HD Flexo

Size Matters

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1 Introduction

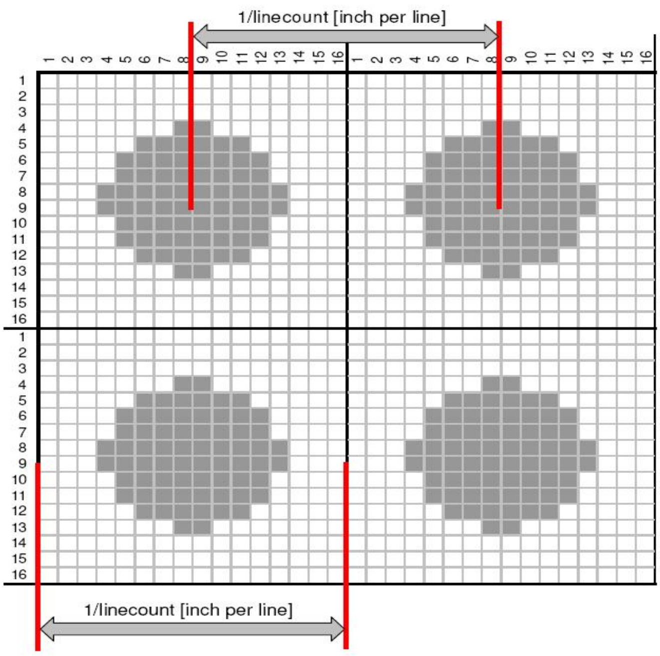
Historically speaking, flexographic printing has had the reputation of being a lower quality printing method when compared to offset and gravure. One reason for this reputation is that coarser screens have traditionally been used due to flexo's printing limitations. Flexo's strength, of course, is its ability to print on a wide range of substrates, including corrugated board and plastics. While we have seen large increases in quality in recent years with the increasing use of digital plate imaging devices, newer screening methods, and improved press technologies, flexo's reputation still suffers from its history.

Recently, EskoArtwork has introduced HD Flexo, a new product designed to reduce the print quality limitations of flexo printing. In production tests, the product has been shown to achieve quality levels that rival traditional offset and gravure printing. So just what is HD Flexo?

HD Flexo is a combination of high-resolution optics with finely tuned screens specifically designed for higher imaging resolutions. The high-resolution optics on the flexo imaging device increases its maximum resolution to 4,000 pixels per inch (ppi). To many, this may seem counterintuitive when considering the historically lower line screens used in the past. Why would increasing the resolution of the imaging device make a difference in the quality of flexo printing?

2 A little history, with a dash of math

To answer this question, we need to understand the relationship between imaging resolution, screening and grey levels. An imaging device exposes a plate or film based on a grid of pixels like a chess board. Every pixel within this grid can be either on (exposed) or off (unexposed); there is no such thing as "half a pixel". By implication, a screen dot can only contain a whole number of pixels. This illustration shows the basic concepts of resolution (the "grid"), pixels and screen dots (courtesy of DuPont):



This leads us right back to the resolution of the imaging device. The most common imaging resolutions used today are 2400 and 2540 ppi. These resolutions have been the accepted standard for more than 20 years;

since the early days of imaging directly to film. And in offset CTP, these are still the accepted standard resolutions. Using these standard resolutions, we can evaluate their impact on screening lines per inch (lpi) and the number of grey levels.

The formula for calculating grey levels is: $(ppi/lpi)^2$. Using 2400 ppi as the resolution, we can calculate the possible grey levels for different screen rulings.

$(2400\ ppi/133\ lpi)^2$ = 324 grey levels

$(2400\ ppi/150\ lpi)^2$ = 256 grey levels

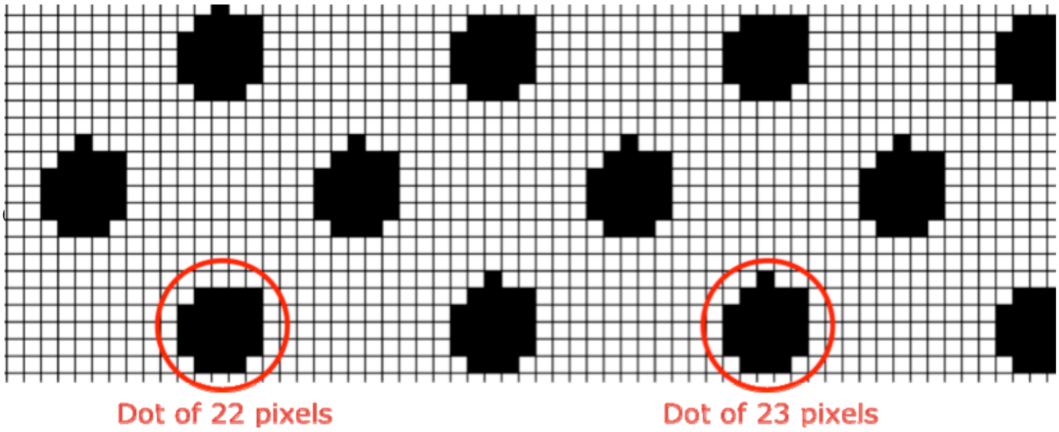
$(2400\ ppi/200\ lpi)^2$ = 144 grey levels

This formula makes it clear that the number of pixels that compose a screen dot has a direct relationship to the number of grey levels that are achievable. For the best possible image, we want to realize all 256 grey levels possible from the front-end software systems. If we want to support all possible grey levels, each dot must be composed of at least 16 x 16 pixels. When imaging at 2400 ppi, these calculations show that 150 lpi is the maximum screen ruling that can be used if we want to image all the available grey levels.

While these calculations seem straightforward, they do ignore an important fact about screening technology: they are based on *single cell screening*. Newer screening technologies introduced in the early 1990's by a variety of imaging device vendors are based on *Supercell screening*. Supercell screening is commonly used today and does complicate our evaluation slightly. As you might expect, Supercell screening also has a relationship between imaging resolution, screen lpi and grey levels.

3 What about Supercell screening?

Supercell screening uses "averaging" or "dithering" to distribute extra pixels to a digital screen dot. This means that a higher screen ruling can be used than with single cell screening while still achieving a high number of grey levels. A look at a few examples helps to illustrate the effect of Supercell screening.

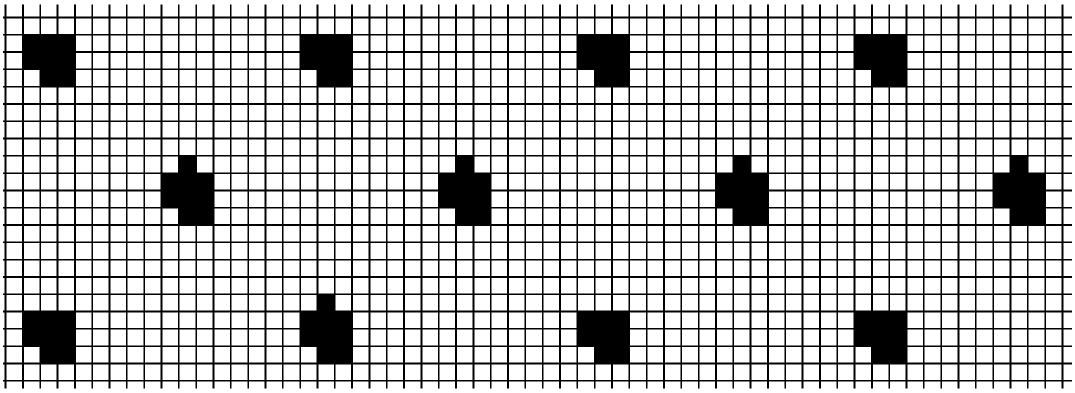


Some of the dots in this screen contain 22 pixels while others contain 23. This mixture of 22 and 23 pixel dots dithered over the screen results in an average of 22.5 pixels. Supercell screening works just fine with these larger dot sizes; after all, there's not much difference between a 22 and a 23 pixel dot. And because the dots are still relatively smooth and round, we don't expect that there would be any issues with printability.

But how does Supercell screening perform with smaller dots? This is an important question for flexo printing since the flexo's major limitations lie in highlight areas; that is, when imaging and printing smaller dots. You've likely seen these limitations in light tonal areas, which are either muddy or nonexistent, or the harsh breaks in vignettes that approach 0%. These problems with highlight areas have traditionally given flexo printing the reputation of poor quality.

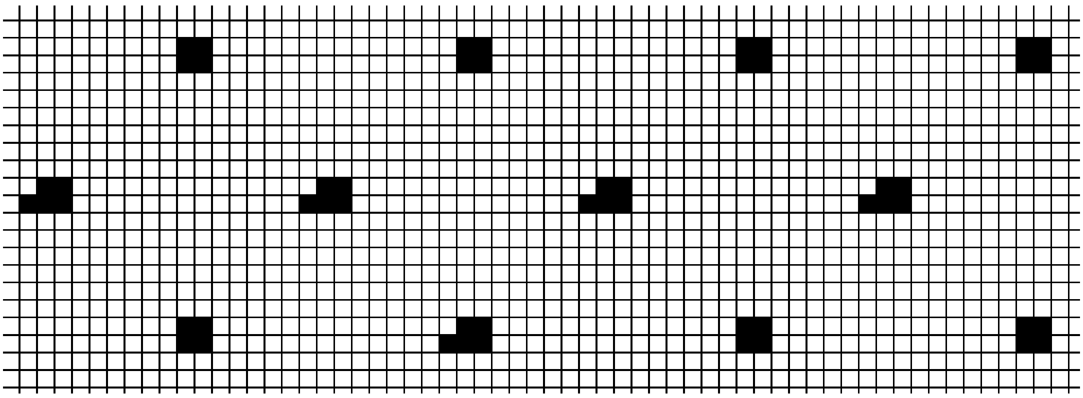
But there's more to it than just quality. Flexo tradeshops and printers spend extra time "massaging" the prepress files to try to overcome these limitations. Furthermore, the creativity of graphic designers to create stunning packaging is also limited. If only we could overcome these limitations in highlight areas. Does Supercell screening have an impact?

Consider this screen of an 7% dot, at 212 lpi and imaged at 2400 ppi:



In this screen, the dots are composed of a mixture of 8 and 9 pixels. Notice that some of the dot shapes are jagged and "lumpy" instead of smooth and round.

Now consider this screen of a 3.5% dot, at 212 lpi and imaged at 2400 ppi:



This dot size requires a mixture of 4 and 5 pixel dots. While all RIPs have clever algorithms to distribute or dither the pixels, a dot size this small is always going to be jagged and lumpy, not round and smooth as we would like. And with some plate making processes, these *jagged dot shapes are transferred to the plate*. These jagged dot shapes will likely have little effect on a "2-dimensional" plate with a nearly smooth surface as in offset. But such a jagged shape can affect printability when they appear on a 3-dimensional polymer plate, like those that are used in flexo.

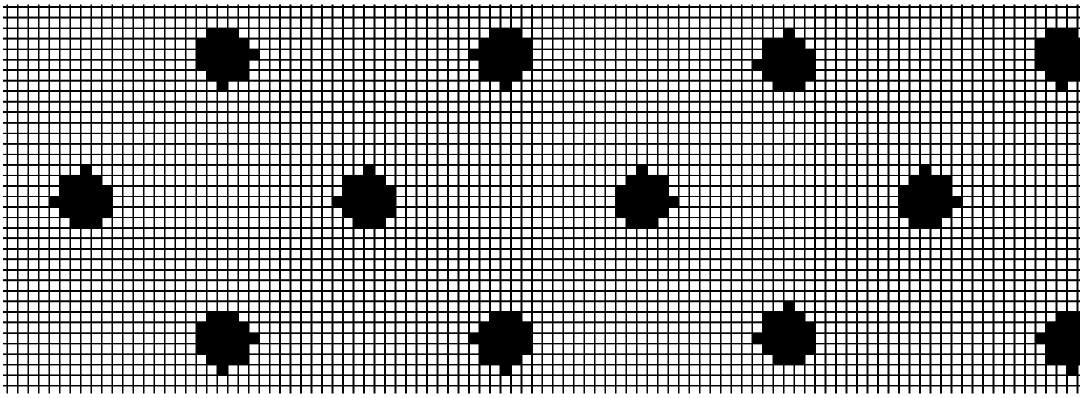
What facts can we conclude from this evaluation?

- When dots are made of a few pixels, they will be jagged and lumpy.
- The jagged corners are weak spots on the dot.
- The jagged corners can collect ink.
- To minimize the jagged corners on the dot, we need more pixels.
- To get more pixels, we need a higher resolution on the imaging device.

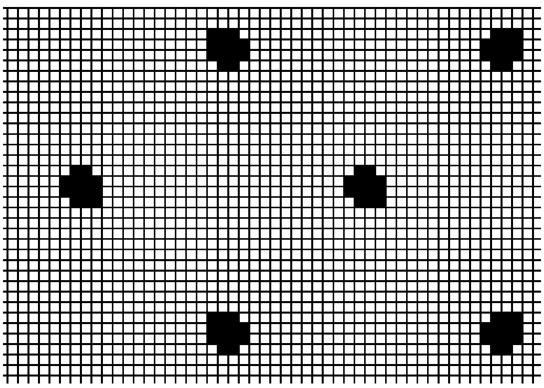
4 High-resolution imaging for flexo (or When size matters)

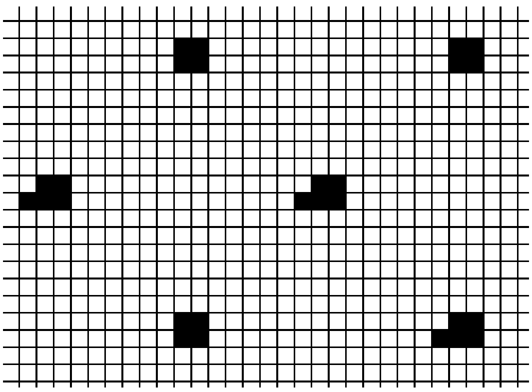
If we increase the resolution of the imaging device as EskoArtwork's HD Flexo proposes, there will be more pixels available to image screen dots. The pixels will clearly be smaller but, in this case, small is good. Let's go back and look at the problematic highlight areas when they are imaged at 4000 ppi.

Consider this screen of the same 7% dot, at 212 lpi but now imaged at 4000 ppi:



It's easy to see the difference if we put both examples next to each other:





5 Other considerations

From the examples above, it seems clear that *in theory* increasing imaging resolution will make a difference on dot shape. But theory is one thing and actual practice is another. One practical consideration is that by increasing the imaging resolution, we also increase the number of bits to be ripped and pixels to be imaged. A quick calculation shows that a 4000 ppi image has 2.8 times as many bits as a 2400 ppi image. Doesn't this affect the speed of the RIP and the imaging device?

Let's go back and look at our history again. In 1995 when the first digital flexo imaging device was launched, a RIP with a 100 MHz Pentium processor was considered “state of the art” technology. And back then, RIP and screening time at 2400 ppi was often a major bottleneck. Today's version of “state of the art” is a RIP with a 3GHz processor with multiple cores. These RIPs are more than *50 times as fast* as the original. So we have 2.8 times the data being processed by a RIP that is 50 times faster. Tests have shown that throughput is not a factor; the RIP can keep up with the imaging device.

So what about the speed of imaging of all that data? Originally, most imaging devices used *single beam imaging* which meant that imaging a full format 42” x 60” plate could take a long time. Today's “state of the art” imaging devices use *multiple beam imaging* with up to 48 beams. 48 beams means that the imaging device is 48 times as fast. Indeed, tests have shown that the high resolution optics used in HD Flexo have an average imaging productivity of 4 square meters per hour at *either 2400 ppi and 4000 ppi*. Therefore, throughput is not a factor at the imaging device either.

The most important consideration should be whether higher resolution imaging actually makes a difference to flexo printing. Tests with live production jobs have indicated that it does make a difference, with measurably increased quality and consistency.

6 Conclusions

We've discovered some interesting facts. One of the most problematic areas affecting the quality of flexo printing is its historical performance in highlight areas where the dots are very small. These small screen dots are composed of a limited number of pixels. Using Supercell screening, this small number of pixels can be dithered to support higher line screens and grey levels.

But Supercell screening (or for that matter, any screening at lower resolutions) still has limitations when it comes to rendering highlight dots. While RIPs do have sophisticated algorithms to effectively distribute the pixels, the hard mathematical fact is that they still have a fixed number of pixels to work with.

Dots with a limited number of pixels will be jagged and can vary in size and shape. It's also true that these jagged shapes will be imaged on the plate with some plate making systems. These jagged corners will cause printing problems, especially at smaller dot sizes. The only way to reduce these corners is with more pixels and therefore higher resolution on the imaging device.

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