

## What is Printer Linearization?

### Introduction

In the diverse world of digital printing, there are many different ways of controlling the way ink is fired from a print head onto a media. This can range from the use of a printer manufacturer's driver, to high end RIP solutions and the level of end user control varies dramatically.

When printing directly through a printer manufacturer's driver, normally you just select a media type from a list, specify the print quality/ resolution you desire, click print and the results are normally pretty good. By selecting the media type, you have basically selected a pre-created linearization for that media at your chosen resolution.

Most wide format printers are driven by dedicated RIP solutions which give the end user the ability to create custom linearizations and therefore gives more flexibility on the range of medias that can be print onto.

The process of linearization is the main form of calibration (not to be confused with profiling) and the most important step in calibrating an ink/ media combination. It involves a number of key steps which are explained in the linearization example below. These steps vary slightly depending on the software creating the linearization, but fundamentally the end goal is the same.

The example below was carried out using Easy Media within Caldera's Visual RIP and gives a basic overview of the steps involved.

### Linearization steps

#### Step 1 (Transition curves)

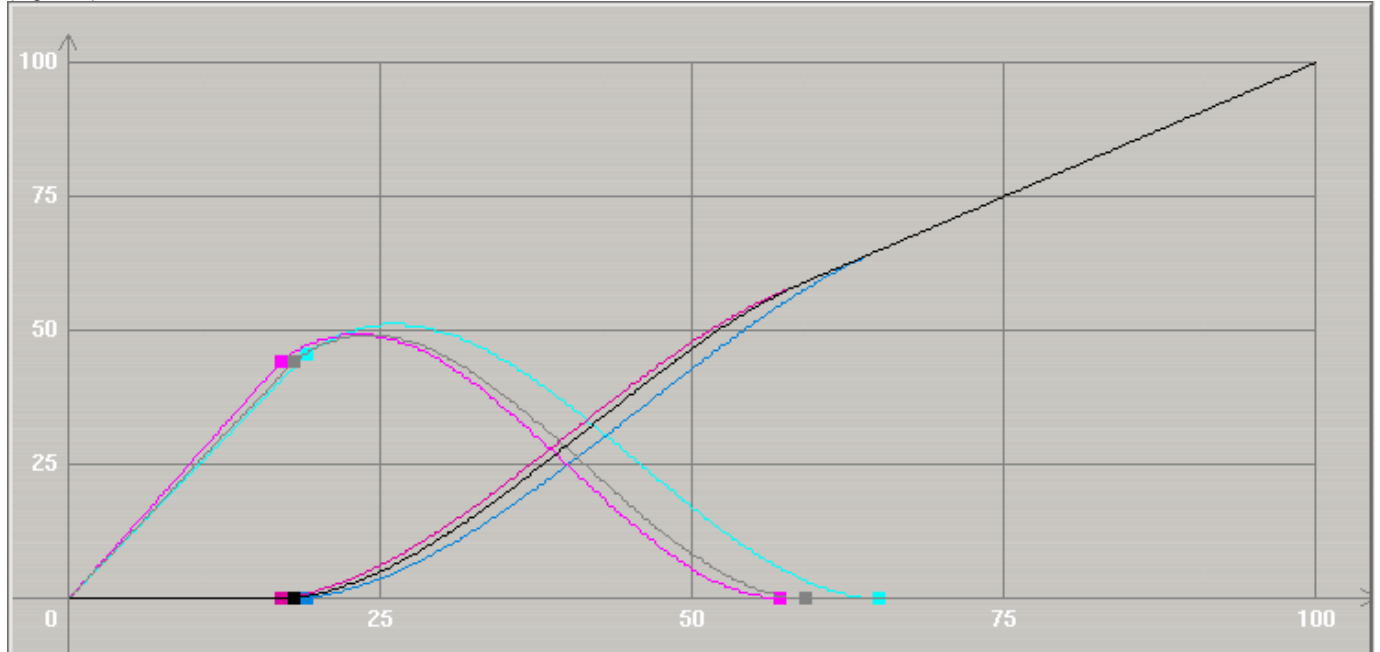
The first step will vary depending on whether your printer has light inks or not. If your printer has no light links, then you will not have to worry about transition curves and move on to step 2.

If your printer has light inks, then you need to control how much light ink is used before the dark ink is introduced and then how these are mixed. Also if your printer has variable droplets, it is normally around this point in which the variable droplet transitions are created, although this can be very complex and normally best left to be created automatically.

After choosing the print quality/ media combination, you will need to print out the light inks on their own and then the dark inks. After this they need to be measured with a spectrophotometer and then analysed. It is important to note that the whole calibration process needs constant visual assessment and one shouldn't just rely on measurement.

Fig.1 below shows the specified transition curves created for a printer with light cyan, light magenta and light black (or grey) in addition to CMYK.

(Figure 1)



As you can see from the calculated curves, the light inks rise steeply from 0% and then smoothly decrease at the point where the dark inks start. In this example the light inks continue to print up to around 55-65%. This is to avoid a noticeable switch between the light and dark ink, but may need adjusting by advanced users, depending on the media, ink and resolution combination.

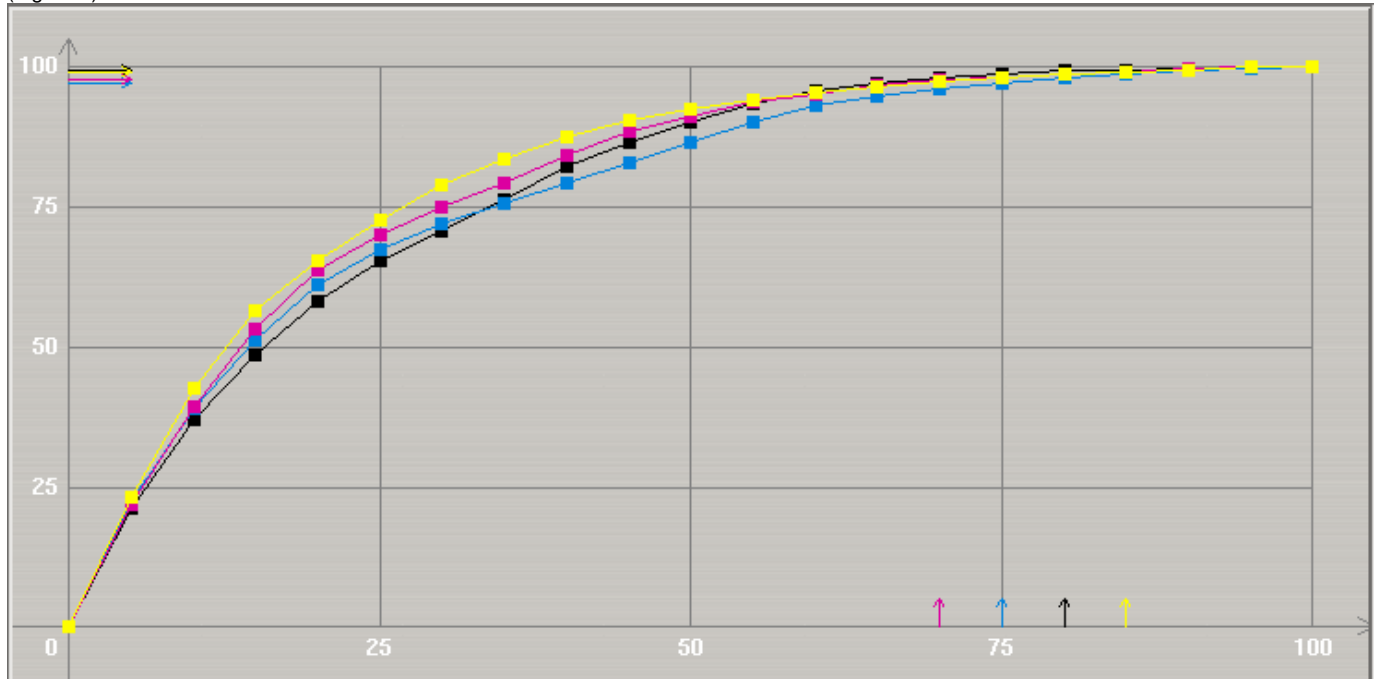
## Step 2 (Ink limit per channel)

After settling on an optimum set of transition curves, the ink limit per channel needs to be defined and will vary considerably between different types of media at different resolutions.

This is done by printing and measuring a gradation of the printers primary colours, (for example CMYK) using both light and dark ink formulations defined by the transition curves.

The result of the initial measurement is shown in Fig.2 below.

(Figure 2)



The CMYK curves above are quite typical and demonstrate how nonlinear the printer is on this media. You can also see how above about 70-75%, the curves start to plateau.

It is around this point that the ink limit per channel needs to be defined, as printing up to 100% for each channel on this media will only waste ink, cause over inking problems and or result in poor graduations.

In previous years, this whole process was density based, which had limitations. Now that most software supports spectrophotometers, the analysis is done on spectral values and takes into consideration LCH (Luminance, Chroma and Hue), rather than density alone.

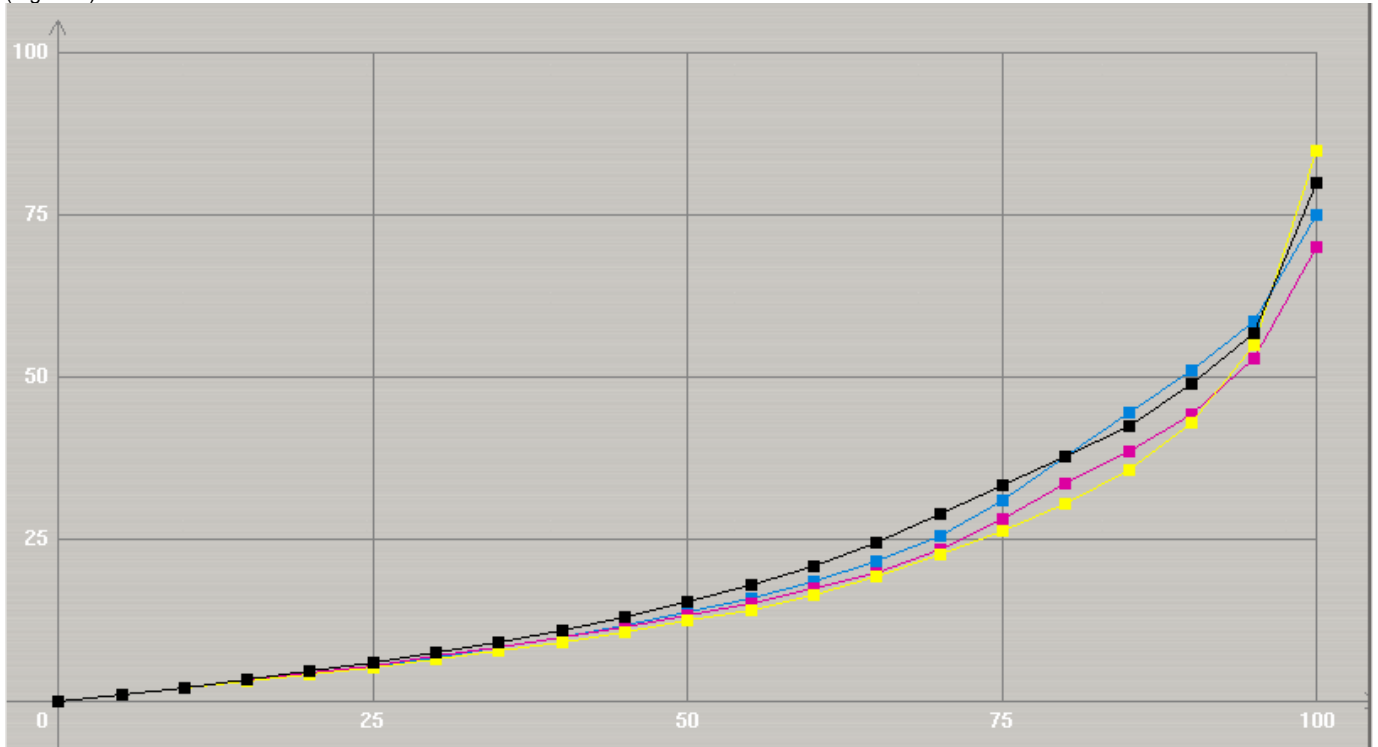
You can find that even though the density of an ink peaks at a level way below 100%, the chroma (saturation) may continue to increase and by capping the ink based on the peak chroma value, you will make better use of the colour gamut in this region. The capping of the black ink however, is normally capped based on its luminance.

### Step 3 (Linearization curves)

After defining the optimum ink limit per channel, these percentages become the new 100% values of each channel and another CMYK graduation target is printed and measured.

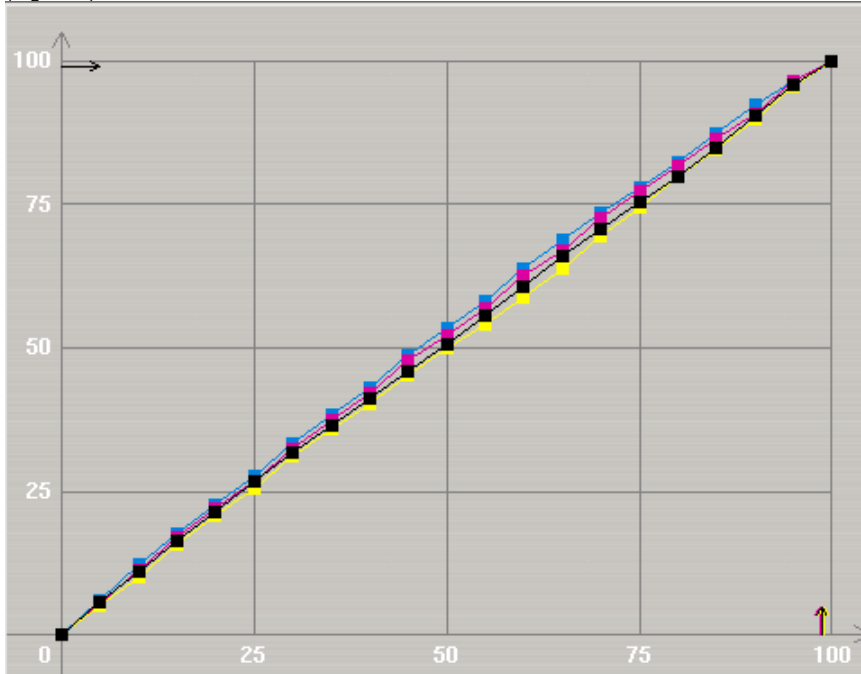
Fig.3 below shows the results of the measurement and the compensation curve calculated to make the output of each channel linear.

(Figure 3)



To demonstrate how linear the output is now, fig.4 below is a measurement taken from the same CMYK graduation printed using the transition and linearization curves.

(Figure 4)



As you can see, the result of the linearization process has been a success and the output is now a nice smooth gradation from 0-100%.

The next steps (not covered in this document) would be to calculate the overall total ink limit before printing a colour profile target for the creation of an ICC profile if required.

## Conclusion

There are many factors which effect how linear the output from a printer is and although it can be time consuming, it is important that each combination of printer, media and quality mode has its own linearization, if you require the best output from your printer.

Even if you have two printers of the same model, each one will need custom linearizations to achieve the optimum results. Also if a print head is changed on a printer after creating a linearization, it will more than likely need re-linearization, to compensate for differences between print heads.

Another factor to consider is print head ware, as over time, the output from a print head will change. Most high end RIP solutions have a quick re-linearization process, so that you don't have to start from scratch, saving precious down time.

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