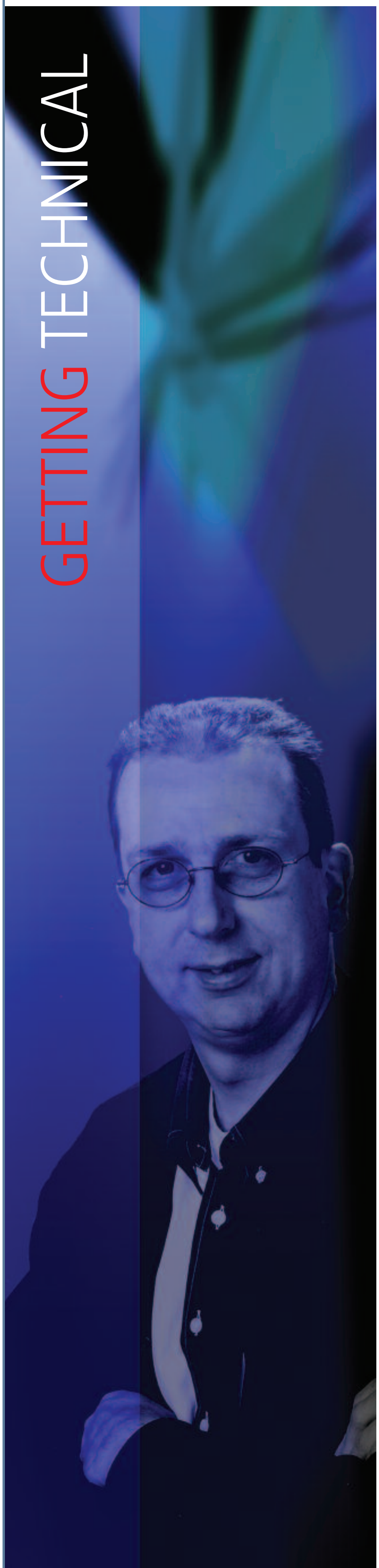

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THE REAL SOURCE OF DOT GAIN?

The Problem

I came across the following images when preparing a print training session for a customer.

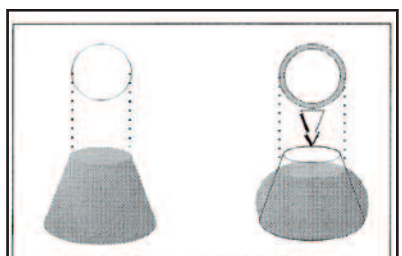
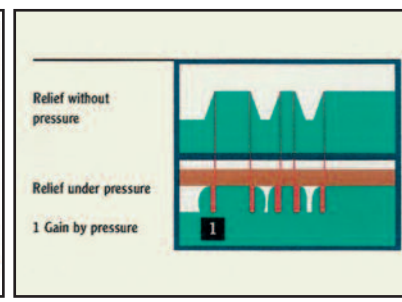


fig 1. Dot enlargement on plate



The images show that dot gain in print can be linked to the deformation of the dot on a plate during printing. This is what's commonly believed — but is it true? I'm sceptical about this being the sole reason for dot gain. Yes, it's likely that the dot on a plate deforms as it's put under stress, but is this deformation enough to explain the dot gain in a printed image?

Why would the dot on a plate deform as shown above when corrugated board is likely to deform far more easily than the plate, especially as the plate is usually mounted on a foam backing.

And then you need to ask, is the volume of the dot constant when it deforms? The fact is that the increase in diameter due to the compression of a dot (as shown in the image) is not equivalent to dot gain we see in print. So how can we establish the true source of dot gain?

The Test

During last year, I was asked by a customer if I could measure the glue consumption on a flexo folder gluer. I developed a system that measures the actual glue consumption independently and provides a value for glue consumed per box. The system worked that well that I also used it for measuring ink consumption during printing. Again, success — although it showed more than just ink consumption. It also showed the start-up affects on ink circulation and how much ink is really in circulation. The ink transfer measured is completely different to what the industry generally thinks.

The first comment you get when measuring inline ink consumption is that it's not possible. People give a thousand reasons why it can't be done.

However, a measuring method should not be criticised before it has been tested. A measuring method can only be considered to have failed if after testing it provides no logical answer.

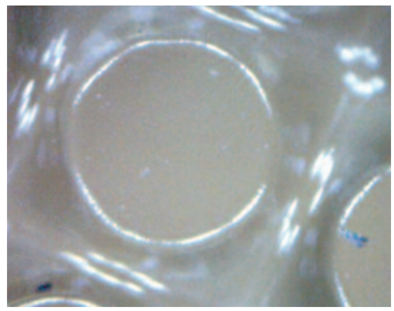
Before testing the system on a machine, I checked the reading speed and accuracy. No problems up to 55,000 sheets per hour. Faster than that I was not able to test — however, according to specifications of the hardware used it will work up to 300,000 sheets per hour. The accuracy is achieved using rather complicated maths and collecting a large amount of readings. So, the lower the ink transfer, the higher the number of readings needed for an accurate ink/glue transfer value. For glue consumption, this is around 1,000 products. For ink, around 500 depending on the start-up effect.

I tested the ink transfer measuring system using different full tone area sizes. The ink consumption data collected correlated well with the change in full tone area when using the same paper, screen roll and ink. After that, I started to do more controlled tests. One of them was comparing full tone print and halftone print. (Note that I use metric dimensions for the test results.) The comparison of full tone and halftone started with printing a full tone area of 0.4488 sqm and measuring ink consumption. Next, I changed the plate and printed a halftone area of 0.17952 sqm. (You calculated right — it's a 40 per cent coverage.) The halftone area had a line count of 22 l/cm. All printing was done on the same Whitetop Kraftliner using the same screen roll and ink. Machine settings were also stable. So let's look at what was found.

The result

Remember that I will only quote two values for ink transfer, but it's based on a large amount of data collected. The ink transfer measured was:

- Full tone area =1.739 g/sheet
- Halftone area = 1.287 g/sheet



Coverage print plate: 38.8 per cent

The results look logical, as the value for the halftone area is lower. This value can be normalised and transformed in to a wet ink film layer using the ink density (kg/dm^3) and the printing area on the plate.

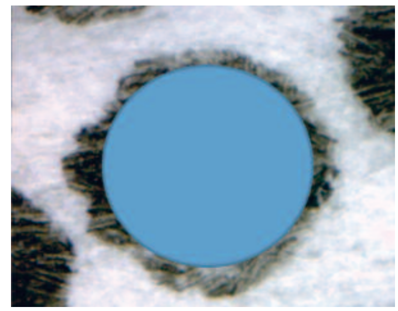
The following values were calculated for the wet ink film transferred:

- Full tone area = 3.600 µm
- Halftone area = 6.867 µm

We see that the relative ink transfer of the printing area is much higher for the halftone area — one might have assumed that they needed to be similar. Even so, this value is still logical, as the wet ink film available on the screen roll was 11.7 µm. It should be noted that only 30.8 per cent of the available ink is transferred to the paper for the full tone area but is 58.7 per cent for the halftone area.

A MEASURING METHOD CAN ONLY BE CONSIDERED TO HAVE FAILED AFTER TESTING THE DATA PROVIDED RESULTING IN NO LOGICAL ANSWER.

Let's now look at the printed result to see what these ink transfer results tell us. The following images show the halftone dot on the plate and the printed halftone dot.

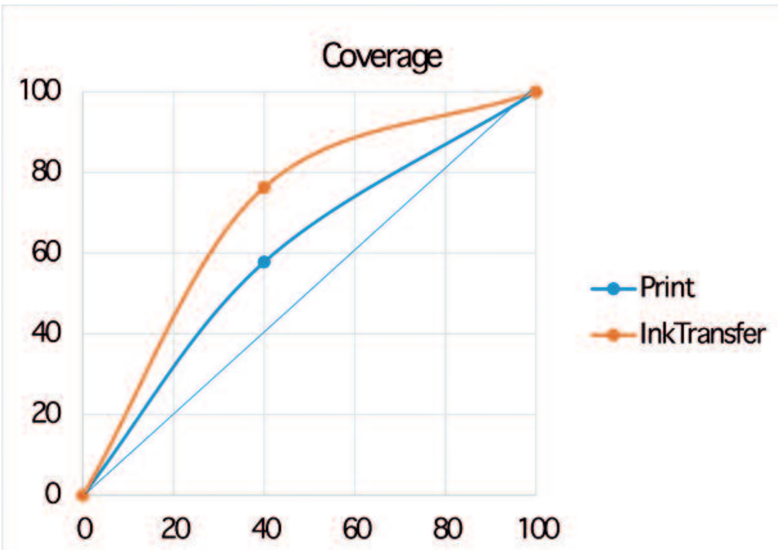


Coverage printed: 57.8 per cent

I measured the actual dot size on the plate and calculated the coverage the same way in which I analysed the print. The measured 38.8 per cent on the plate is very close to the target of 40 per cent. It showed that the measuring procedure for coverage is acceptable. Using the same method for the dots in print gave a value of 57.8 per cent. (Using image analysis resulted in a value of 54.4 per cent — only minor differences.) I have also put a circle, representing the size of the dot, on the plate over the printed dot to give you an idea of the gain.

It is also possible to calculate coverage for the halftone area based on the ink transfer values measured for the full tone and halftone area. We can do this if we assume that the wet ink film thickness is identical when printing full tone and halftone. This would result in a predicted halftone coverage of 76.3 per cent! At this coverage, the printed dots would 'melt' together and you would only see 'negative' dots as unprinted areas.

The graph below shows the coverage curve based on the printed dot size and the coverage predicted using the ink transfer data.



higher when printing a dot than a full tone area. This is supported by the visual 'donut' shape dot when printing on coated liner. The ink is squeezed to the sides of the dot.

Is what we see logical? To some extent, yes, as we know what happens when printing on coated liner — dot gain is larger for coated liner than uncoated liner when using the same settings (screen roll, ink and plate). This can mostly be observed from printed results. But, if you do controlled ink transfer tests then it will show that when using the same ink, screen roll and full tone plate, less ink is transferred when printing on coated liner than when printing on uncoated liner — and we record more dot gain for coated liners.

It is therefore still likely that the ink transfer test results are correct. So, when printing halftones, more ink is transferred than expected and most of this ink is not contributing to the dot size but disappears in the paper. Why? Well, one hypothesis could be that the pressure per unit area for a halftone area is higher than for a full tone area. The pressure between paper and print plate applied on the ink when printing is

Conclusion

The tests done give us a new insight into what happens when printing. It also shows that it is likely that dot gain for 99 per cent of the time is linked to the amount of ink transferred. That makes deformation of the dot on the plate unlikely to be the sole source for dot gain. That might sound logical, but what about the impact on ink transfer by the screen roll, paper and ink.

The screen roll dictates how much ink is available for transfer. The engraving will influence the release of ink. But can it influence the ink release difference between full tone and halftone so that more or less ink is realised when printing halftone? This needs more testing. The impact on ink transfer by paper and ink also needs more testing before correct answers can be provided. ■

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