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# The Digital Dots Buyer's Guide to Colour Management & Proofing

Digital Dots

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## The Digital Dots Buyer's Guides

This publication is part of a series of independent buyers' guides for publishers, graphic arts professionals, printers and print buyers. Buyer's Guide titles provide straightforward explanations of how technology works, what it's for and considerations for investment.

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## About Digital Dots

Digital Dots is an independent graphic arts research company established in 1999. The company is a collection of like-minded graphic arts consultants, pixies and professional journalists specialising in digital prepress and publishing technologies. Digital Dots provides exclusive market research, testing and evaluation services for prepress and publishing applications, and publishes a monthly newsletter. Spindrift is the industry's only truly independent resource for graphic arts news, analysis and comment, and has a rapidly growing worldwide readership.

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Thanks to Todd Brunner for production and layout under fire.


**For John W. Seybold, 1916–2004**
**The father of digital typesetting**

# Introduction

**Welcome to the Buyer's Guide to Colour Management & Proofing**

It's confusing, difficult and not terribly exciting. But at a time when everyone's eyes are on cost, colour is one of the few remaining areas of prepress where there are substantial savings to be had through improved process management.

In the following pages we cover everything you need to know about colour management and digital proofing. We introduce the basics to explain what digital colour and proofing are, how an ICC colour managed workflow works and its importance for workflow automation and production efficiency. We also cover all the main issues that you need to consider for your investment into a colour managed workflow, including hardware and software. Device calibration and profiling are fundamental to an efficient, colour managed workflow, but there is a lack of general understanding as to their importance. We include an overview of such pragmatics in order to help you get started with colour management.

Colour management is as much about workflow philosophy as it is about hardware and software. This guide includes case studies of two very different approaches, demonstrating that how one implements colour management is completely dependent on the demands of the application. Increasingly developers recognise this and are designing their colour management technology strategies to provide managed environments, rather than isolated technologies.

This guide is not exhaustive. It does not include an endless list of colour management tools, but it does provide examples of some of the more sophisticated hardware and software. Our goal with this guide is to explain how colour management and digital proofing can improve throughput. Colour management is important for any professional company involved in content creation, production and supply throughout the media supply chain. It can help extract costs and improve efficiency. Most important of all, effective colour management contributes to process automation.

Successful investment is about choosing the right technology for your business, but with colour management it is vital to understand what you expect to gain. This is as much about revenue development as it is about cost extraction. Colour management investment is about supporting customers' content needs in line with their business requirements. The Buyer's Guide to Colour Management & Proofing is intended to help you better understand the technology, and to give you ideas about how to implement it. We hope you find this publication useful and welcome your feedback.

# Tricking the Light Fantastic

**There is a marvellous irony to the idea of digital colour. Think about it. A digital system is based on the principals of electronic processing. Electronic systems use binary logic to define objects and processes. Clever software works by reducing all parts of a process to a logical choice between true and false. We can build incredibly complex digital systems like this, but they all come down to simple logic. Like a light switch that's either on or off, a digital system is fundamentally binary.**

Colour however isn't at all binary, either conceptually or practically. Every colour is a complex muddle of stimulation and response values, so it's subjective, not objective. It isn't absolute or tangible, and even though we know it's everywhere, it doesn't really exist, except in our heads.

Colour is a phenomenon created of sensations, light vibrations and surface textures, plus the brain's decisions about what all that means. A digital system constructs colour using mathematical descriptions that are far from subjective. It is this inherent contradiction that's at the heart of why digital colour management and production is confusing and difficult.

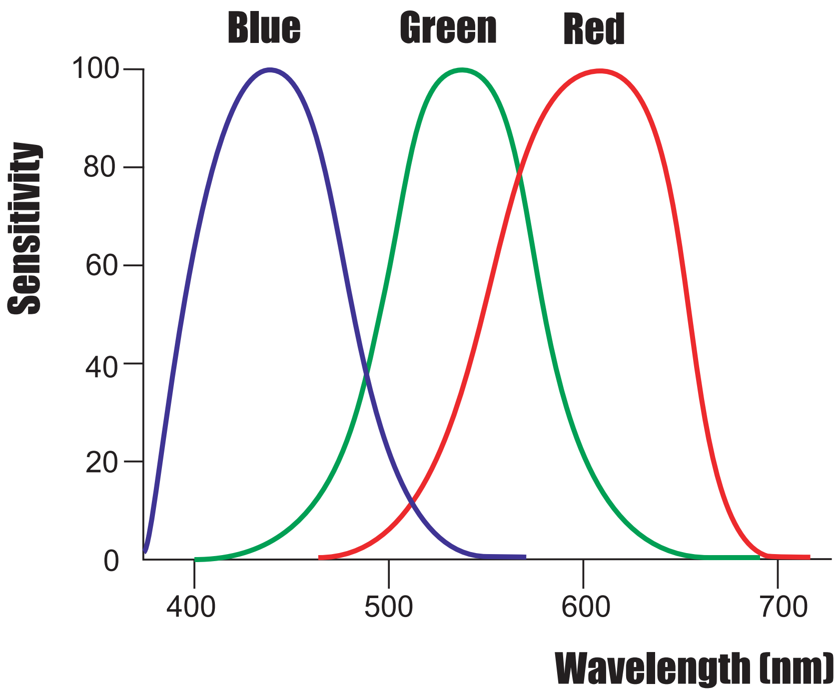
In the real live analogue world glittering and shimmering all around us, colour is everywhere. It's a property of our environment rather than a real entity, so it can't easily be pinned down and fixed. Colour is an attribute, perceptible when light interacts with the objects and surfaces that make up our environment. Everything to some extent absorbs and reflects light. Some things absorb so much light they appear black, some so little they appear white, but most do both. The combination of how the eye captures light and the brain processes the photometric signals, turns bouncing light into colours, even though it's only inside our heads.

## Real colour capture

Light enters the eye through the iris which expands and contracts to control the amount of light entering. It's a bit like the way the aperture in a camera controls the amount of light reaching a camera's image capture system. A camera uses either analogue film or electronic optics to capture the information in a scene, based on the type and intensity of light. The human visual system relies on the retina to capture information about light and its intensity in much the same way. But what happens next is far more complicated and there is no digital system that even comes close to the human brain, when it comes to processing data.

Located at the back of the eye's interior, the retina is a complicated nerve structure made up of cone and rod cells. The cones contain light sensitive pigments corresponding to long, medium and short wavelengths of light: red, green and blue. Digital image capture devices, such as a camera or digital scanner, use a similar concept but although it's similar, it isn't anything like as efficient.

The retina's rod cells are not sensitive to colour and work in low lighting situations, telling the brain how much light is entering the eye. The rods are about lighting conditions, rather than wavelengths. Together these cones and rods collect data about the kind of light bouncing around and how much of it there is, sending this information to the brain. The brain then forms a picture of the environment, distinguishing different surfaces and structures according to how light shapes and colours them. There are as many green cones in the eye as there are red and blue combined, which is why we perceive such a vast array of greens and greenish blues. It makes sense really, if you consider all that hunting and gathering that our ancestors did so well. So many forests and plains rippling with predators, so many oceans and rivers to cross. In many ways, a digital capture device works rather like the eye, but there is one very, very important difference. It is this difference that is at the heart of all colour management in the graphic arts and printing industries. It is a difference that we have yet to completely overcome with mathematically constructed colour descriptions.




## Digital colour capture

Digital capture samples a series of points and builds a digital equivalent of the image based on the red, green and blue light information captured in each sample. The human eye captures information dynamically, sending a constant stream of highly complex information to the brain. This the brain processes at phenomenal speed, incorporating much other information sourced from elsewhere in the brain, to form an accurate picture. The brain throws away an awful lot of information, hanging on only to the important stuff. What counts as important or not depends on all sorts of factors, from the viewing environment to individual experience. This subjective assimilation of data is at the heart of why a printer knows immediately what is wrong with a page. It is why some people are better at evaluating a proof for print than others, and why digital colour management is problematic.

## It's all about light

The optical systems in digital colour capturing devices are, like the eye, sensitive to red, green and blue wavelengths. Rather than photopigments in cone cells, they rely on filters on the electronics to separate white light into red, green and blue. An analogue to digital converter then turns this information into digital data. Like the human eye such devices are designed to capture the full range of colours, but this is seldom achieved. Most devices are blind to a whole range of colours in the visible spectrum. The visible spectrum? Well, it is a small part of the electromagnetic spectrum. Too much physics? Forget physics and think of a sunny day on a riverbank, water glittering, air gentle and soft, a day of brightness and warmth, and that wonderful awareness of how wonderful the world is under an endless blue sky. You haven't forgotten the physics at all, because all that visible spectrum stuff is entirely to do with the endless blue sky and the sun's warmth.

The sun puts out electromagnetic radiation rippling in millions and millions of endless waves, and the waves are all of different sizes. The electromagnetic spectrum is the complete range from radio waves to gamma and cosmic rays, most of which are invisible. Somewhere in the middle is the collection of wavelengths the eye perceives, the visible spectrum. When we look at them all at once, we see white light but when light bounces off of something like a rooftop or a tree, some of the wavelengths bounce about and others get absorbed. When white light is refracted through water or through a prism it is split into its various wavelengths and we see a rainbow. But we do not see clear distinctions across the wavelengths, which is another problem for digital systems. Remember that binary thing? No can do, when it comes to splitting light.


The visible spectrum is only a tiny proportion of the sun's ensemble of wavelengths, ranging from 380 to 720 nanometers (nm). Blues and violets are in the 400s, and reds are in the 630 to 720 range. All wavelengths in the visible spectrum help create perceptible colours. Clever or what?

## So what's really the problem?

Colour is fundamentally a concoction of interacting variables, so it's often hard to say what colour the sea or the sky really is. It's impossible to state absolutely that grass is green or that a field of barley is golden. What's green or golden anyway? The exact colour depends on the conditions of light and ripeness, and the perceptual characteristics of the viewer. Unfortunately light and ripeness change constantly so we are dealing with a dynamic, not a static view. These changes happen in minute instances and the brain normalises the information coming in to build an acceptable picture of the scene, like a digital camera or scanner does. They all come up with a series of fixed perceptual values for the colours, but base their conclusions on very different sets of data. The way the brain processes colour information doesn't really lend itself to binary logic and processing, and with colour nothing is true or false, but everything is possible.

## An endless rainbow with a finite palette

Consider a piece of plain bleached paper. What colour is it? If the light is on, the paper is white, but if there is no light the page is black. So add to the surface a few scribbles with coloured pencils and under light colours appear. The scribbles reflect and absorb different wavelengths of light, and everywhere else stays white (or black if there's no light). The whiteness of the surface can also contribute to the way the scribbled colours look, because it shines through depending on how thick the scribbles are. This is the basis of the trick that is printing using cyan, magenta and yellow inks. Printing manipulates the eye's perceptual capabilities to fool us into seeing colours printed onto a substrate, so that they appear to look like they do in the real world. It's an optical illusion using tricks of the light to create what appears to be an accurate reproduction of a natural world scene.

## The temperature of light

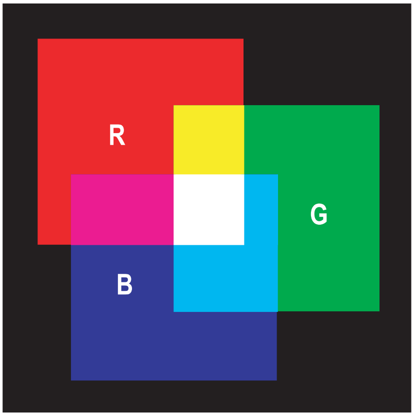
In reality, on screen and in print colour is about light, but there are many types of light varying in brightness and intensity. If you have ever tried to read by candlelight you will know that no matter how many candles you light, reading is still difficult. Candlelight has a low colour temperature and brightness, and regardless of how many candles are lit there will never be enough to read by without serious risk of fire. We refer to the temperature of light because anything heated eventually emits light, glowing gradually brighter from red to orange, yellow and white.

One way of classifying a source of light is by means of its colour temperature. This is the temperature at which a heated object appears closest in colour to the light source. It is measured in Kelvin units after Lord Kelvin, the British physicist and inventor, who defined the temperature scale. Candlelight is at the bottom at around 2000ºK and the brightest sunlight is at the top at around 10,000ºK. Given these extreme values it is easy to appreciate why any subject or scene will appear to have different colours when viewed under different light. Even daylight changes during the course of the day and throughout the course of the year. Graphic arts professionals use D50, a standard light source with a colour temperature of 5000°K, defined as an average daylight simulation.

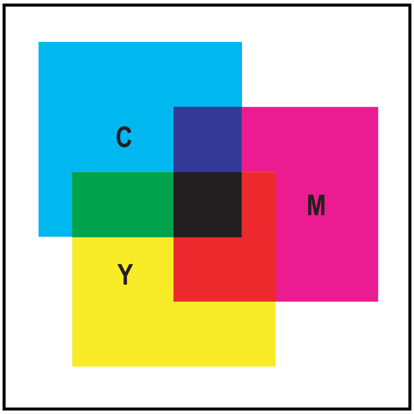
## Adding & subtracting light

Light is made up of red, green and blue wavelengths and when it hits a surface some wavelengths get absorbed and some don't. Adding together all of the wavelengths of light makes white, and adding selected wavelengths together creates different colours. For obvious reasons this is called additive colour.

If there is no light source such as the sun or a computer screen to emit the red, green and blue light, addititive colour doesn't work. Paper has a fixed surface texture and it doesn't emit light, so printers rely on how a surface absorbs and reflects light to create the illusion of colour. The process relies on substractive rather than additive colour using cyan, magenta and yellow inks working in reverse to the red, green, blue approach. Each printing ink absorbs and reflects different parts of the visible spectrum, working like a filter. Light passes through the ink filters as it reaches the page and when it is reflected from the white paper. The ink that absorbs the red component therefore transmits green and blue and hence appears cyan. The ink that absorbs the green component transmits red and blue and appears magenta. The ink that absorbs blue transmits red and green and therefore appears yellow. Together all three colours will absorb all of the light, and appear black.




Additive colour mixing




Subtractive colour mixing

Impurities in inks mess up the physics here, so if one overprints cyan, magenta and yellow the result is a sort of murky brown, not black. This is the main reason for using an additional pure black ink in printing. Together cyan, yellow, magenta and black can mimic many, but not all, of the red, green and blue combinations we see on televisions and computer screens. A clever printer can even convince us that the cyan, yellow, magenta and black on the page replicates what we see in the natural world. Printers print CMYK, using black as the key colour (K) to pull the rest together.

## Printing colours

To a professional printer colour is about the subtractive colours cyan, yellow and magenta, plus black. Each colour is printed in sequence as a series of screened dots with the dots in each screen at slightly different positions relative to one another in the sequence. The idea is to create the appearance of lots of colours using just four printing inks, so screening is very important if the illusion is to work. Black is vital because it can increase the apparent density and richness of the print. It's cheaper and dries faster than coloured inks, so if it can be used effectively it can save money. Black is also better for printing text and black line art which can look blurred when printed CMYK.

## Colour spaces

RGB in the analogue and digital worlds, and CMYK in print, all express different colour ranges or gamuts. All of them can be represented mathematically, and colour scientists have developed three dimensional models to represent where the colours fit relative to one another. Three dimensional models of colour spaces are unique to each kind of mathematical definition of colour.

## RGB

Not surprisingly, RGB colour spaces are vast and there are often incompatibilities across devices that use RGB colour spaces. This is mainly because of differences in the phosphor sets used to generate the red, green and blue signals. The larger problem is that many industries use RGB colour spaces for vastly divergent applications. Also, these different industries and applications have their own colour histories, traditions and expectations. However they all use print, without appreciating or caring about the differences between additive and subtractive colour. Conversions from RGB to CMYK are therefore notoriously badly behaved, and it is generally the printer who sorts out the problems. The difficulty is that colour data is essentially determined according to the characteristics of the device used to create it. This device dependency is a problem for digital colour, and is why working with industry standards and device profiling is so important.

## International Colour Consortium (ICC) & device profiles

The ICC standards are based on input from colour technology developers and users of the technology. The ICC standards facilitate accurate data transfers within the workflow so that colour files are no longer device dependent. The use of device profiles is fundamental to an open colour workflow.

A device profile is a small data file with information about the colour characteristics of a device in a colour workflow, and how well that device matches the colour values it is supposed to have. Every RGB device has its own colour gamut, and pretty much all of them are larger than CMYK, so the bits that are different can't be printed. Of course that could change as developers push CMYK to increased gamuts but that could get us bogged down in more physics and life's too short for that.

## CMYK

As is the case with RGB, there are many CMYK colour spaces although not quite so many standard ones. The printing industry uses several standard CMYKs such as the SWOP, Euroscale and SNAP inksets. As with RGB devices, every press and printing engine has its own gamut and profile of how it behaves. RGB or CMYK colour spaces are not equivalent, and none of them tell the full colour story. So how do we print images created in RGB on a device that uses CMYK colours?

## Moving from space to space

The only way to turn the RGB data captured with a digital camera or scanner into something that can be printed with CYMK inks, is to convert the source data into data defined for the target colour space: RGB to CMYK. It's a bit like transposing a piece of music from one instrument to another. The music should sound the same on both instruments, without compromising the characteristics and attractions of either.

With colour conversion we move from the realm of physics into the marginally less spikey realm of mathematics. Sums, very difficult sums. Suffice to say that colour management depends utterly on turning mathematically defined RGB values into mathematically defined CMYK values, so that those clever printing dots can be imaged correctly. And often from CMYK to RGB. More sums, very difficult sums. Since neither RGB or CMYK can describe the same range of colours, the calculations involved are pretty tricky.

## CIExyz & CIEL*a*b*

In 1931, CIE (Commission Internationale d'Eclairage – the International Committee of Illumination) measured human responses to different wavelengths of light. The objective was to quantify the typical response to red, green and blue light expressed as numerical values. The CIExyz RGB colour space is this collection of values and it is the basis of the CIEL*a*b* standard used in the graphic arts. Defined by a complex mathematical transform of CIExyz, CIEL*a*b* defines colours according to their position on one of two chromatic planes and their lightness values. The planes measure red to greenness and blue to yellowness and their degrees of lightness. In this model there is no theoretical limit to the colours that can be defined.

The ICC's work to define standard colour management methods is based on the CIEL*a*b* colour space. Its vast gamut means that there are no colours in either RGB or CMYK colour spaces that cannot be defined. It isn't so much a matter of complicating something that is already hard, but of coming up with a sort of universal melting pot for colours. CIEL*a*b* is that melting pot for turning data defined in the source colour space to CIEL*a*b* and CIEL*a*b* values into those required for the destination colour space.

Colour use in print is rising as is the use of digital origination tools for colour content. Converting red, green and blue data to cyan, magenta, yellow and black data is no trivial task, but it can be done and done reliably. But not without care, and not for every workflow and every application. This is why many printers and developers are basing production on ICC data standards and device profiling. It may not yet be perfect, but it's a great place to start.

# ICC Colour Management Theory & Practice

**It's a sad but unfortunately true fact that for most people colour management is unspeakably boring. Many brave souls have tried innumerable times to read up on it because they know they ought to. Trying hard to concentrate they inevitably doze off, lost in a dreamy sea of physics and spectral hyperspace. And who's to blame them? The science underlying colour management may be important, but really it shouldn't be an issue anymore, right? Colour management should just happen in the background, shouldn't it?**

Well yes, but no. Unfortunately colour management hasn't been entirely solved. Colour is a dynamic and highly subjective concoction of interacting variables and unavoidably its management is based on understanding how the variables interact. It's almost impossible to pin down, but colour management is something everyone in the media supply chain should care about. Colour management is about saving time and money and when both are in short supply, appreciating the basics can make a real difference.

## The International Colour Consortium

Saving time and money is why Adobe, Agfa, Apple, Kodak, Microsoft and Sun Microsystems several years ago founded the International Colour Consortium (ICC). Since then the sixty or so active members of the ICC have developed data standards and a common processing model for managing colour in digital workflows. The idea is to provide the kind of colour security that typified the closed and highly proprietary colour systems of the past, but to do it using open technologies.

Before the advent of desktop computing and low cost colour printers, colour production was the strict preserve of the repro house. It was a mysterious black art and hardly anyone understood it, so it was always toe-curlingly expensive. Computing advances allow anyone today to create and produce colour files. The problem is that not everyone can produce colour files suitable for printing. It's hard enough getting them to appear the way they're supposed to on a computer screen. When it comes to process colour printing, something hard becomes almost impossible. The ICC was set up to make the impossible possible in open colour production.

## What is open colour?

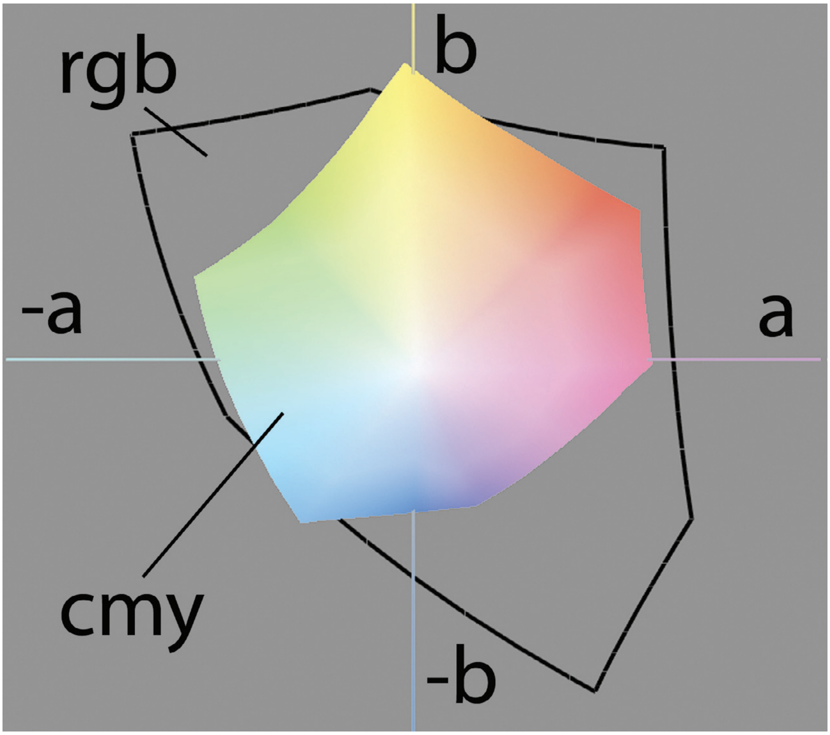
Open colour production is about marrying the colour worlds of red, green and blue (RGB) and cyan, magenta and yellow (CMY) into some sort of cohesive whole. The RGB world is inhabited by people who mostly don't know a lot about colour printing, and the CMY world by people who mostly do. In the RGB world, light's three primary colours combine to create colour for such things as televisions and computer screens. In the CMY world, light's behaviour is used to create colour in print. The two colour sets and their user communities are complementary cohabitants of the same digital world. ICC standards embrace both, a sort of universal environment underpinning all types of colour description.

## The black channel

The natural world exists in RGB and its printed equivalent exists in CMYK. K, what K? K stands for Key (not black as is sometimes stated) and refers to the black component in a CMYK inkset. It's obviously used to print the black elements of a job, but it's also used to improve the density range of the inkset and to deepen shadow areas. It can also be used to replace some of the cyan, magenta and yellow inks in shadows and some colours. It's also a mechanism for reducing the amount of ink used, particularly when printing on low grade substrates. Black ink is also cheaper.

## Colour spaces

RGB colour is rendered with red, green and blue light wavelengths, and CMYK provides an equivalent appearance by cleverly manipulating the behaviour of reflected light. It's all about light and if colours are light, then digital colours are the




**The inner contour represents the colour gamut of sheetfed offset quality print. The outer contour (black line) represents the colour gamut of a standard CRT monitor.**

numeric equivalent of light for both RGB and CMYK. We can describe colours and their relative differences mathematically using a colour space, but the RGB and CMYK colour spaces are not the same. Not all reds, greens and blues can be printed, and not all cyans, yellows and magentas can be viewed on screen. And it gets worse, because devices don't necessarily display the same sets of red, green and blue, and printing presses don't necessarily print the same sets of cyan, magenta and yellow. There is however one colour space that is larger than both RGB and CMYK, CIEL*a*b*. This is the colour space underlying all ICC colour managed workflows.

CIEL*a*b* is a perceptual colour space that defines colours according to their luminance, from black to white and degrees of red or green-ness, and of yellow-ness or blue-ness. CIEL*a*b* can define most colours that exist in nature.

## ICC device profiles

An ICC workflow combines the CIEL*a*b* colour space with the concept of device profiles. An ICC device profile defines the spectral and behavioural characteristics of each device used in a digital workflow. This includes everything from monitors, digital cameras or scanners through to proofers and multiunit presses.

Device profiles contain mathematical representations of each individual device's colour values. Device profiles are based on a simple check of the way a device behaves, referred to as characterisation. Any device can be characterised using measuring tools and comparing the device's colour values to CIEL*a*b* values. Colour values for a device are established by measuring colour charts. Each colour patch in the chart combines specific percentages of cyan, yellow, magenta and black inks and obviously the more patches, the greater the volume of data and the better the device profile. There are standard charts such as IT8 and ECI, and charts built for specific purposes that have many more patches.

ICC profiles help to ensure correct colour reproduction throughout the workflow by defining the relationship between the digital values a device captures or transmits, and the CIEL*a*b* colour space. A device profile indicates how its RGB or CMYK colour values ought to be transformed to their CIEL*a*b* equivalent.

These numbers provide the basis for converting one set of values, say for example the RGB of a monitor, to another such as the CMYK values of a digital press. Conversions from RGB to CIEL*a*b* use the input profile data, and conversions from CIEL*a*b* to the CMYK or RGB output device, such as a monitor, use the output profile. The Profile Connection Space (PCS), based on CIEL*a*b*, is where the colour calculations take place. There are several vendor specific colour management systems that interpret the profile data, before and after it has passed through the PCS. Although developers use the same principles to construct their colour management engines, they do not construct them in the exact same way. In other words, they don't all do the maths in the same way.

The device profiles provide the colour management system with additional information for colour calculations. This means that when turning an RGB data file into its CMY equivalent, the characteristics of the devices used to produce the file can be taken into account when the sums are done, to convert one set of data into another. The same principles apply when a digital image is viewed on the monitor, so that the behavioural characteristics of the monitor can also be taken into account when the colours are rendered on screen. ICC colour management can be applied to any colour workflow and for optimising colour for any output environment.

## Deliberate deception

ICC colour management uses the CIEL*a*b* space as a sort of universal clearing house for colours, so that any colour file will look the same wherever it is viewed. By converting RGB or CMYK colour data into CIEL*a*b* data, it is possible to then reconvert it into a new data set, one that takes into account the colour capabilities of the target output device. Colour data can be converted from RGB into CIEL*a*b* and then again into CYMK values producing as close an equivalent as possible. It also works for converting one set of CMYK values to another for output on more than one CMYK printing system. We can mathematically rearrange data, so that an advertisement or photograph appearing in Vogue should look just as good when it's viewed in a brochure. The colours should appear to look the same on the web, or when printed in a fashion show catalogue or in the newspaper. ICC colour workflows strive to achieve complete visual integrity for images and colours across media. It's a deliberate deception that persuades the viewer that the specifics of an image and its colours are the same.

## Limitations of ICC workflows

Although the underlying principles are brilliant, putting them into practice doesn't always produce brilliant results. Keep in mind that colour is highly subjective, and that expectations for how it appears vary with the medium. Most of the problems with colour management are due to the fact that different software developers interpret the specification differently. The ICC has started to address this problem with the version 4 profile specification.

Even so ICC workflows aren't idiotproof. Apart from the obvious problems that arise from carelessness and imprecise measurements, there are other more fundamental difficulties. Mostly they come down to the fact that what works well for a standardised process is inherently less likely to work well for deviating processes. In a production environment with a finite number of devices and file interchanges it is relatively straightforward to qualify and quantify the variables. However, in production environments where it is impossible to capture all the variables, colour management can turn into a real mess. All of the processes in the workflow must be properly controlled before even starting to apply colour management.

The ICC workflow has removed a lot of the uncertainty of colour production, but it is still not ideal for all workflows. In environments where there are numerous technologies from different vendors, quality control can be difficult because different colour management systems can produce different matches for the same colour. There is also rather limited scope within an ICC workflow for working with non-CMYK workflows such as those using exclusively special inks.

Colour management increasingly has to work with unknown variables and in distributed environments, with output to a range of substrates, the behaviour of which may not be known. We need to know more about how printing stocks behave. Also assigning profiles to different page components is only possible with some RIPs such as Gretag MacBeth's Iqueue which uses single ICC profiles for monochrome images, vector graphics, RGB and CIEL*a*b* images. Within the ICC framework there is no means of controlling individual colour channels. This is why adjustments to the black channel impact the entire page image, rather than just the parts of the image they are intended to affect.

There are alternatives to working with colorimetric rendering and these are largely compatible with an ICC workflow. Esko-Graphics has developed a colour management technology called Kaleidoscope based on spectral response. Instead of using colour intensity as the basis for colour calculations, it uses the specific measured wavelengths for a given colour to control individual ink behaviours. According to Esko-Graphics, working with spectral data in this way means proofing with special colours can be more accurate and special inks can be profiled. This workflow is outside the standard ICC processing model, but it is compatible with it.

The biggest challenge for the ICC today is to support a wider range of workflows, so that there are fewer exceptions undermining a workflow's integrity. The ideal graphic arts colour managed workflow should ensure the preservation of some specifics of CMYK input channels and accurately convert all colour data for the target output, including contone and screened colours. Another common problem is the conversion of CMYK colours to CMYK colours, resulting in a kind of double colour management. Colour workflows also need some means of quality control. The ICC is working on all these areas, and application development and user education are among the committee's major initiatives.

Although colour management is never going to be easy, software is getting more sophisticated and colour processing more reliable. Implementing a colour managed workflow starts and ends with the ICC, even for systems that rely heavily on proprietary technologies. Standardised processes may not work well for deviating processes, but within the standardised framework there is plenty of scope for application specific solutions. Improved precision in colour transforms and tools for resolving specific problems can all function within the ICC framework. How proprietary they are and how cost effective they are within the framework, depends on the nature of the problem and of course the solution.

# Life Yet for Film & CMYK

## Company:

**BV+R Pre-Media BV**

## Type of work:

**A repro house with a variety of high quality colour work, for packaging and commercial print customers. End products are data (Illustrator, Esko-Graphics GRS, ArtPro, PDF, PS, EPS), proofs and film.**

## Equipment:

**Screen Tanto imagesetter with digital workflow technologies from Esko-Graphics and Artwork Systems.**

## Time of installation:

**2001**

## Top advice:

**Eye-One Pro Bundle (Gretag Macbeth) – This complete colour management package is ideal for the creative designer and the photographer that not only wants to build and apply profiles, but also wants the ability to edit them and to have more control over separation settings.**

Erik Vink system manager at BV+R Pre-Media BV in the Netherlands has been involved in colour management for the last seven years and has seen pretty much everything that can go wrong with it. BV+R has 40 staff and over the last five years a stable turnover. However there are fewer staff today than in 1999. “We have less employees than five years ago, but for production we are the same.”

BV+R has a data based CMYK workflow with Esko-Graphics’ Backstage and Deskpack systems, plus Artwork’s Nexus workflow management technology. If supplied digital images contain a device profile then colour management takes place at the start of production, but it is always applied during output. BV+R works with around 30 different profiles from different press houses. Output is to Screen Tanto imagesetters, with Iris 4 Print and Agfa Grand Sherpa devices for hard copy proofing. There are generally two proofing cycles before final platesetting at remote customer sites. Soft proofing is sometimes used for certain commercial customers, but not usually for packaging jobs with spot colours. All output devices are calibrated on a weekly basis.

Despite the widespread shift to computer-to-plate production, BV+R has found filmsetting to be a more economic option for them because “film is inexpensive, so for us there’s no reason to go to a platemaking system, and film is only used to make a print proof for the customer”. This company has used ICC specifications and device profiling for a number of years. Erik believes that: “When everyone is using the technology as intended it is great! However there are a lot of people who are doing strange things during the process. At this point I think that we are on the right track, but it will take some time before everyone knows what they’re doing.”

Colour production is the basis of BV+R's business. Erik explains that: "With colour management we go a long way back and we were one of the first companies using [Esko-Graphics] Kaleidoscope and then later, ICC. In the last couple of years we have been involved in a project to see how RGB could be introduced into printing, and the answer is 'not yet' because most of the time people don't attach the right ICC profiles to files. Working professionals know what they're doing, so it's going to work. In my opinion education is important, but it has to be the right education."

Colour management education should, in Erik's view, be focused on designers who "Create artwork and use images without a profile and see a reference print, but don't understand how to match the printer and the screen. This is the first point of failure. By the time the file comes to us, there's no RGB profile attached to the file and just a reference print, so colour management cannot be applied." Education isn't a simple matter, but it is an issue facing everyone involved in the media supply chain. For Erik "it's a nice challenge, but it has to be on a level where you see the whole chain, so that ICC profiles are used as they are meant to be used. You have to make clear that if they use the right tools, the results get better. The right calibration and colour matching is how it has to be." He adds that "a calibrated screen and calibrated printer is not that expensive, but it does require some knowledge to use it."

BV+R is not a large company by any means, but it is continuing to move forward with its colour developments. One of the areas the company would like to see improvements is simplifying the use of device profiles. Erik "There are ideas where the workflow is setup in such a way that the choice of press house can be at the very end of the production stage. If the device profiles are known this could work."

# Calibration, Profiling & Device Management

**It's quite obvious why colour management can enhance the publishing process, but putting it into practice isn't that simple. It's all about process control and while it may not be very exciting, device calibration is the foundation of process control in a colour managed workflow. Before device profiling or colour conversions can even be considered, colour management starts with device calibration. Colour management professionals generally recommend a three stage approach to colour management based on the three Cs: Calibration, Characterisation (often referred to as profiling) and Conversion.**

## Calibration

The first step in workflow calibration is monitor calibration. Monitors are fairly simple to calibrate, but there is still some confusion as to how to actually do it. Fortunately there is a standard for monitor calibration, ISO 12646 and unfortunately very few vendors refer to ISO 12646 in their manuals. This may explain why there doesn't seem to be any real consensus for how monitors should be calibrated.

## ISO 12646

Approved in 2002, ISO 12646 covers recommendations for monitors used in high end graphic arts production and colour critical work. It states that monitors should be set up in a room with low ambient light of not more than 32 lux (one lux is a measure of the light intenstity produced by one candle roughly one metre away). According to ISO 12646 the monitor's white point should be 5000º Kelvin at a luminous intensity of around 80-120 candelas per square meter. This barrowload of physics basically means that monitors should work in ambient light conditions similar to those of a normal office. They should also be positioned well away from incoming daylight from windows and doors. The key point is to control the light around monitors used in a colour managed workflow, ideally conforming to ISO 12646.

Calibrating scanners is rather more simple, since in most cases it only involves checking the light source intensity and the focus settings. However there may also be a need for adjustment curves for different film materials, especially when scanning negative film.

Although it's reasonably easy and straightforward to calibrate a monitor or a scanner, output devices are a little trickier. With a colour laser or inkjet printer, there are paper options to consider as well as such things as resolution, screen type and frequencies. A colour printer should be regularly calibrated (checking the condition of print heads etc) and linearised. Linearisation ensures that all input and output values are equivalent, so that when a 40% magenta is printed, you only get 40% magenta and nothing else. Characterisation and linearisation are done for each paper type and resolution setting, and noted along with other settings that affect printed results.

And that's only the beginning of the story. Calibrating a printing press gets even more complicated because a press profile must take into account all the variables influencing the final output. This includes calibration of the obvious components such as imagesetters or platesetters, and the chemistry and temperature in the developer. It also includes the less obvious factors such as the choice of paper, which determines the amount of ink that can be used. Paper and ink characteristics must be embedded in the press profile and there are several standards to choose from such as SWOP (Standard Web Offset Printing), the Euroscale ink sets and the ISO 12647 series standards for press conditions.

Press profiling is clearly no trivial task and press calibration is best done by an experienced press operator. The press should be regularly maintained and the interaction of press and different paper types documented. Each paper has optimum ink settings for a given press and the dot gain characteristics are often specific for each of the individual CMYK colours. The press should operate to its optimum performance, according to paper type and ink setup. If the platesetter and processor are also functionally correct and stable, characterisation of the devices can be done.

## Characterisation (profiling)

Once the devices in a colour managed workflow are calibrated, accurate ICC device profiles can be made for each input and output device. The monitor is an RGB output device, but other RGB devices such as scanners and digital cameras are input devices. Characterisation starts with a test form that is scanned or photographed. The resulting red, green or blue colour values are expressed as CIEL*a*b* values and stored in a list or look-up table within the ICC device profile. These values are then used as a reference for subsequent colour value conversions.

For an output device the procedure is similar. A test form is printed, and the result measured with a colorimeter or spectrophotometer. Whatever colour the print engine creates, based on the incoming CMYK values, is expressed as a series of equivalent CIEL*a*b* values in a list or look-up table. It is sometimes suggested that an ICC device profile can correct errors in the printer or monitor, but this is not true. A device profile only describes the behaviour, good or bad, of the colour output device. Any corrections required are up to the colour conversion engine to handle at a later stage. Some hints for these colour conversions can be embedded in each ICC device profile, such as the amount of ink used and the black generation curves. If the output device software or raster image processor doesn't provide tools for proper linearisation, a linerisation curve can also be stored with the ICC device profile for later use.

For monitor calibration, the procedure is to generate a series of colour samples on screen for measuring with a colorimeter or spectrophotometer. The results are saved as CIEL*a*b* values inside the device profile. The gamma setting in a monitor is the equivalent of a linearsation curve in a printer, so this is also stated in the profile.

## Colour conversion

Colour management is not possible without device calibration and profiling, but it also needs some means of handling colour data conversions as files pass from device to device within the workflow. Calibrating devices and building ICC profiles is the basis of modern colour management, but the really interesting work starts when we try working with profiles in different colour conversion scenarios. This is where most color management errors are made, particularly when moving from RGB to CMYK colour spaces.

The most common conversion is from an RGB scanned image to the CMYK values of an output device. If the gamut is about the same for the input device as for the output device, this is pretty simple and straightforward. However in many cases the colour gamut of the RGB image is larger than that of the output device, so it needs compressing without compromising the colours in the image. The colours beyond the scope of the CMYK printing device are considered to be out of gamut, because they really can't be reproduced correctly. To overcome this problem, out of gamut colours are replaced with colours that come closest on the printing device. It is in this delicate work that different colour software will do a good or not so good job.

The ICC standard incorporates four colour conversion methods. Perceptual conversion is often used when coming from a larger colour space to a smaller one. Relative Colorimetric conversion is for converting from similar colour spaces, using the same white point for the substrate. For printers this would typically be ordinary white paper and for scanners or monitors the white point of the RGB colour space. Absolute Colorimetric conversion is used when the white point of the printer is substantially different to that of the original colour space, such as for example when printing proofs for newsprint on a printer loaded with very bright white paper. Saturation colour conversion is often suggested for vector and business graphics, but if the colour spaces are fairly similar it can be used to boost colours in a photograph. The latter should be tried with some caution though, as it's easy to overdo the saturation.

Colour data management is initiated in the computer's operating system or, in many cases, within application software. On a Windows computer the colour framework is called Image Colour Manager (ICM ) and on a Macintosh it's Colorsync. Both interface with Color Management Modules (CMMs) that handle specific colour conversions. Several vendors have developed sophisticated technologies for this, including Adobe, Agfa, Apple and Kodak.

With so many interacting components there is no doubt that colour management is hard. It depends on careful and meticulous device calibration and profiling, and on accurate data conversions. There is however still no real means of evaluating the quality of different profiles. This is the challenge that lies ahead. Also we need to reach a consensus on which standards to follow when calibrating monitors, printers and presses. A colour managed workflow is entirely achievable, but it's a continuous, never ending task.

# Colour Management Hardware & Software

**Colour management is all about control. Colour management hardware and software developments are intended to enhance process control throughout the workflow. However successful colour management depends entirely on proper calibration and using the correct device profiles based on the International Colour Consortium's (ICC) specification. Calibration requires measurement devices appropriate to the task. Monitor calibration is one of the simpler tasks to do, and there are software solutions that don't require a measuring device. Instead the operator is asked to make decisions based on test patterns projected on the monitor. Solutions that take this approach include Adobe's Adobe Gamma software and the built in calibration tool in the Mac OS. While the result of this sort of calibration is perhaps better than no calibration at all, professional colour management assumes that one uses measuring instruments in conjunction with software to achieve precise process control.**

## Measuring devices

Calibrating a monitor is a fairly straightforward process using either a colorimetric measuring device or a spectrophotometer. Of the two a colorimeter is the simplest and cheapest. The colorimeter measures the colour components of the monitor light through red, green and blue filters, in a way that is similar to how the eye works. There are many colorimeter brands to choose from, but the best known and most commonly used within the graphic arts industry are those from Colorvision, Gretag Macbeth and X-Rite. Most high end monitors designed for colour critical work are bundled with a measuring tool and calibration software.

CCDot Dotmeter

A densitometer is necessary for calibrating a printer or printing press, and with the help of a densitometer one can check many parameters. Of these, dot gain and ink density are probably the most important. A densitometer is also necessary for linearising the imagesetter. When measuring plates, especially digital plates for computer-to-plate output, most conventional densitometers have problems achieving accurate measurements. Instead a dotmeter should be used. A dotmeter, sometimes called a digital microscope, works like a high resolution digital camera. It calculates the density values from the close up image of the screen pattern on the plate. Companies like Centurfax (recently acquired by X-Rite), FAG, Gretag Macbeth, Techkon and Troika Systems all manufacture dotmeters.

Once all output devices in the workflow are calibrated, it's time to build ICC profiles. While it is possible to use a colorimeter for this, a spectrophotometer is a better choice. A spectrophotometer measures the whole visible spectrum and can be used in a wide array of applications. A spectrophotometer can in fact also be used as a densitometer, if coupled with the appropriate software. If you invest in a good spectrophotometer you may not need an additional colorimeter or densitometer. There is of course a whole range of spectrophotometers to choose from, ranging from handheld devices to more or less automated versions. Of course the faster and more automated the spectrophotometer, the higher the price, but for creating and editing ICC profiles on a regular basis, it is probably worth considering the more advanced spectrophotometers. Avantés, Gretag Macbeth, Techkon and X-Rite are among the most well known manufacturers of these tools.


**ColorVision Spyder**

# Colour management software

It's all well and good to have a measuring instrument, but it's of little use without good software for operating it. Most vendors of computer-to-plate systems offer colour management solutions of their own, so if you already have, or plan to invest in, a platesetting system you should check out the price and options in the colour management system suggested by the vendor.

Agfa provides a colour management system called Colortune. This software allows you to create ICC profiles for monitors, digital cameras, scanners and output devices. Colortune can be coupled with Agfa's Quality Management Software (QMS) to facilitate calibration and linearisation of devices throughout the organisation.

Creo's Profile Wizard Suite is used for editing and creating ICC profiles for monitors, digital cameras, scanners and output devices. Profile Wizard supports the use of more colours than just CMYK and has functions to preserve the black channel information.

Esko-Graphics offers two different colour management solutions. Mosaic has its origins in technology developed by Barco Graphics, which is now part of Esko-Graphics. The company has also developed a colour management system based on Global Graphics' Harlequin technology, with extensions to the Harlequin Eclipse PostScript interpreter.

Fujifilm Colourkit can create and edit ICC profiles and provides functions to apply electronic sharpening of images at a late stage in the workflow. This type of function is not generally included in standard ICC workflows. Colourkit can be integrated in asset management solutions in order to help automate scanning and image processing.

The Coloropen colour management suite from Heidelberg has three ICC compliant components. Viewopen is used to create monitor profiles, Scanopen is for scanner profiles and Printopen creates profiles for output devices. Companies which have invested in a Heidelberg scanner recently also have profile editing functionality in the Newcolor scanner software.

Screen has a colour management solution called Labfit which helps to automate image and colour processing. Recently Screen added a JDF compliant colour control system to Labfit, enhancing the software for such things as remote proofing functions.

Most of the solutions mentioned above are standalone software that can be bought even by those who don't use the vendor's RIP system. Others cannot be bought unless you buy some other equipment from the vendor.

In addition to colour management tools that function within a larger system, there is a huge range of vendor independent solutions. One of the most popular software packages amongst colour management consultants is Profilemaker from Gretag Macbeth. One of the features in Profilemaker 5 is an option to save the measuring data either as CIEL*a*b* or spectral data. The latter provides more flexibility for rebuilding ICC device profiles without needing to measure the test form again.

The list of standalone colour management solutions is virtually endless, but some of the most widely used tools are Binuscan's Colorcase, Color Solutions' Color Blind, Kodak's Colorflow and Monaco Systems Monaco Profiler.

Software for editing and creating ICC profiles is well established. Distributed production increases the need for reliable colour management, but it all begins with accurate data management on a small scale. As can be seen the options for this are numerous and the technology stable.

# Colour Proofing Basics

**The use of digital plates and direct to plate workflows is at about 30% worldwide and growing rapidly. However traditional analogue proofing based on reprographic films isn't possible with a computer-to-plate system. There are no films, so as CTP production spreads, the need for digital proofing systems spreads with it.**

An overview of the proofing systems on the market is somewhat overwhelming, because proofing's role in the workflow varies depending on the proof's function. There are lots of systems available more or less suitable to the different functions, and these various proofing solutions can be split up into several different categories. The fact that the same colour printer can often be used coupled with different front ends and raster image processing systems, only adds to the confusion. What at first glance appears to be the very same print engine, may provide varying functionality and quality depending on the technology controlling it.

## Contract proofing

The perfect contract proof should ideally be a test print run on the actual printing press using the paper stock to be used later on for the final print. In most cases this type of wet proof is a far too expensive option, but there are those who argue that it is the only real way to proof. On a modern press with automatic plate loading and presetting of the ink ducts, it may indeed be reasonable for many applications. It is possible to produce some sample sheets of a couple of spreads in around half an hour, so if one compares the time and associated repro cost with costs for high quality contract proofs of all the signatures, it may balance out. However it all very much depends on the job, its content and the run length. For very long runs the economics can easily shift in favour of wet proofing on press, but the trend in printing is towards shorter runs and increased colour usage. Much of this work cannot economically be proofed on press, so for many applications a digital proof is a better option.

In most applications a digital contract proof, ideally on the actual paper stock, is preferable. But then the discussion starts. Should the proof be a screen accurate dot for dot proof, or colour accurate or both? Or will a colour accurate proof displayed on a calibrated monitor do?

## Three basic options

Looking into the digital proofing options available on the market, the three main categories are screen accurate dot proofs, colour accurate proofs and finally soft proofs viewed on the monitor.

Screen accurate proofs should of course also be colour accurate, but there might in fact be a conflict here. To be able to use an identical screen in the proof as will be used in the final print, one basically has to use the same resolution on the proofer as is used in the platesetting device. What is more, one needs to use the same type of inks, or at least inks with the same characteristics as will be used on press. This may seem obvious, but in reality the characteristics of say the ink used in rotogravure are quite different from those of inks used in an inkjet printer. So if it is so difficult to produce screened dot and colour accurate digital proofs, why bother? Well, those in favour know that this is the only proofing technology that can reveal the possibility of moiré in the print. Moiré is one of the worst horrors for a printer and shows up as a disturbing and unwanted pattern in the printed images. Moiré can appear because of several factors, primarily the inappropriate setting of screen angles. Another type of moiré occurs if the image itself contains some repetitive pattern, such as fabric, that comes into conflict with the printing screen used. The problem with possible moiré is mainly associated with conventional AM screening. FM or stochastic screening uses random dot patterns and does not rely on conventional screen angles and so there is no risk of moiré.

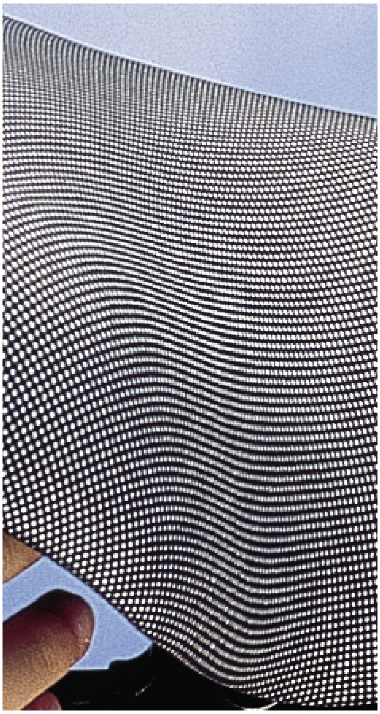


**Image related moiré**

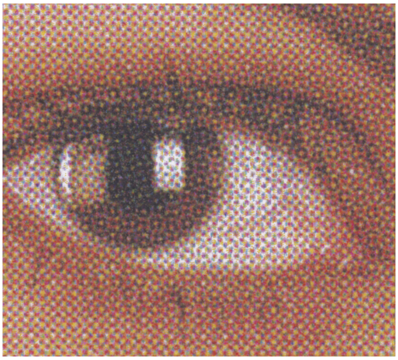
Trying to use the same dot structure as will be used in print on an inkjet printer may be desirable, but it is not very easy. Normally an inkjet printer places dots in a way that is similar to that of FM screening and to force it to use a conventional AM screen instead takes clever algorithms and programming. This is the approach taken with solutions developed by companies such as Agfa (Dot4Dot), Compose (Starproof), EFI Best (Screenproof), and GMG (Dotproof).

Another approach is to build a dedicated proofing engine and to supply special inks to simulate the characteristics of the ink used in the printing process. Often those inks are transferred to the paper using special transfer media. One of the benefits of using a transfer media for the ink is that in most cases this means that one can proof on the actual paper stock.

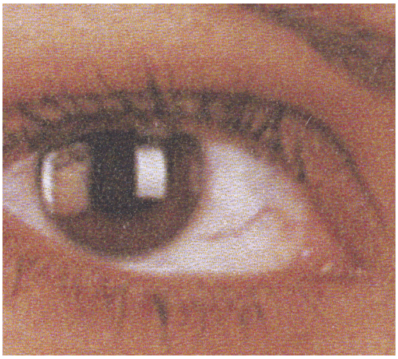
This type of proofer is offered by Creo (Spectrum), Dupont (Digital Chromalin), Fujifilm (Finalproof) and KPG (Digital Matchprint and Approval). These systems offer both screen accurate dot proofs as well as colour accurate proofs, but since they are custom built for this purpose they tend to fall into a higher price bracket than systems based on the more generic colour printers.

If the workflow and proofing don't necessarily demand screen accurate proofs, there is quite a wide variety of systems to choose from. This category is by far the largest group of systems, since it comprises systems based on general inkjet printers, as well as those based on colour laser printers. In this category almost any quality colour printer can be considered for proofing tasks, provided there is a suitable RIP system connected to the printer. A number of these systems can render dot structures in the proof. Most of the modern RIP systems from the platesetter vendors offer proofing and colour management modules. However there are also many standalone solutions on the market.

Among the vendors of colour printers are Agfa, Canon, Creo, Encad, Epson, HP, Mutoh, Roland, Mimaki and Xerox. Some of these offer a front end suitable for proofing, but there are several standalone solutions on the market. Among those are technologies from developers such as CGS (Oris Colortuner), Colorgate (Proofgate), EFI (Best Color and Splash), KPG (Rainbow), Perfectproof (Proofmaster) and Xitron (proofing plugins).



**Conventional screening – offset print**



**Inkjet screening**

Using an inkjet printer generally means one doesn't have a screen accurate proof, since the device uses a screen more like an FM screen. And since the ink characteristics are often quite different from those used in printing presses, the colour management system may have to mix the colours in a way that might look a little strange, if one looks up close. When viewed under a lupe, a pure yellow area in the final print may appear in the proof to have some elements of cyan or magenta. This is due to the fact that the proofing engine somehow has to simulate the whiteness of the paper in the proofs, as well as compensate for differences in the ink characteristics. When using inkjet printers or colour laser printers it's not always possible to use actual printing stock, although some devices sold for newsprint proofing have this capability. Generally the proofing material therefore has to be able to simulate both the whiteness of the paper as well as its texture, including gloss, semi gloss and so on. The key thing here is accurate colour appearance. The proof has to look similar to the final print in terms of its colour rendering, even if the dot shape of the screen and the screen pattern may look different.

Many proofing systems can be extended with remote proofing technologies. Dedicated tools are required to ensure that the locally produced proof matches the proof produced at the remote site. Of course what is regarded as the remote site varies. The local proof can be the one made at the editorial site and the remote proof produced by the printer, maybe located across the world. At both locations, the proof is typically measured using a spectrophotometer, and then the results are compared. It sounds easy enough, but it's important that the data exchanged contains enough information to set up both the proofer and the measuring device correctly. Several of the vendors mentioned above offer this kind of solution, and some use the JDF data format when encoding the colour information.

Finally the ideal proofing method, remote or local, may be a soft proof. As with any proofing device this calls for proper and accurate calibration and characterisation, if it is to work properly. If some printers and publishers hesitate when choosing to go with a screen accurate dot proof or not, there is probably even more anxiety as to when, and if, one can really trust a monitor for high end proofing. For those brave enough to try it, the results are often surprisingly good. A correctly calibrated monitor, be it a conventional monitor or flatscreen LCD, can actually proof most colours in a fairly satisfactory way. Consider the fact that all digital retouching in the imaging process is done on screen, even the colour matching. With a proper setup with no ambient light pollution, there is a good chance for accurate evaluation and page proofing on screen. The advantages of soft proofing are quite obvious: fast turnaround independent of location and no costly materials involved.

Among the handful of companies offering soft proofing of high resolution images and pages is Real Time Image, recently acquired by KPG. Danish vendor IBW has developed another very interesting server based proofing solution called Webproof. Instead of mailing PDFs for review to all members in a project, the whole publication can be proofed using a web browser. All corrections and notifications are centralised to the Webproof server, hosted typically by the printer or prepress company. Since the interest in soft proofing is on the rise, we can expect more solutions of this type to be offered by manufacturers of computer-to-plate RIP systems.

The more one looks into proofing technologies, the more complicated the task actually gets. But keep in mind the specific proofing demands for a particular type of production, and it should be possible to choose a proofing application that suits both the application and the budget.

# Managing Colour in the Workflow

**It's tempting to think digital colour workflow management is a new thing, but it's existed since the early days of digital prepress. The difference now is that colour management is out in the open. Instead of existing within a tightly controlled, closed system, everyone can get involved in colour production using off-the-shelf technologies. Some tools, such as Photoshop, create excellent colour files and some of them, like PowerPoint, do not.**

Graphics professionals still have to cope with the results, which may be why colour management is gaining attention, albeit for the wrong reasons! Despite the horror stories, working with colour data doesn't need to hurt (much) and managing colour efficiently can seriously reduce production costs and improve throughput. Take colour proofing. Approving proofs with only a couple of correction cycles and output and courier charges, saves money and time. Remote softproofing extracts even more cost, so this scenario is getting increasingly popular. A colour managed workflow can also save time and money on press, which is probably the best reason of all to implement it.

Of course coming up with a cunning colour management plan isn't easy, but part of the problem has been a sort of cultural confusion. Somewhere between the mysterious world of colour management and traditional print, and the zingy new world of digital production, hovers an identity crisis. The RGB versus CMYK debate is as much about this cultural ambivalence as it is about anything else. Fortunately the benefits of working with RGB are increasingly recognised.

## What's the point?

The best place to start when building a colour managed workflow is to work out how colour management might enhance a business's creative and production performance. Prepress production ideally supports anything a designer wants to do, but this isn't necessarily the best place to start. Colour management is all about accurate output, so the workflow should encompass all tasks associated with output requirements, with options to support new tasks and functions when required. And it should use proven technologies, working with standard targets such as the IT8 or Ksmart colour targets.

Virtually all image creation is RGB based, so this ought to be the colour space of choice for digital image editing and processing. Device independent RGB workflows with raw RGB data ensure file independence and freedom from specific output constraints. Deciding to work with RGB is only the first teensy step along the way however. The next step is rather more tricky. It requires a long, hard look at the entire production chain including every possible source of colour data and every possible kind of output required, from digital cameras and scanners through to proofers and presses.

Audit all of the prepress equipment, computers, software and measuring tools, quantify throughput and work out where the costliest production errors occur. If any of these are to do with colour, you have a good starting point for workflow revision. Talk to suppliers about colour management, but make sure you understand thoroughly what you are asking for, and what they are offering. Talk to customers and pressroom staff too and involve them as much as possible in any workflow changes.

## ICC compatibility

Any colour management tools installed should be ICC compatible. This international standards body has developed a series of specifications for managing colour in an open digital workflow based on a common processing model for colour data.

The ICC's profile specification defines the spectral and behavioural characteristics of each device used in a workflow, and is relevant for everything from a digital camera to the cardboard used in packaging printing. Together with the ICC's Profile Connection Space which is based on CIEL*a*b*, device profiles can be used to calculate the right colour values for a colour file taking into account those factors influencing its appearance.

## Harnessing the components

One of the biggest difficulties with a complex data environment is that there can be many variables to control. Colour is horribly subjective, so it is even more vital to identify and manage variables. Even the origination software used can introduce anonymous factors into the workflow, and so standard defaults should be set up for all operators. Even Word, if it is to be used in a colour managed workflow, needs to be kept under tight control. Use the same versions of Photoshop, Illustrator, XPress and InDesign and use the same defaults on all workstations. Equally important is that everyone involved in a colour managed workflow understands what happens to files moving through production. This may seem basic, but it makes a serious difference to file processing.

Yet more important is regular hardware calibration, particularly monitors. Manufacturers of high end monitors for colour critical work such as La Cie and Barco generally recommend specific calibration tools and provide appropriate software. There are however many other tools on the market such as Colour Blind's Prove It, a simple but effective method for calibrating monitors and building ICC profiles. GretagMacbeth's Eye-One is a similar tool for profiling monitors and printers, and further up the scale is Pantone's Colorvision Suite which includes all tools necessary for precision monitor and printer profiling. Relatively new is the Monaco Optix XR from X-Rite with a built in function for evaluating the status of the monitor.

## Colour management developments

The development community has been pretty quiet of late, but a number of companies have declared future strategies for colour management. Fortunately everyone is sticking with ICC standards . Many of the new developments echo proven ideas Esko-Graphics originated with products such as Inkswitch and Blacksmith, primarily used in packaging applications .

Agfa has a new technology for managing colour in packaging applications. Alterna is a multiple colour printing tool for reducing or even completely avoiding the need for spot colours. Alterna also lets the user define their own colour standard working with ICC profiles and PDF based workflows.

Creo is also working on improving colour production, with Staccato Extended Colour Screens. This product brings the total screens available in a single job to ten, helping printers avoid problems with trapping and overprint artifacts.

KPG is the industry's leading developer of proofing technologies, with devices ranging from screen based softproofing with Match Print Virtual and the recently acquired Real Time Proof, to extremely sophisticated output devices such as the Approval XP. KPG's Colour Fidelity System is an ICC compliant colour production environment for colour critical data management.

Screen is also expanding its colour management reach and is one of the few companies to have declared colour management support within a JDF compliant production environment.

## Small is beautiful

Besides these large companies there has been considerable activity elsewhere in the market. Alwan is a small developer working on colour management tools for ICC workflows. Alwan CMYK Optimiser automatically and dynamically corrects colours and ink weights of incoming files prior to sending them for output. CMYK Optimizer is essentially a preflighting tool for colour that checks incoming files to help reduce the amount of ink used without compromising print quality. CMYK Optimizer analyses the CMYK values of incoming images, correcting them for optimum output according to the demands of the destination output process. The software sorts out ICC Profile mismatches and also dynamically corrects image dependent Total Area Coverage mismatches. This avoids excess ink on the paper which can create ink set-off and overprinting problems. Dot gain mismatch between that of the incoming separations and the actual substrate is also corrected and black generation is optimized for ink savings and higher print quality.

MY PrinTech has its origins in MY Cartons Printing and has developed a colour tool called FM6. This is essentially a colour converter that gets more print jobs on press in less time.

Clearly there is a lot to choose from, and there are lots of reasons why colour managed workflows are necessary for the printing industry to stay ahead. Developers are increasing the output gamut on inkjet printers and conventional presses, through clever colour conversion technologies and screening. New dye based and long lasting inks with wide colour gamuts are coming onto the market and we are seeing an increase in the number of colour stations on digital engines such as the new Xeikon 5000 and Indigo 5000 presses. This all gives customers more choice, but it also makes the need for colour consistency across devices and applications even more important. In for example transaction printing where colour use is rising, colour will need to be matched across a wide range of engines used in diverse environments.

Developments in spot colour simulation will help here as will the increase in soft proofing, however there will be no way of avoiding the need for a colour managed workflow. Already many printers have seen substantial financial and competitive returns through managing colour efficiently, but success isn't an immediate result. Colour management needs careful planning, testing and re-testing. Like the Japanese Kaizan concept colour managed workflows are about constant, reiterative, never ending production improvement.

# Shed that CMYK Skin!

## Company:

**Reptil prepress studio, Stockholm, Sweden**

## Type of work:

**Prepress and imaging bureau**

## Equipment:

**Fujifilm Celebrant RIP-system, Fujifilm Finalproof, Epson 4000 colour proofer coupled with Best Color Proof and Screenproof, Xerox DC12 colour laserprinter, Xinet Fullpress OPI, Dalim Twist workflow, Gretag Macbeth colour processor iQueue, Xinet Web Native Venture DAM system, Heidelberg Tango high end scanner and Imacon Flextight slide scanner.**

## Time of installation:

**2001 to 2003.**

Reptil has 20 employees and is part of Citat Media Group which has a total of 200 employees. At first glance the company seems to be quite a conventional repro house, but looking into how IT managers Per Gysing and Pelle Bergsten, have transformed the workflow during the last couple of years, it's clear that Reptil has some pretty unique qualities.

Three years ago Per and Pelle were given the task of auditing the existing workflow. The result was a series of suggestions for whether and how the workflow should and could be improved, and early on in the discussions the idea of implementing an ICC based colour management system came up. At first Per and Pelle weren't at all sure that this was possible to do in a high quality production environment, but they decided to give it a try.

After some initial research the conclusion was that when implementing an ICC based colour managed workflow, the shift to an RGB based workflow was the logical inevitability. For Reptil this decision wasn't without pain and anxiety, since the much-loved drum scanner couldn't produce images saved directly in RGB. After some internal and often heated debate, the existing drum scanner was sold off and a new scanner was purchased.

The decision to go for an RGB workflow was based on the fact that Reptil, or rather its client base, has a very varied type of production. Reptil handles print production for almost every possible kind of press and a wide range of colour printers. Reptil scans all images in calibrated RGB, mainly using Colormatch or Adobe RGB 1998 colour spaces, and then stores the files in the Xinet Web Native Venture digital asset management system. Reptil likes to postpone the colour conversion until the very last minute, when they apply the appropriate ICC output profile. When delivering documents for printing on large format plotters, Reptil often delivers documents still in RGB, since this is often preferred by those printers. Cross media production also includes preparing images for the web, where RGB is the preferred colour space.

The last minute colour conversion can be done in several ways. The Xinet Fullpress OPI server can perform the colour conversion on-the-fly when replacing the low res FPO (For Position Only) images with the high res versions. The Dalim Twist workflow system can do colour conversion at output and the Gretag Macbeth iQueue colour manager can also do colour conversions on-the-fly for chosen output queues.

Another area where colour management is crucial is proofing. Many of Reptil's customers demand a high end screen accurate proof, and for this Reptil use the Fujifilm Finalproof. The Celebrant RIP system drives this proofer so the proofs are more or less identical to the print, since the proofs can be made on the actual printing stock. But a growing number of clients settle for the proof output on the Epson 4000 colour inkjet proofer. With the Screenproof software from EFI Best, the high resolution raster data from the Celebrant system can be output on the Epson 4000. A third option for proofing is the Xeroc Docucolor DC 12, colour managed through the iQueue or Dalim Twist software.

Reptil has been able to transform itself into a cross media service bureau, with a flexible and modern workflow. Because of their experience with colour management, Reptil often act as consultants in this field. When helping clients, often printers, Per and Pelle use Heidelberg's Printopen profiling software which they have found to produce quality ICC profiles. This colour management software works in conjunction with Heidelberg's Newcolor scanner software.

Colour managed files are delivered as PDFs with embedded ICC profiles to printers for output. This is today accepted and even preferred by most printers, and works extremely well according to Per and Pelle. Pelle Bergsten explains: "We would not have been able to achieve this level of productivity if we had clung on to a CMYK workflow. It's just too cumbersome and time consuming, since we often face last minute changes of the print parameters."

# Techno Colour: Future Developments in Colour Management

**The graphic arts industry has always been about colour management. The widespread implementation of ICC workflows extends the reach of colour management at the same time as it extends the need for more people to understand how colour functions in the workflow. This is not the exclusive preserve of print production. Although print is still the ultimate arbiter for quality, cross media production is central to the digital communications premise.**

Industry trends within professional print reflect the changing market reality. Print runs are down, but colour usage is up. More work than ever before is produced digitally and the percentage of material that exists only in digital form is rising. Contributors to a digital workflow include content originators and distributors, as well as producers. Proofing is integral to the workflow, from the point of content concept through to the press, and much of it is required for both screen and hardcopy output. This is the legacy of the digital revolution and open technologies. Inexorably the industry is moving away from CMYK workflows, to instead embrace RGB workflows.

Media production is all about on demand manufacture and automation, and colour management is fundamental to the model. It facilitates process efficiencies and consumables economies everywhere, from distributed proofing across sites through to on press ink management.

Developers have responded to these trends at all points in the workflow. Real Time Image, now part of KPG, has long been in the business of soft proofing. The company's latest innovations include a version of Real Time Proof with support for Apple's Safari web browser, secure approval authentication and lockout features, plus multiple view and compare tools. These tools present the user with up to four versions of the same file, highlighting changed areas, showing only the edits. KPG and RTI are working to bring KPG's Virtual Matchprint and RTI's Real Time Proof closer together. All of these developments will be integrated into an ICC compatible and JDF compliant environment. Besides its work with Esko-Graphics, KPG is further developing its commercial relationship with Heidelberg.

The only true colour arbiter is the human eye and the only way of presenting reality in print is through the printing press. Prepress advances for colour have settled down to some extent, such that many developers are focused on controlling colour on press. FM6 was developed by MY PrinTech, which has its origins in MY Cartons Printing. FM6 is a colour converter for improving press efficiency and extending colour gamut, although this is not the software's primary purpose. Benefits include faster printer wash up, as short as 30 minutes through using a fixed ink sequence for composite printing on press, and the possibility of printing 1000 spot colours in a single pass. The savings in ink, the number of plates required and time are substantial.

The software has four components: an FM screen, standard CMYK colours plus two of three possible specials, and a colour conversion engine. The technology only works on linework leaving alone image areas and converting data into the special FM6 colours.

With FM6 there is apparently no need for any changes to the workflow and no major prepress changes. The technology uses seven inks to print any spot colour to within a Delta E of less than two, and there are two fixed combinations, CMYK plus two of the three FM6 orange, blue or green colours. An FM6 curve specifies ink values, is applied at the output stage and is proprietary to a printer's particular output. The company has developed various FM6 colour profiles for colour proofing with Dupont. This of course means that good results are utterly dependent on accuracy with which controls are set up in prepress, and on the absolute stability of the press. One of FM6's main benefits is the possible ink savings that can be achieved, but MY Cartons has found that instead they use the technology to lay down more ink for really bright saturated colours.

MY PrinTech is cooperating with Creo to market this technology, however Creo has a few tricks of its own up its sleeve. The company has developed Spotless printing with CMYK plus one or two extra colours, in order to take advantage of Staccato screening and its SquareSpot imaging technology's inherent stability to expand colour gamuts. There are two versions, Spotless 4 which is CMYK and Spotless X for CMYK plus one or two extra colours. This system is based on characterisation of everything in the print process, including paper and quality requirements for colour improvements such as a wider gamut and brighter images. The technology integrates with ICC proofers, is ink set independent and can convert most of the Pantone library to a printer's conditions. Spotless has been trialled with a number of packaging printers and is gaining acceptance from large consumer companies. Most of these tests have been done with offset presses, but Creo is also testing Spotless with flexo presses.

Agfa's Alterna is a multiple colour printing tool for reducing or even completely avoiding the need for spot colours. Alterna also lets the user define their own colour standard working with ICC profiles and PDF based workflows. Alterna includes a colour conversion engine to convert spot colours to the user's defined colour standard. This will allow the user to combine multiple spot colours on a single plate to avoid the need for multiple press runs, saving press time and reducing ink costs. Agfa's objective with Alterna is to expand the colour gamut on press, to improve press efficiency and to significantly reduce printing costs. Although it is positioned initally for packaging, it is likely that Agfa will make this technology available for other applications as well.

## CMYK advances

One of the greatest difficulties facing colour production professionals is managing colour conversions. The ideal graphic arts colour managed workflow should ensure the preservation of some specifics of input CMYK channels, and accurately convert all colour data for the target output, including contone and screened colours. Black channel control is a particularly thorny problem, but advances here are also underway.

Alwan's CMYKOptimiser is all about providing channel control for colour conversions, so that prepress and printing companies can produce ICC or standards compliant colour separations. The company describes its technology as "the way forward towards standardisation and optimisation of CMYK data exchange" and CMYKOptimiser is indeed pretty unique. The software provides controls so that separations are optimised according to a standard or actual production process. It works with either a single standard reference ICC profile, such as SWOP or Euroscale, or with destination press ICC profile and print specifications.

Images as well as PostScript and PDF data are managed to ensure the colour separations comply with the target standards and jobs in terms of high TAC (total area coverage), black generation and dot gain. One of the most innovative features of CMYK Optimizer is Dynamic Image Correction so that CMYK To CMYK corrections are made with image dependent ICC Device Link Profiles to preserve the integrity of original image colours and contrasts.

The software helps to avoid stability problems on press so that there is no risk of getting too much ink on the paper, and blacks and skin tones don't look greyish. All of this can add up to savings in consumables and eases the workflow by harmonising image rendering, even if images come from different sources.

Colour data management and harmonisation should ideally be the goal of any workflow management system. Digital origination is rising and this increases pressure on colour management systems to control RGB data flows. Although colorimetric ICC paths are good for proofing, they lose control of the K channel which can cause problems on output. Several of the major RIP developers are taking a revised look at colour management, with a view to improving support for RGB workflows, especially for CMYK applications. This is an important move because the market has no really clear colorimetric definites and there are no interchange standards for RGB data. Vendors are striving to overcome these problems however.

Fujifilm's Digital RGB creates a multipurpose master for any type of output, maintaining colour consistency across devices. The company's Fuji Image Intelligence technology currently under development focuses on RGB workflows and applies intelligence at all stages in the workflow to manage colour across every device. The idea is to create a Fujifilm RGB based colour network supporting everything from digital camera to press.

KPG's latest advance into colour management is the new Colour Fidelity System that automates colour critical data management from RGB capture to output. KPG's Colour Fidelity System has three cooperative modules. Module 1 is for configuring RGB images for specific output while retaining their output independence. Module 2 is for colour matching on screen to multiple outputs and module 3 handles profile management, conversion to colour corrected TIFFs (in PDF wrappers) and the rasterising. This module is based on Global Graphics Harlequin technology.

Of the three, the most mature module is the PDF conversion from high quality CMYK (SWOP) workflows into for example newspaper CMYK (SNAP). Using validated SWOP to SNAP profiles as basis, profiles are validated numerically and by visual comparison of screen, print and proof. According to KPG the use of rendering intents and colorimetric rendering alone is no good because of infilling. Perceptual intent optimises colour repro across different systems, but is not yet well defined or done in a common way, so KPG's approach preserves the three dimensional LAB values plus CMYK's characteristics. Instead of using device link profiles the technology achieves the same objective but does so within the colour management module for channel control, rather than the Profile Connection Space. KPG's technology is based on techniques developed for digital cameras plus Kodak's knowledge of analogue to digital colour management and device profiling.

Colour management is even becoming hip in the big wide world beyond prepress. HP has announced technology that sounds as if it is going to save the world from every colour ill, but it probably won't. CMYK+ is about providing "unsurpassed image quality in digital publishing", with easy to use tools. This ICC compliant technology is RIP based and interfaces with commercial CMYK workflows. It provides professional CMYK quality on HP's inkjet, laser and liquid ink devices and supports a wider output gamut than CMYK standards such as SWOP or Euroscale.

HP's technology preserves the black channel but also ensures that different primary colours are rendered accurately for RGB and CMYK workflows. Designed to get the most out of HP engines, this technology could also function with other devices, such as those Agfa sells as its Sherpa line. It uses adaptive transformation of the source colour gamut to make maximum use of the target device colour space, so that instead of printing the edge of a particular CMYK gamut, such as SWOP, the printer can render its own maximum gamut, without compromising the core gamut colours. CMYK+ covers all gamuts moving colours significantly when it can change them, but without compromising colour relationships.

Despite HP's claims colour isn't getting any easier, simply because its use is rising and workflows are getting more complex. Obviously this can only continue. Probably the most important issue facing any company getting into colour management, is training. Education of everyone involved in the media supply chain is vital if colour management is to become part of the production habit. Colour is never going to be easy or interesting for the vast majority of print buyers, however there are plenty of problems that can be resolved before they occur with a little bit of education. Who knows, maybe customers would even be prepared to accept the cost of their errors if they understood why they happened in the first place!