Re-linearization vs. L*a*b* correction

Three ways to achieve good printer adjustment

efi GmbH
Kaiserswerther Str. 115
40880 Ratingen
Germany
www.efi.com

Status 24.04.2006

Table of contents

1 System configuration

This article applies to the following system configuration:

Software Version:

Colorproof XF v2.6
Lintool or Color Manager (option)

Miscellaneous:

2 Topics

This document explains the differences between performing a re-linearization, using an L*a*b* correction profile and creating a new base linearization. Furthermore it will provide the correct circumstances for using each method and the benefits to the customer.

2.1 Introduction

The production of a printout, for proofing or production purposes, relies on a linearization file which adjusts the printer's behaviour according to the type of paper being used and the ICC profile which characterizes the specific combination of printer/paper and provides transformation tables for conversion between color spaces. The combination of these two files ensures the optimal behaviour of the printer and high-quality color conversion. However, printer behaviour is subject to change over a period of time. Replacing the ink cartridge or environmental influences can also affect the printer.

In order to compensate for this, EFI recommends three practices:

- A re-linearization of the printer.
- The creation of an L*a*b* correction profile.
- The creation of a new base linearization.

2.2 The re-linearization

2.2.1 General explanation

Installing a printer and accompanying software package usually requires you to create a new linearization file and a new ICC profile. These two files ensure the quality of the printout.

If the printer behaviour now changes over a period of time it is not always necessary to repeat the whole procedure. A quick re-linearization can realign the printer to the original status so that the "old" ICC profile can still be used. The advantage of performing a re-linearization instead of creating a new linearization file is that it involves less work. A new linearization takes four steps whereas a re-linearization can be completed in only two.

Depending on the printer, it might even be useful to perform a quick re-linearization once a day.

2.2.2 How does a re-linearization work?

The process of creating a re-linearization includes:

- Adjusting the ink limits for each channel.
- The actual linearization.

The method of adjusting the ink limits per channel varies depending on whether you are performing a re-linearization or creating a base linearization.

When creating a base linearization the channels are adjusted to specific reference values. For example, EFI Color Manager uses the primary L*a*b* values from the isocoated profile as default values. The calculated values can be changed by users who wish to make customized adjustments.

During re-linearization it is important that you load the original base linearization. This is necessary to enable the software to extract information from the original linearization file, e.g. the former ink limits. These values serve as reference values when defining the new ink limit for each channel. The ink limit per channel focuses on the primary colors only. Secondary or tertiary colors are not considered.

The actual linearization simply redistributes the number of available nodes per color gradation (C, M, Y, K) in order to smooth gradations and transitions.

2.2.3 When to do a re-linearization?

The first step is to determine the current behaviour of the printer. After creating a base linearization it is recommended to print a control strip without color management and save the color measurements. After some days or printer maintenance another control strip should get printed. The color measurements of this control strip need to get compared to the measurements from the newly calibrated printout. Another simple way to ascertain whether the printer is still calibrated or not is to create a “standard” proof and check if the values are within the tolerance values.

A re-linearization is useful if:

- The average Delta E is higher than 2.5.
- The highest Delta E values appear to be in the primary colors.
- The gamut is decreased.

If poor delta E measurements are within the color gamut a re-linearization would not have any effect.

Please note that a re-linearization can only correct small deficiencies. It cannot turn a delta E value of 3.2 into a value of 1.0. A re-linearization is therefore only recommended for rough improvements.

2.3 The L*a*b* correction profile

2.3.1 General explanation

The L*a*b* correction profile follows the ICC standard. Whereas device profiles contain transformation tables for conversion from a device color space (RGB or CMYK) to L*a*b*, the L*a*b* correction profile contains transformation tables for conversion from L*a*b* to L*a*b*.

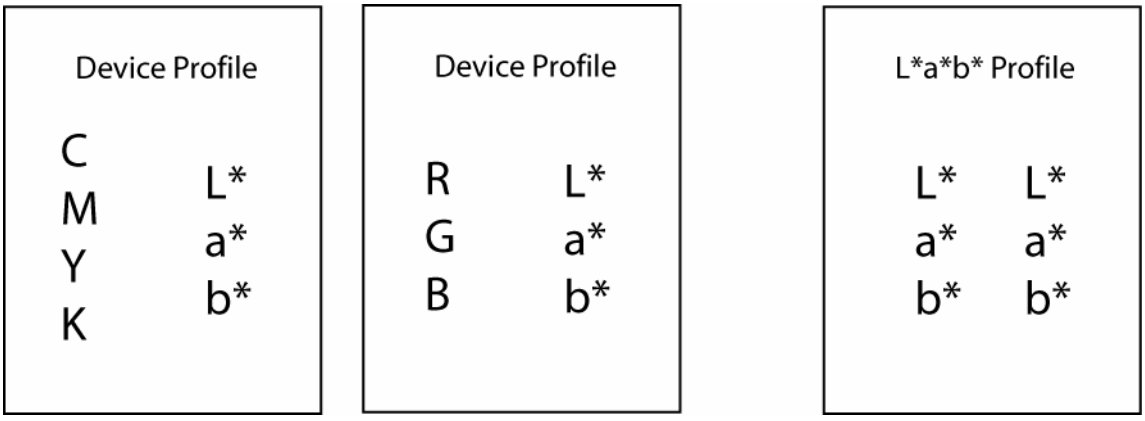


*Fig. 1: Makeup of standard device profiles and the L*a*b* correction profile*

A normal color conversion process during proofing would be as followed:

RGB input to L*a*b*; L*a*b* to CMYK simulation; CMYK simulation to L*a*b*; L*a*b* to CMYK paper profile.

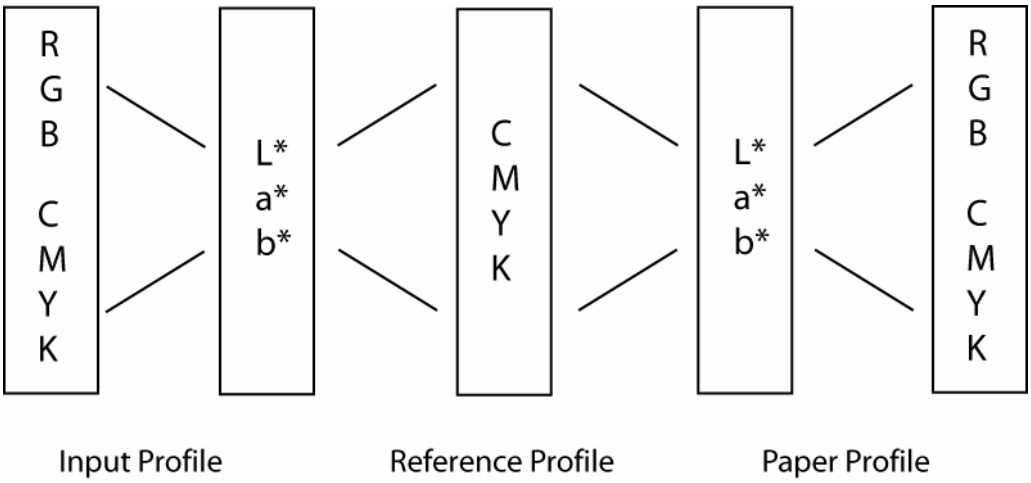


Fig. 2: Standard color conversion in a proofing workflow

The L*a*b* correction profile affects the L*a*b* values between the reference profile and the paper profile.

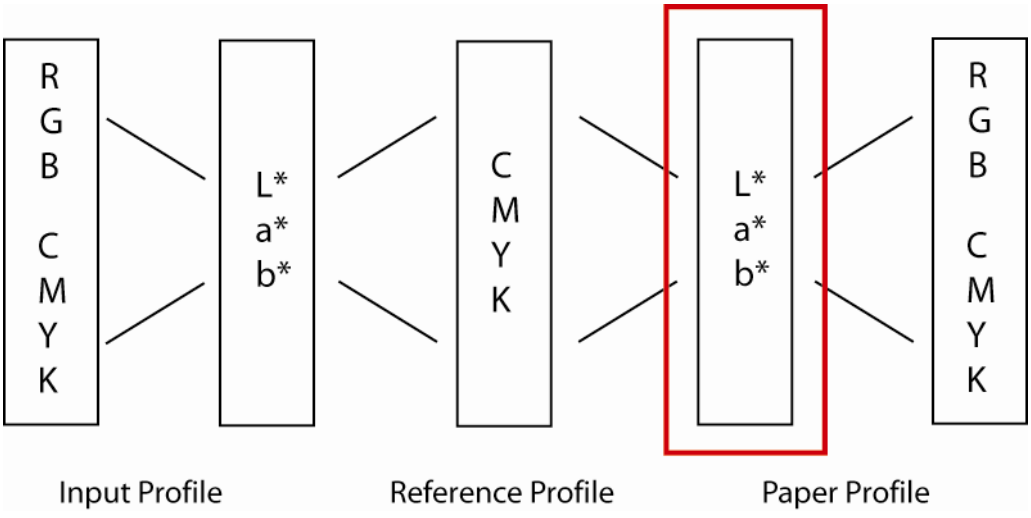


*Fig. 3: The L*a*b* correction occurs in the L*a*b* color space between the reference profile and the output profile (paper profile).*

The advantages of using a correction profile in L*a*b* are as follows:

- The optimization occurs in the same color space.
- The optimization is independent of the source, simulation or output color space.

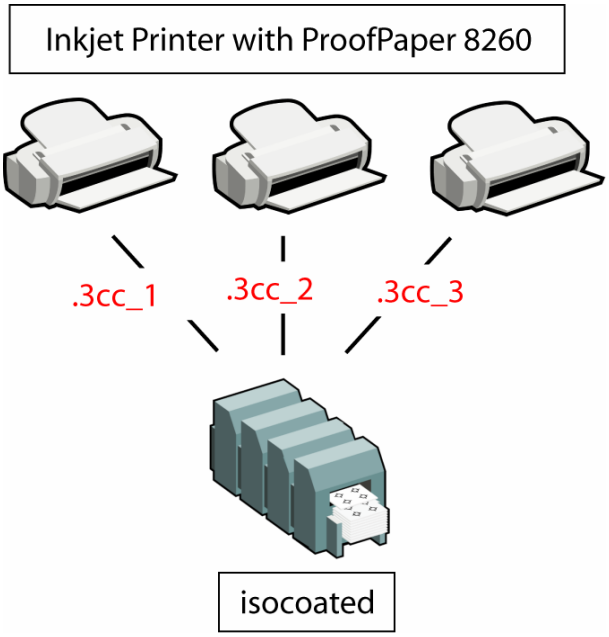
2.3.2 Areas of use

The L*a*b* correction profile can be applied to:

- Adjust the quality of a single printer to a specific reference.
- Adjust other printers to the same reference.

The first area of use is probably the most common. A standard linearization in conjunction with an ICC profile can give good results. However, an L*a*b* correction profile can improve this quality, particularly if the user is attempting to match the printer to a specific reference. The L*a*b* correction profile alters the given L*a*b* values in order to get as close as possible to the desired values. However, it will not save these values to the ICC profile. All changes will be saved to the L*a*b* correction profile (3cc).

As a result, the L*a*b* correction file can be used to adjust multiple printers to a specific reference. A practical example might be a print shop using three inkjet printers with the same paper loaded in each. All the printers need to simulate a specific reference profile (ISOCoated). The L*a*b* correction profile (3cc) now adjusts the behaviour of the devices relative to the reference. All the paper profiles are the same, the reference profile will stay untouched. The only file which will vary is the 3cc. The following diagram illustrates more clearly what happens:



The adjustment happens purely via the L*a*b* correction profile. If the print shop wants to match a different reference it just needs to replace the 3cc file.

2.3.3 When to use an L*a*b* correction profile (.3cc)?

As previously mentioned, the most common area of use is to improve the quality of a single printer. But how does a user know when to use the L*a*b* correction profile? The first steps before creating an L*a*b* correction profile (3cc) should be to create a good base linearization file and, from this, a good ICC profile. In many cases, the combination is already very good. For example, an average Delta E value of 1.0 would be considered a satisfying result and no L*a*b* correction profile would be necessary. On the other hand, the L*a*b* correction profile cannot correct an average Delta E of 4 to achieve a desired Delta E of 1.0. The optimization can only work within certain limitations and the ICC profiles used still need to be accurate.

Creating an ICC correction profile is useful if:

- The average Delta E value is lower than 2.5.
- The highest Delta E values are within the color space and not along the saturated colors.

2.3.4 Differences between a re-linearization and an L*a*b* correction profile

An L*a*b* correction profile does more fine-tuning and tries to get the best out of a good linearization file and ICC profile. In order that the L*a*b* correction profile can do its job, it needs a good basis (base linearization, ICC profile). It cannot improve the quality of a Delta E from 4 up to 0.8.

Therefore, if a comparison result is higher than 2.5, it is a good idea to perform a re-linearization. In particular, a re-linearization is advisable if the highest Delta E values are in the saturated areas. If the highest results are somewhere in the middle of the color space, a re-linearization will probably not work. In this event, you should create a new base linearization.

2.3.5 When to perform a new base linearization

As previously mentioned, it is very important that the original base linearization file is of high quality. If there is something wrong with the base linearization, it does not make sense to create a re-linearization or a 3cc file. You should create a base linearization if the re-linearization does not lead to the expected results, e.g. if, after creating the re-linearization, the proof still has a Delta E of more than 2.5 and the highest Delta E values appear to be in the primary colors (section 2.2.3).

2.3.6 Benefits to the customer

Re-linearization

The re-linearization process is a quick version of the original linearization process. It only takes about 45 minutes, which includes the drying time for the targets. The actual time would be around ten minutes. The creation of a new base linearization takes at least two hours.

L*a*b* correction profile

Users without any knowledge of color management can calibrate their systems to an acceptable state, using the standard paper profiles delivered with the software and then performing an optimization in order to achieve high-quality results.

3 Summary

EFI recommends three techniques in order to update the linearization to the current state of a printer. These are:

Re-linearization is recommended:

- If the average Delta E between a reference profile and the measurement values is higher than 2.5.
- If the highest Delta E values are on the rim of the color gamut near the saturated areas and not within the color space.
- If you only want to make rough adjustments.

Creating an L*a*b* correction profile is recommended:

- If the Delta E value is lower than 2.5.
- For fine-tuning.
- In order to adjust different printers in a multi-printer environment.

Creating a new base linearization is recommended:

- If the highest Delta E values are within the color space (brown, dark green etc.).
- If the result of the re-linearization did not achieve the expected results.