

DEVICE-LINK

THE RIGHT PROFILING
TECHNOLOGY FOR COLOR
MANAGERS WHO WANT PERFECT
COLOR FIRST TIME, EVERY TIME

**CONSISTENT COLOR
A WHITEPAPER**



PRINTFACTORY.CLOUD



Every wide format printer faces three common challenges. Printing consistently on different substrates; achieving accurate color reproduction; and getting different print devices to print exactly the same color as each other, over and over again, miles or months apart.

This whitepaper aims to help color experts and production managers who want to overcome these color 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.



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Consistent color. Why?

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

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 color 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 color' – when they don't need to?"

Designers are also pushing the boundaries, exploring the potential for special effects. The integrity of color 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 color spot on – no pun intended.

It is also fair to say no two businesses print color 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:



Color **accuracy**

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

Color **consistency**

– the ability to produce a color exactly, time after time, on different devices that are working in different environments.

Color **reproduction**

– how well the same color 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 color 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 color 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 colors, black generation and neutral colours. And, as an added advantage, device-link profiles can improve color 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 color 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 CIE L*A*B* color 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 color or, worse, the wrong hue completely.



CIE L*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 color.

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

	Input				Conversion	Output
					CIE L*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 CIE L*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 color is the output. Colors get contaminated In the CIE L*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 CIE L*A*B* conversion will deliver lower quality color; less vivid output; and inaccurate, irregular color reproduction across different printers. If a print buyer or color manager has high standards, then the difference will almost certainly be enough to get a job rejected.

The true cost of compensation

Another side-effect of having this weak black 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 color drift.

When color 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 CIE L*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 color 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 color from one color space to another, directly. It doesn't work through an intermediary area.

Device-link profiling preserves color separation by doing direct CMYK-to-CMYK conversions (or RGB-to-CMYK, CMYK-to-CMYKOG, etc.), and sending instructions directly to the color 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.

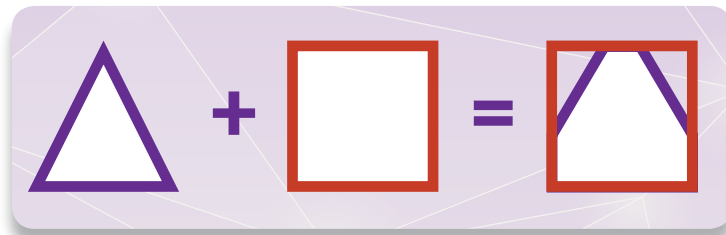
Device-link's direct conversion results in a much stronger K channel. With this stronger black channel in play, end results have more of the detail and depth intended in the source files.

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 color means there's not as much need for extra colored ink output, as is often required by ICC profiling.

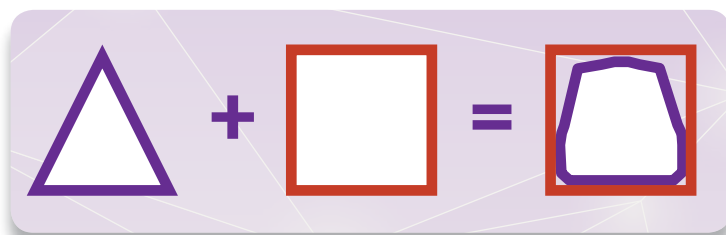
	Input				Device-link output
					CMYK
VALUE A	25	25	25	0	20/20/20/0
VALUE B	0	0	0	25	0/0/0/20



COLORIMETRIC RENDERING

Instead of compressing a printer's entire gamut to match a color profile, colorimetric rendering clips everything that lies outside the gamut. This leaves the area of the profile matching the printer

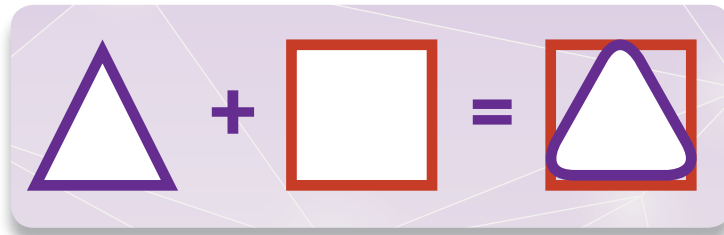
intact, which delivers the most accurate output possible in terms of CIELAB values – but colors falling outside the gamut can appear incorrect.



PERCEPTUAL RENDERING

For standalone job reproduction, using a specific media with one specific printer, perceptual gamut clipping can be the logical alternative. This approach compresses every color of an assumed gamut into the printer gamut, even those colors

that did not need compressing. As result the visual appearance may look good to the naked eye, but none of the colors 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 color 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 color 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 color shades).

As a result, the RIP needs to be truly multi-color, 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 colors that fall within the mid-segment (where the gamut of the input and the printer overlap), which means better color 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 color output possible.



How to reap the benefits

Most wide format printers expect to recalibrate their printers on a regular basis. Traditionally, when any color drift is spotted, color 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 color 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 color 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 color' 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 color as stored in the 'golden state'. An automated version of the way press-operators tweaked density to press in the past, but - rather than being for a whole - the software does this color-by-color individually.

In short, if workflow software is using device-link profiles instead of ICC profiles, then it can guarantee that color 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.

	Input				Conversion	Output
ICC					CIEL*A*B*	CMYK
VALUE A	25	25	25	0	26/1/0	25/25/26/+0
VALUE B	40	50	0	0	N/A	41/49/0/+0

Device-link

The hidden advantage of this 'simple' calculation is in the obvious math. Color 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 color channels offers another way to combat metamerism. This is the phenomenon of two color samples that appear to be the same under one light, but change shade when exposed to different lighting conditions. In color 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 color 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 tune 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 color 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 colors 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 (CIE L*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 color L*A*B target values, device-link powered color management tools can calculate the CMYK output values from a Spot color library to match a printer's unique color space. This removes the noise and 'dirtying' of Spot color 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 color values, Spot colors can be edited and tuned to improve the visual match of a job for added flexibility.

Getting consistent color, everywhere

The very nature of device-link profiling - the direct transformation of color from a source to each individual printer's color 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 color production across all printers and substrates.



Business benefits

Lower ink and media costs

With no need to lay down more colored 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 color 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 colors can be processed and edited effortlessly. Proof-perfect color 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 color reproduction was a recurring challenge for Signtech. When the team created color 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 color management software, only highly-skilled staff members could operate the system and correct color when inconsistencies occurred. Making matters worse (after a job's color profile had been finalized and printed to standard the first time), when it came to reproducing the job months later, Signtech experienced difficulties matching colors to the original run.

Color drift is inevitable, but Signtech's existing color management solution did not account for it. As a result, further color 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 color and get consistent results across all printers and substrates.

With more accurate conversions and a proof-perfect color 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 color management process; it's no longer the exclusive domain of 'color experts'. Any printers affected by color drift can be recalibrated to match the original job color quality easily - and this has helped Signtech to output identical colors 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 color.

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

Color managers can spend a significant amount of time chasing color, getting repeat jobs to match earlier color 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 color reproduction means less wasted media, higher profit-margins

AURELON

Aurelon is the company behind PrintFactory, ProofMaster and more. Aurelon develops award-winning software that helps wide format printers to work more efficiently today, preparing for more advanced levels of automation tomorrow.

The Aurelon team has re-engineered wide format workflows to deliver an intuitive, future-proofed RIP and a portfolio of tools using device-link technology. Find out more about PrintFactory's workflow software.

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