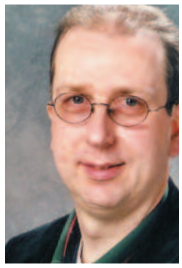
MR STREEFLAND HAS WORKED IN THE CORRUGATED INDUSTRY SINCE 1992. DURING THAT TIME, HE HAS BEEN TECHNOLOGY DEVELOPMENT MANAGER FOR SCA PACKAGING AS WELL AS TECHNICAL MANAGER AT STORK SCREENS. HE STARTED TECHNOLOGY COACHING BVBA IN FEBRUARY 2005.



THE REPRO PARADOX

THIS ARTICLE QUESTIONS 'IF MORE IS BETTER' WHEN IT COMES TO SCREEN RULING AND MORE SPECIFICALLY, SCREEN RULING IN ARTWORK.

The print industry often refers to offset printing and the 'holy grail' of high screen ruling images. Yes, you need high screen ruling if you want to print fine detail in an image, but at the same time this also has negative side effects.

Print quality is measured by how close the printed image is to the original artwork from which the printing plates were made. The process of creating a printed image involves fixing the values of a number of variables. The values chosen determine how close to perfection the printed image is — ie its quality. The customer and supplier come to an agreement as to the acceptable quality and the supplier then applies his skill and expertise to achieve this in a commercially sensible manner.

At this stage, the values of the variables are set — including dot size (dpi) and screen ruling (lpi). The paradox — the subject of this article — being the assumption that the quality improves with increasing screen ruling. So, look in more detail at what happens in pre-press.

We all know that we have a raw image. That image can be converted in halftone by separating it into basic colours (yellow, magenta, cyan and black) and setting a screen ruling (positioned at different angles, but this is not what the article is about). We can explain the colour separation process as applying a grid to the image based on the screen ruling selected. In the individual cells of the grid, the colour is averaged and split into the four basic colours. Depending on how much colour density of each of the basic colours is needed to reproduce the desired colour, the dot sizes for the basic colours in the cell are calculated. We aim for a circular shaped dot. This can be positive or negative.

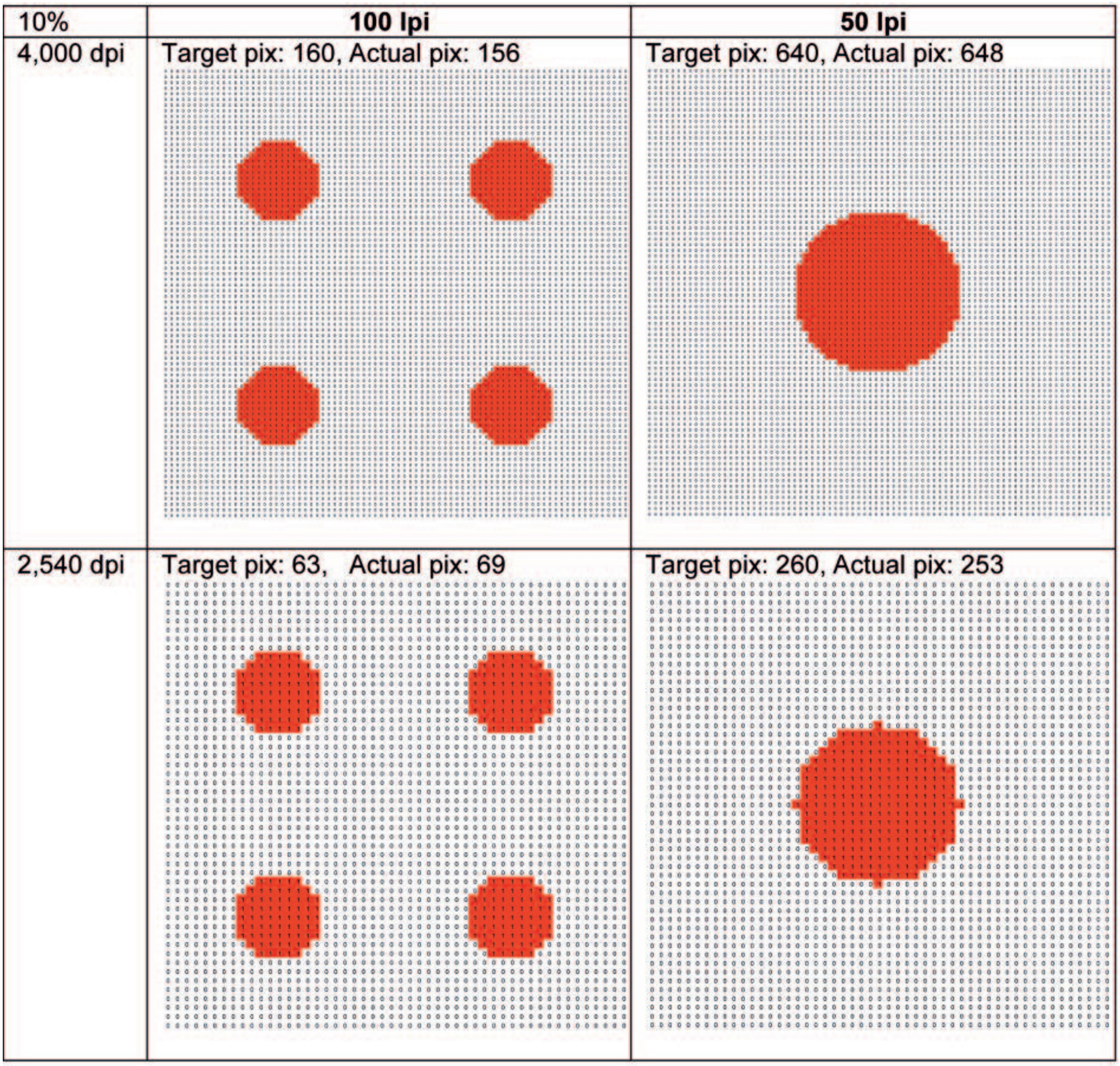
A different approach would be to convert the RGB value of each individual pixel of the original image to YMCK and apply a grid and determine the required density for the YMCK colours in the individual cells, after which we calculate the dot size.

The two approaches will offer a different result due to the different method of rounding and averaging the colour. This again is not what the article is about.

The next step is that all the dot sizes in the gird have to be imaged on printing plates or films — and it is here that we have to apply the screen of the imaging system. This process is commonly referred to as producing the 'rip' file. Every halftone dot will be imaged using the resolution of the equipment producing the film or plate. This resolution is expressed in dpi (Dots per Inch). This is the same expression as used for the resolution of your original

BUT WHAT ABOUT THIS PARADOX BETWEEN PRINT QUALITY AND HIGH SCREEN RULING?

image. It might start to sound confusing! There is, however, one difference — we only talk about 1 colour in the rip file (single colour bit map). When we talk about the resolution of a still camera or scanner it is always the 3 colours RGB (Red, Green and Blue).



The Problem

So where is the paradox? Let's look at the consequence of increasing the halftone line count and the number of pixels available (the resolution of the image setting system) to produce a dot. We will do this using two options for setting the resolution of the imaging device (4,000 dpi and 2,540 dpi) and then for two screen rulings (100 lines per inch [40 Lines/cm] and 50 lines per inch [20 Lines/cm]). We aim to produce a circular dot. To show how the dots are made-up using pixels, I built a simulation for creating dots in Excel, which gave me the full flexibility in choosing coverage and screen ruling. This is how a 10 per cent coverage dot would look for the different settings. Every Excel cell represents 1 pixel.

Four dots are shown for the 100 lpi screen because I would like to show that they have the same total area as 1 dot at 50 lpi. Note that you can compare the number of pixels for 100 lpi with 50 lpi by multiplying the 100 lpi pixels value by four. The resolution difference between 4,000 dpi and 2,540 dpi is also clearly visible.

The dots produced at 4,000 dpi have a 'sharper' edge but it is also clear that the 50 lpi dots have a sharper edge relative to the 100 lpi.

The difference in the actual number of pixels used for making the dot and the actual number of pixels is due to a rounding error. In my calculations, I use the standard equation for a circle. The algorithm based on the standard circle equation decides if a pixel is part of the circle representing the dot or not. This is based on how big the pixel contribution is to the dot. You could write an algorithm that builds the dot of the centre of the circle, following a spiral path. This option would require more computing power or more time. The result would be that you stop when you have reached the target number of pixels needed. Thus the area the pixels represent is the same as the area of the dot. It does highlight the bottlenecks and difficulties of writing the software to make a rip file for the CDI or film setter.

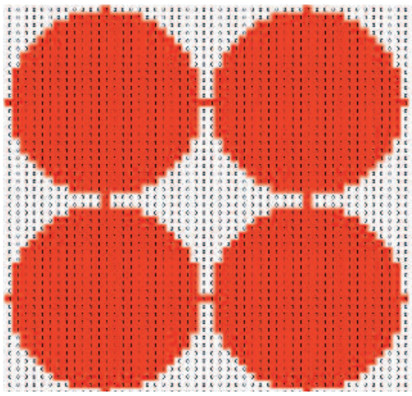
This is not a big problem when we only produce small images e.g. for labels on a bottle. The file size is relatively small, even when we process it at high resolution and apply complicated algorithms. But if it is a corrugated box, it goes out of proportion. That's why flexo print plates for the corrugated industry are mostly produced using 2,540 dpi on the CDI and no additional algorithms are used to optimise the dot shape.

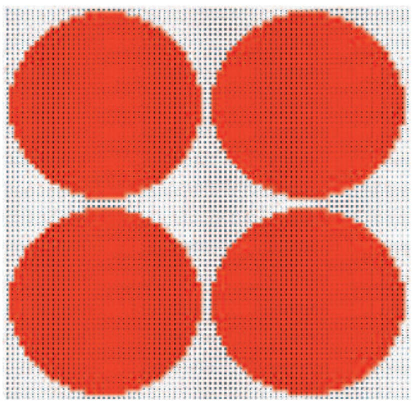
It could be argued that it is not the flexo print process that is the limiting factor for printing perfect high screen images on a corrugated box. For the moment, we see clear limitations in generating sharp edge dots on the printing plate when using a high screen count and low resolution (2,540 dpi) rip file. But at the same time, we can ask ourselves if 4,000 dpi is really high enough in general when producing images of 100 LPI. Also, at 4,000 dpi, we see that rounding errors for generating a dot in the rip file are likely to happen.

The 'Repro paradox' is now complete. When we increase the line count of the repro and claim this is better, we have at the same time introduced a limitation in shaping dots with sharp edges due to the number of pixels available to do so — because of the limits of the CDI imaging system. Therefore, we force ourselves to print with dots that have lower edge resolution when increasing the line count.

What's the result?

'Un-sharp' dot edges are likely to collect ink and start the process of filling in. This is applicable for positive and negative dots. It's not unusual to see the start of filling in at a 70 per cent coverage area. The simulation of this dot size using 2,540 dpi for a 100 LPI screen shows why.





This is how it would look at 4,000 dpi for 70% and 100 LPI.

It's easy to imagine that ink might start building up between the narrow channels separating the dots. Therefore, the changeover from positive to negative dots is in the 70 per cent area from this point onwards — producing a 'star' shaped negative dot. In the corners of the 'star' the ink is likely to build-up.

You could decide to make the change over from positive to negative at 50 per cent coverage, however that would result in square dots for the 50 per cent area. This is not what we want.

Reversed, you could make the change over at 30 per cent, but that would result in 'star' shaped positive dots. In addition, on these dots it is likely that ink will build up. These dots will also be deformed, due to the washing of the plate after exposure.

The better solution would be to develop algorithms that would decide whether it is better to use the 30 per cent or 70 per cent coverage changeover from positive to negative so that we have circular dots. This again would require more computing power.

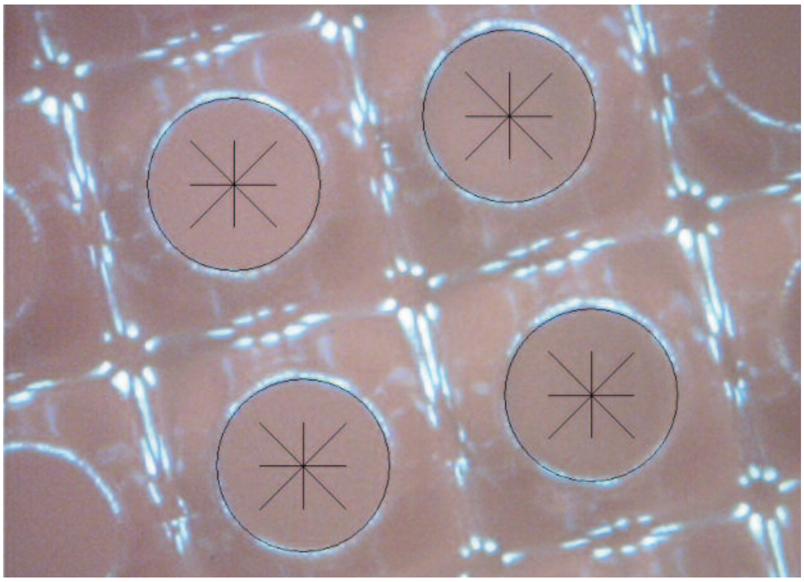
What all this tells us is that if we increase the line count, we must be able to print smaller dots to get the same contrast. To be able to reproduce smaller dots on the printing plate, we need a higher resolution of the CDI. 4,000 dpi for digital plates is currently state of the art, but is it high enough for 100 lpi?

We also have to understand that not changing anything other than the line count in the image means that higher line count will result in lower contrast. How does this work in practice?

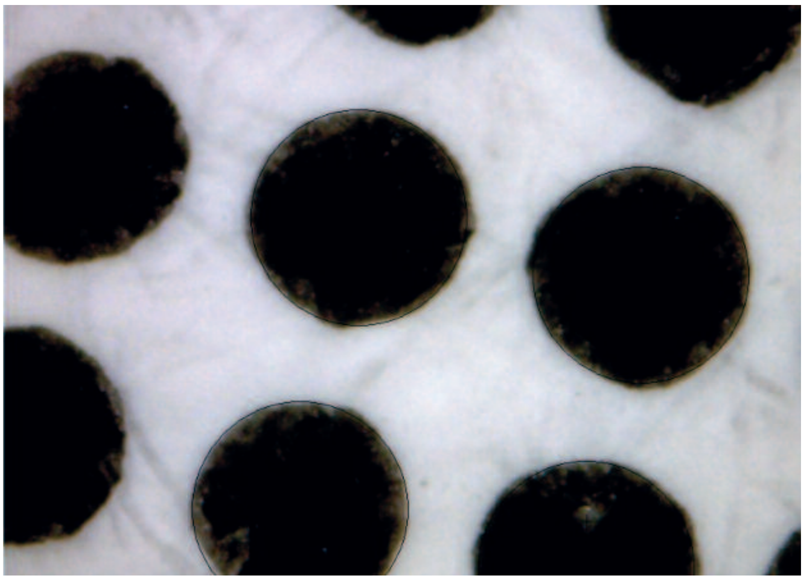
- Short viewing distance: Contrast can be low — the human eye is sensitive enough to compensate, but resolution needs to be high. We use a high line count.
- Far viewing distance: Contrast must be high, but resolution can be low. We can't see it anyhow, due to the limitations of the human eye. So we use a low line count.

This guideline already indicates that line count in the image is not a measure for quality. Edge sharpness is! But what can repro houses and printers do better?

Wouldn't it be good to check the actual dot size on the print plate supplied? Surely we must be able to produce the dot size and check if it's what we want? Let's look at a practical example. The positive dot diameter for 40 per cent coverage at 100 LPI is 178 µm. We developed a tool that allows for accurate measuring and systematic recording of: coverage, line count and dot diameter for the different steps in the plate making and printing process. This is a screen shot of a print plate check.
The actual dot diameter measured in the image is: 153 µm



The next image shows the printed dot size using the same plate.



IF WE WANT TO GET CONTROL OVER THE PRINT PROCESS, THEN WE NEED TO BE ABLE TO PREDICT ACCURATELY THE DOT DIAMETER WE WANT TO PRINT.

The measured dot diameter is 201 µm.

All these results are based on using common practise for making plates and printing. But, if we want to get control over the print process, then we need to be able to predict accurately the dot diameter we want to print. We first need to learn how to make print plates were the dot diameter on the plate is the same as the one we chose in the artwork. Second we need to know how to change the dot size on the printing plate so we print the dot size as needed in the artwork. It means we implement two correction curves:

1. The correction curve for the plate making process, (which is linked to plate material, relief depth and processing of the photopolymer plate);
2. The print process correction curve related to substrate, ink, screen roll and pressure settings.

Following this working procedure, it will allow us to measure if:

1. The print plate is manufactured correctly;
2. The print process set-up is correct.

This working method will also significantly reduce the number of correction curves used for making printing plates (most likely by a factor of four!).

We measure the 'mechanical' dot size not using a densitometer, but using images taken with a microscope. So, colour needs to be independently measured in full tone using a Spectrophotometer and off we go — run a job allowing monitoring the individual 'dot' settings, colour and size, without them being interdependent.

This might just be the logical way forward to supply the required quality print. ■

Wilbert Streefland can be contacted at: wilbert@tcbvba.be