depends both on what ink and device that is used, but even more on the properties of the substrate.

Reality Check

Applying colour management theory in a practical environment requires that you do some basic analysis of existing practices. Develop a check list of what you need to do in order to apply colour management technology to create a robust system. For instance all equipment should be capable of operating within the required tolerances. Even though the standard is specific to offset printing, many print buyers are including ISO 12647 compliance as a general requirement in their procurement processes. There is no part in this standard for digital printing process control, however many companies use ISO 12647-2 as a reference, so be aware that achieving the targets in this standard might need to be considered as part of your colour management implementation. If you do not implement it, you may find your company excluded from bidding processes.

If you follow a standard such as ISO 12647-2, you can use it for guidance on digital printing processes as well. While originally intended mainly for offset litho, it makes good sense to use ISO 12647-2 as a common reference across devices and substrates as an increasing number of printers around the world are doing. Your customer can then approve a proof that has been produced to simulate what the colours will look like for example on a coated paper, and through applied colour management you can then produce more or less the same result on your digital press or large format printer. How close a match you will achieve depends on the device and the substrate you use, but you can define what tolerances should be

acceptable for your production workflow. You should have a comprehensive set of valid ICC profiles for commonly used substrates. Move profiles that you do not need on a regular basis to a separate archive, as it is very easy to click on the wrong one if many obsolete or irrelevant profiles are listed. ICC profiles should be available for all substrate grades used and should be paired with information about what the aim values are for ink density, dot gain (also called Tone Value Increase or TVI), grey balance and so on, so the press operator can check that the print conditions are the same as when the ICC-profile was created. Many companies find it convenient to include this information in a central colour management database.

Include reference colour bars, solid and halftone patches where appropriate, and information about the measurement tools used.

Establish routines for profiling new substrates and device calibration. The details of this will obviously be specific to your business and particularly your customer base, but profile new substrates if you have customers in mind likely to use them. Consider producing test samples that your sales team can show to existing and new clients. Remember that the colour management system is a living beast and that you should be constantly updating and maintaining it, so keep up to date with new technologies and developments in colour science.

Profiling using automated table Barbieri

Applied colour management is as much about business management as it is about technology implementation. It is a tool for improving production quality, reducing errors, waste, customer complaints, remakes and ultimately reducing business risk. If you know how to measure something, you know how to control it, and control is what applied colour management is all about, because control will lead you to improved profits. More than that, applied colour management gives you the knowledge you need for the future. It is your foundation for growth.

Further Reading

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