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The repro paradox

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This article discusses whether more is better. The author is talking about screen rulings and more specifically, screen rulings in artwork. The print industry always refers to offset printing and their holy grail of high screen ruling in images. Yes, one needs a high screen ruling if one wants to print fine details 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 forms 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, i.e. its quality.

The customer and supplier normally agree on an acceptable quality level and the supplier then applies his skill and expertise to achieve this in a commercially sensible way. At this stage the values of the variables are set, including dot size (dpi) and screen ruling (lpi). The paradox is, the subject of this article, the assumption that quality improves with increasing screen ruling.

But what about this paradox between print quality and high screen ruling? This article will look in more detail at what happens in prepress.

We all know that we have a raw image. That image can be converted into halftones by separating it into basic printing colours (Yellow, Magenta, Cyan and Black) and setting a screen ruling (each colour be 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 is calculated. The aim is a circular shape dot. This can be positive or negative.

A different approach would be to convert the RGB (Red, Green, Blue) value of each individual pixel of the original image to YMCK and next apply a grid and determine the required density for the YMCK colours in the individual cells after which the dot size is calculated.

The two approaches will give a different result due to a different way 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 grid have to be imaged onto printing formes 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. Thus every halftone dot will be imaged using the resolution of the equipment producing the film or forme. This resolution is expressed in dpi (dots per inch). This is the same expression which is used for the resolution of the original image.

It might start to sound confusing. There is however one difference, we only talk about one 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 three colours RGB (Red, Green and Blue).

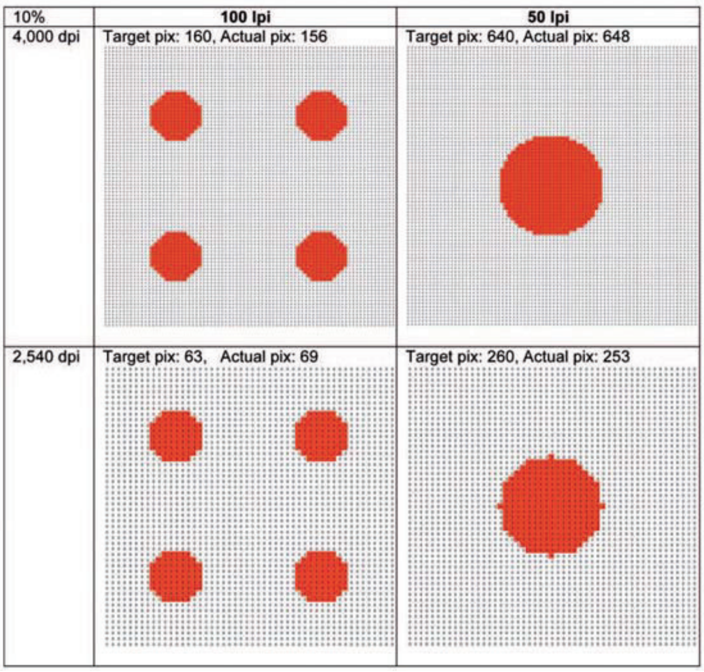

***Figure 1:* This is how a 10% coverage dot would look for the different settings. Every excel cell represents one pixel.**

***Figure 2:* The simulation of this dot size using 2540 dpi for a 100 lpi screen shows why.**

The problem

So where is the paradox? Let us 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. This will be done by using two options for setting the resolution of the imaging device 4000 dpi and 2540 dpi and then for two screen ruling 100 lpi (40 l/cm) and 50 lpi (20 l/cm). The aim is to produce a circular dot. To show how the dots are made-up using pixels the author has built a simulation for creating dots in excel which provides full flexibility in choosing coverage and screen ruling.

Four dots are shown for the 100 lpi screen because the author wishes to show that the four dots at 100 lpi

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have the same total area as one dot at 50 lpi. Note that the number of pixels for 100 lpi with 50 lpi can be compared by multiplying the 100 lpi pixels value by four. The resolution difference between 4000 dpi and 2540 dpi is also clearly visible.

The dots produced at 4000 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 used number of pixels is due to a rounding error. In his calculations the author used 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. An algorithm could also be written 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 to stop when the target number of pixels needed is reached. Thus the area the pixels represent is the same as the area of the dot. It does highlight the bottlenecks and difficulties for writing the software to make a RIP file for the laser imager for plates or a film setter.

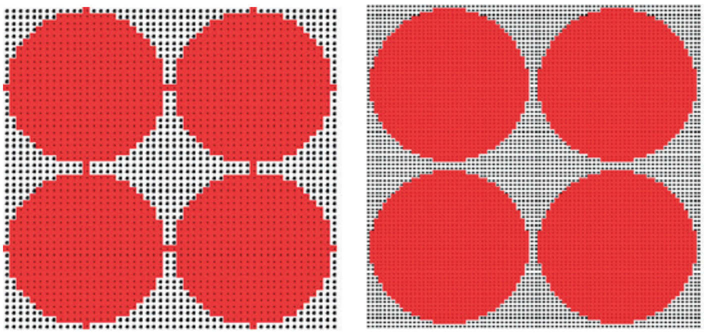


Figure 3: This is how it would look at 4000 dpi for 70% and 100 lpi.

All of this is not a big problem when only small images are produced e.g. for labels on a bottle. The file size is relatively small even when processed at high resolutions and apply complicated algorithms. But if it is a corrugated box it all goes out of proportion. That is why flexo printing formes for the corrugated industry are mostly produced using 2540 dpi on the laser imager and no additional algorithms are used to optimise the dot shape.

It might thus not be the flexo print process which is the limiting factor for printing perfect high-screen images on a corrugated box. For the moment one sees clear limitations in generating sharp edge dots on the printing forme when using a high screen count and low resolution (2540 dpi) RIP file.

But at the same time we can ask: is 4000 dpi really high enough in general, when producing images of 100 lpi. Also at 4000 dpi rounding errors for generating a dot in the RIP file are likely to happen.

The »repro paradox« is now complete. When the line count in the repro is increased and the claim that 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 because of the limits of the plate imaging system. Thus we are forced to print with dots that have lower edge resolution when increasing the line count.

What can be the result of this?

Unsharp dot edges are likely to collect ink and start the process of filling in which is true for positive and negative dots.

It is not unusual that we start to see filling in at a 70% coverage area.

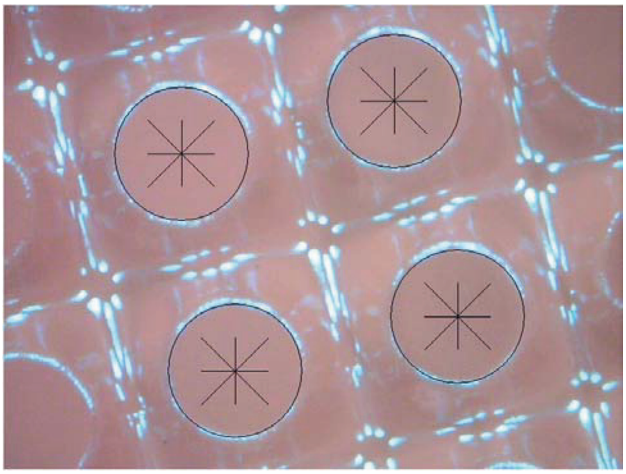
It is easy to imagine that ink might start building up between the narrow channels separating the dots. Note that this is the way most dots are generated. Thus the changeover from positive to negative dots is in the 70% area from this point onwards one gets a »star« shaped negative dot. In the corners of the »star« the ink is likely to build-up.

One could decide to make the change from positive to negative at 50% coverage. However, that would result in square dots for the 50% area. This is also not what is required.

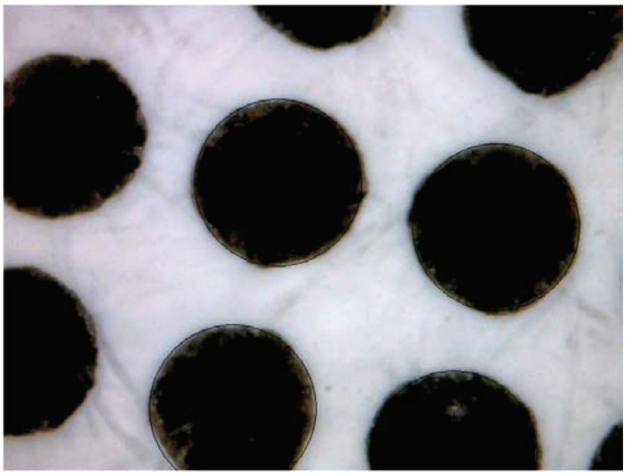
On the other hand the change-over could be made at 30%, but that would result in »star« shape positive dots. Again there is the likelihood that ink will build up on these dots. These dots will also be deformed due to the washing out of the print forme after exposure.

The better solution would be to develop algorithms that would decide whether it is better to use the 30% or 70% coverage changeover from positive to negative so that circular dots are produced. 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 print forme we need a higher resolution of the



The actual dot diameter measured in the image is 153 micron.



This image shows the printed dot size using the same forme. The measured dot diameter is 201 micron.

laser imager for plates. 4000 dpi is, for digital formes, currently state of the art but is it high enough for 100 lpi?

We also have to understand that by not changing anything other than the line count in the image means that higher line count will result in lower contrast.

How can this be seen in practice?

- *Close viewing distance*: Contrast can be low, the human eye is sensitive enough to compensate, but resolution needs to be high. A high line count should be used.
- *Distant viewing*: Contrast must be high but resolution can be low. We cannot see it due to the limitations of the human eye. So a low line count is used.

These guidelines already indicate that line count in the image is not a measure of quality. Edge sharpness is!

But what can repro houses and printers do better?

Would it not be good to check the actual dot size on the print forme supplied? Is it not a must that we are able to produce the dot size and check if it is what we wanted?

Let us look at a practical example. The positive dot diameter for 40% coverage in 100 lpi is 178 micron.

A tool has been developed that allows accurate measuring and systematic recording of: coverage, line count and dot diameter for the different steps in the forme making and printing process. This is a screen shot of a print forme check.

All these results are based on using common practice for making formes and printing.

But really, if we want to take control of the print process we then need to be able to predict accurately the dot diameter we want to print.

We first need to learn how to make print formes where the dot diameter on the forme is the same as that chosen for the artwork.

Second, we need to know how to change the dot size on the printing forme so we print the dot size as needed in the artwork.

This means that we implement two correction curves:

- The correction curve for the formemaking process which is linked to forme material, relief depth and processing of the photopolymer forme.
- 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:

- The print forme is manufactured correctly.
- The print process set-up is correct.

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

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

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