PrintFactory™

Device-Link

The right profiling technology for colour managers who want perfect colour first time, every time.

Consistent Colour
A Whitepaper

Every wide format printer faces three common challenges.

Printing consistently on different substrates; achieving accurate colour reproduction; and getting different print devices to print exactly the same colour as each other, over and over again, miles or months apart.

This whitepaper aims to help colour experts and production managers who want to overcome these colour problems, and to benefit from the financial advantages of doing so.

In it, we describe a technology that is changing the printing industry. **Device-link profiling.** This paper was produced by PrintFactory, makers workflow software that includes easy-to-use, device-link technology.

Consistent colour. Why?

A wide format printer's true value can be measured by the ability to deliver consistent colour.

Customers' expectations of print quality are higher than ever. In consumer-driven markets where initial perceptions can be the determining factor in the purchase of any object, service or experience, accurate and consistent colour reproduction has become the best indication of a wide format printer's value for money. As a result, print-buyers have raised standards; competition is fierce; and reputations and contracts can be won or lost on a poor print run.

> *"Why do wide format printers sacrifice so much of their profit margin by 'chasing colour' – when they don't need to?"*

Designers are also pushing the boundaries, exploring the potential for special effects. The integrity of colour has a strong impact in communicating a brand's identity, or selling a product straight off the shelf. It's becoming more and more important to focus on getting colour spot on – no pun intended.

It is also fair to say no two businesses print colour the same way. Every wide format printer offers a different level of product quality, and this range of quality is reflected in three, key, different aspects of their workflow:

Colour Accuracy

Whether or not a finished, product matches the intentions of the designer, as shown in the artwork.

Colour Consistency

The ability to produce a colour exactly, time after time, on different devices that are working in different environments.

Colour Reproduction

How well the same colour can be reproduced on different substrates.

The old-fashioned approach

For a long time, ICC profiles have been seen as the answer to the problems of colour consistency. But ICC profiles are not a panacea.

The decision to use ICC profiles can create more problems than it solves, leading to inaccurate, inconsistent output and many hours of overtime chasing colour without a good result. It's inefficient and expensive, for everyone involved.

New thinking

Device-link profiles are the alternative. They're nothing new. But device-link profiles are still misunderstood, and they have a reputation for being too complex to handle and inaccessible compared to their ICC alternatives.

This is a little ironic, as device-link profiles offer a much simpler way to achieve the same if not better results. For a start, they give operators far more manual control over 'tricky' gamut colours, black generation and neutral colours. And, as an added advantage, device-link profiles can improve colour reproduction across the board. They enable accurate, fast recalibration across different devices and use less ink – without reducing print quality.

In this whitepaper, we explain what a device-link is in more technical detail; how it works; and why the move to using device-link profiles makes good economic and great business sense.

If you're a wide format printer, and you haven't explored the difference between traditional ICC profiles and device-link profiles, then this document will also help you to understand how making the switch can increase your profit-margins.

Perhaps most importantly, it could also help you deliver higher quality print to your customers.

The problem with ICC profiles

For wide format print, ICC has long been the accepted profiling standard. However, ICC profiles come with a problem. Unfortunately, ICC profiles only have limited control over the conversion of the black channel between two different colour spaces. This creates a conversion 'lottery' for printers, which usually leads to one or more of these three problems:

- Identifying sub-standard print takes time
- The identification process uses ink and media, which eats into profit margins
- Print production (on that device) usually comes to a temporary halt

The problem is a simple one: an ICC profile works hard but the data it 'takes in' from the original file isn't always reflected accurately in what it 'puts out', to the printer. Rather, the ICC profile does a conversion in an intermediary CIEL*A*B* colour space.

This means that an ICC profile converts data by taking it through three channels (L*A*B), rather than four (CMYK). In the process, the K value – K for 'key', black – can get lost, quite literally. The result is less vivid colour or, worse, the wrong hue completely.

CIEL*A*B* was created by the International Commission on Illumination (French Commission Internationale de L'Éclairage), to serve as a device-independent model for referencing colour.

It is a colour space that describes all the colours visible to the naked human eye. The datasets used to characterise a colour input or output device, or a colour space, are known as ICC profiles.

	Input				Conversion	Output
					CIEL*A*B*	CMYK
VALUE A	25	25	25	0	25/0/0	10/10/10/+10
VALUE B	0	0	0	25	25/0/0	10/10/10/+10

Here, you can see how the results from a CIEL*A*B* conversion differ to the results we see if Values A and B are converted directly from CMYK-to-CMYK. Less ink gets laid down as part of value 1 in comparison to value 2, which means a less vivid colour is the output. Colours get contaminated In the CIEL*A*B* space, which sees both values as being equivalent and therefore converts these to identical outputs. Quite simply, the output isn't what was intended.

With this lack of control over the K channel, other inks get laid down to compensate; outputs lose their neutral tones and can become ever-so-slightly pink, blue or green. Rendering intents are another problem. ICC doesn't take the real-time characteristics of the job into account; rather, ICC profiles only focus on the printer's properties during the profiling process – compressing or expanding a printer's entire gamut indiscriminately to fit the L*A*B space, rather than adjusting according to what lies outside the gamut.

In comparison, the output from a CIEL*A*B* conversion will deliver lower quality colour; less vivid output; and inaccurate, irregular colour reproduction across different printers. If a print buyer or colour manager has high standards, then the difference will almost certainly be enough to get a job rejected.

Another side-effect of having this weak black

The true cost of compensation

channel is greater print head wear. This may seem to be a minor consideration but, in larger operations, this has a notable impact on maintenance schedules and, in turn, results in more frequent colour drift.

When colour drift, environmental and substrate changes happen, it's a time-consuming and intensive process to recalibrate ICC profiles. It means recreating the ICC profiles from scratch.

The original CMYK output values get lost in the CIEL*A*B space. Even though the difference is subtle (and the settings are the same), the internal algorithms might produce a significantly different black. If this happens, it's trial-and-error until the ICC generator is 'massaged' to deliver similar, if still not the same, results. It can difficult to identify which values have been affected over a period of time. And if jobs are being reproduced months – or thousands of miles – apart, then this translates to a significant amount of time being invested in creating new profiles to achieve the same colour output.

The only thing that's consistent in this whole situation, is unnecessarily higher ink costs.

Device-link | Direct advantages

Simply put, **Device-link profiling** transforms colour from one colour space to another, directly. It doesn't work through an intermediary area.

Device-link profiling preserves colour separation by doing direct CMYK-to-CMYK conversions (or RGB-to-CMYK, CMYK-to-CMYKOG, etc.), and sending instructions directly to the colour space of the target output devices – the printers.

Rather than being converted to L*A*B and back, this 'normalised' printing means every channel's values stay the same – ensuring consistency and accuracy, with no manual intervention.

Device-link's direct conversion results in a much stronger K channel. With this stronger black channel in play, end results have more of the detail and depth intended in the source files.

In addition, device-link profiles don't need to compress or expand a printer's gamut to fit CIEL*A*B values.

Instead, device-link technology translates a profile directly onto a printer's gamut with a mix of **colorimetric** and **perceptual** rendering, which combine to be known as a **visual match.** (This is in contrast to ICC, as the device-link knows both the input and the output during the calculation, and therefore understands in which part of the gamut to use colorimetric conversion and where it needs to compress perceptually.)

Each approach has its advantages. For example, colorimetric rendering may work best for proofing. Perceptual rendering suits stand-alone reproduction, while visual match is best for matching to a proof and providing optimal cross-printer and media consistency. But this 'true rendition' of colour means there's not as much need for extra coloured ink output, as is often required by ICC profiling.

	Input				Device-link
					CMYK
VALUE A	25	25	25	0	20/20/20/0
VALUE B	0	0	0	25	0/0/0/20

Colorimetric Rendering

Instead of compressing a printer's entire gamut to match a colour profile, colorimetric rendering clips everything that lies outside the gamut. This leaves the area of the profile matching the printer intact, which delivers the most accurate output possible in terms of CIELAB values – but colours falling outside the gamut can appear incorrect.

Perceptual

For standalone job reproduction, using a specific media with one specific printer, perceptual gamut clipping can be the logical alternative. This approach compresses every colour of an assumed gamut into the printer gamut, even those colours that did not need compressing. As result the visual appearance may look good to the naked eye, but none of the colours are correct as all of them have been compressed (less or more as teh case may be).

Visual Match

Brought together, visual matching offers the best of both worlds. And as a result, a key benefit of **Device-link profiling** is its ability to produce and reproduce colour accurately and consistently across devices and substrates.

Visual match identifies those parts of a profile that fall outside of a printer's gamut; it compresses them selectively – to fit the gamut – with perceptual intent.

Spot colours are rendered independently from the gamut compression and/or clipping. The algorithms for Spot colours ensure a clean, crisp colour reproduction, in and outside of the gamut: they're not handled like the colours of an image (which need more compression to retain the subtle colour shades).

As a result, the RIP needs to be truly multi-colour, creating CMYK+Pantone+Pantone-to-PrinterCMYK Device-Links on the fly, without touching the CMYK-to-PrinterCMYK conversions.

Crucially, through colorimetric clipping, a visual match can also maintain the colours that fall within the mid-segment (where the gamut of the input and the printer overlap), which means better colour accuracy and higher quality across different devices.

Plus, wide format printers can leverage the full potential of a printer's gamut for the strongest, most accurate colour output possible.

How to reap the benefits

Most wide format printers expect to recalibrate their printers on a regular basis. Traditionally, when any colour drift is spotted, colour experts have to recalculate each profile. Every one needs to be individually corrected, which might take an hour or more, and this usually involves taking colour experts away from their workstations, using extra ink and media in hard proofs, and additional wear and tear on printers (it's minimal, but it all adds up). Plus - downtime.

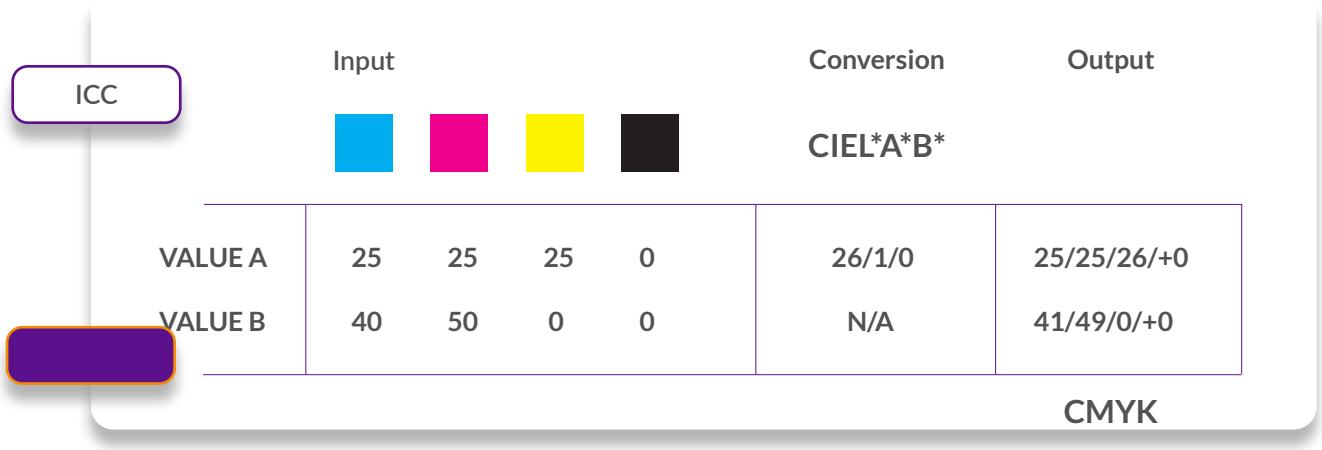
Even then, it may not be easy to identify the source of the colour drift, due to the unpredictable nature of the conversion from L*A*B to CMYK. So corrections must be made on a trial and error basis with multiple stages of 'chasing colour' to get the right result.

However, with the device-link profiles defining settings for a first 'golden state', the right software can benchmark successive outputs automatically – delivering iterative recalibration in almost real-time, reflecting and correcting instantly for changes that are caused by printing environments and media. This iterative calibration doesn't need any settings, decisions, or human intervention. It's merely changing the existing channels to bring back the colour as stored in the 'golden state'. An automated version of the way press-operators tweaked density to press in the past, but - rather then being for a whole - the software does this colour-by-colour individually.

In short, if workflow software is using device-link profiles instead of ICC profiles, then it can guarantee that colour outputs will be consistent – even if the print production is happening miles (or months) apart.

Worth its weight in gold

Device-link profiles translate directly to a printer. The first, perfect result using those profiles can be captured as the definitive golden state.



The hidden advantage of this 'simple' calculation is in the obvious math. Colour managers can see exactly where (if any) discrepancies have occurred. Then, recalibration back to the golden state can be done in three simple steps, rather than successive test-and-learn iterations.

Print. Measure with a spectrophotometer. Add new values to the calibrator - three simple steps.

Device-link profiling delivers massive time and resource benefits, removing the need to constantly remeasure and recreate profiles for each device and substrate.

And when one profile is calibrated, all of the other device profiles can be automatically adjusted to reflect those changes – increasing accuracy, rather than reducing it.

Technical advantages

Combatting metamerism

Device-link's greater control over the different colour channels offers another way to combat metamerism. This is the phenomenon of two colour samples that appear to be the same under one light, but change shade when exposed to different lighting conditions. In colour management software, this gets dealt with by using a Light Adaptation Tool (LAT).

The LAT provides a variety of viewing conditions that sit outside normalized D50 daylight, which makes colour tuning easier. In fact, as some companies know under exactly which lights will be used to illuminate a product, the availability of a good LAT is essential. For supermarket packaging, for example. And for specialist retailers, like textile manufacturers, who often tuen to D65 rather than D50.

LAT allows for shifts in hue to the gray balance, enabling a neutral gray under a specific light. Printing yellow, green, cyan, blue, magenta and red variants - and comparing these with the original profile - enables printers to pick a desired gray balance that better suits the display lighting conditions. And a stronger black channel can also improve a job's resistance against illuminant changes for less metameric colour degradation.

Retaining the strength of the K channel

The impact of retaining black channel in device-link profiles can't be overstated. As well as delivering more vivid colours with less ink, separating the K channel during the CMYK-to-CMYK conversion maintains the subtle details and gray balance intentions of the original image.
Different ink mixtures that have significantly different K levels may be the same colormetrically (CIEL*A*B*), but the human eye will still see them differently due to other characteristics, such as gloss. If you look at the spectral reading of the two colours you will see also a difference. Again, for high-standard print buyers, it can be enough to make a difference.

Spotting (the difference)

Drawing from a library of spot colour L*A*B target values, device-link powered colour management tools can calculate the CMYK output values from a Spot colour library to match a printer's unique colour space. This removes the noise and 'dirtying' of Spot colour output typically seen in traditional ICC profiling. ("Dirt" gets introduced because the algorithm to convert colours is designed to retain the subtle colour shades, and it does so, but almost too effectively. This is why we introduced a tailored algorithm for Spot colours.)

And, as with individual colour values, Spot colours can be edited and tuned to improve the visual match of a job for added flexibility.

Getting consistent colour, everywhere

The very nature of **Device-link profiling** - the direct transformation of colour from a source to each individual printer's colour space - ensures the source values are faithfully and reliably reproduced within each printer's unique gamut.

In other words, this translates to technology that can guarantee accurate, consistent colour production across all printers and substrates.

Business benefits

Lower ink and media costs

With no need to lay down more coloured ink to overcompensate for a weak K channel, Device-link profiling can deliver ink savings of up to 15% - with no drop in quality. Media consumption is also reduced by getting the right colour first time, every time.

Faster, smoother production

Creating profiles is quicker than ever. It takes a few minutes. And there's no need to regenerate profiles for each printer and media. Spot colours can be processed and edited effortlessly. Proof-perfect colour output across every device and substrate removes the troubleshooting process. And all of this frees up time to focus on the things that matter - achieving higher throughput and maximum job quality.

Increased productivity

Case studies show that a switch to Device-link profiling can boost output by as much as 25%.

Smarter workflows

Many people talk about 'smart', thinking that 'smart' must mean 'automated', or 'digital'. However, a truly smart workflow is one that uses *all* the resources available, effectively, to achieve a desired outcome. This also means making best use of qualified staff in the right roles.

With Device-link profiling, the recalibration processes can be done by anyone on the team, at any time it's necessary. This removes the burden of having to have highly-qualified staff available, all of the time, to do maintenance jobs (like recreating profiles for existing media-printer combinations).

It puts the emphasis back onto offering a much more attainable - and sustainable - level of quality control, which isn't always possible, if highly-qualified staff aren't readily available.

Case Study

> *"The difference in profiling technology is like night and day."*

Signtech, a UK company, has more than 20 years' experience as a wide format printer, providing a wide range of services from design through to manufacturing and installation.

The problem

Achieving consistent colour reproduction was a recurring challenge for Signtech. When the team created colour profiles, what was on screen did not accurately match the output on Signtech's printers, requiring time-consuming changes to be made and stalling productivity on the shop floor.

Due to the complexity of Signtech's colour management software, only highly-skilled staff members could operate the system and correct colour when inconsistencies occurred. Making matters worse (after a job's colour profile had been finalized and printed to standard the first time), when it came to reproducing the job months later, Signtech experienced difficulties matching colours to the original run.

Colour drift is inevitable, but Signtech's existing colour management solution did not account for it. As a result, further colour management, troubleshooting and device recalibration had become part of the process, creating unnecessary bottlenecks in the workflow.

The solution

Signtech installed PrintFactory's workflow software, which includes Device-link profiling technology. This more streamlined, productive workflow has given Signtech a boost in production capacity of over 25%.

Device-link profiling technology is ensuring that Signtech can match colour and get consistent results across all printers and substrates.

With more accurate conversions and a proof-perfect colour output on the first print, Signtech no longer has the need for additional troubleshooting cycles. In addition, the ability to create device-link profiles in under 10 minutes has meant the team can take ownership of the colour management process; it's no longer the exclusive domain of 'colour experts'. Any printers affected by colour drift can be recalibrated to match the original job colour quality easily - and this has helped Signtech to output identical colours when a job is reproduced months after the original, saving valuable time and resources.

Sean Guegan
Managing Director, Signtech

"The difference in profiling technology is like night and day. Before, our staff were putting in overtime nearly every day to achieve the right colour.

Now, the overtime has been reduced, our staff are more confident and the quality of our output is unmatched. It's sped up our whole workflow, made it more streamlined and created much more productivity from the same amount of input. Customers are coming to us for quality that our competitors just can't beat. We wouldn't work without Device-link profiling now. It's as simple as that."

Conclusion

Colour managers can spend a significant amount of time chasing colour, getting repeat jobs to match earlier colour standards.

But it doesn't have to be this way.

By choosing workflow software that uses device-link profiles, wide format printers can boost productivity and will increase their profit margins by using the same or fewer resources.

Device-link profiles deliver a product that uses less ink, with no reduction in quality.

It takes just a few minutes to create or regenerate new device-link profiles and start saving ink.

Accurate and consistent colour reproduction means less wasted media, higher profit-margins.

PrintFactory is a suite of colour-focused workflow tools. Driven by a world-class colour engine, PrintFactory's tools all connect to faster, smarter RIP for perfect large format digital print.

PrintFactory is easier to use.
It was made by printers, for printers.

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