E 14009 · Volume 17 · March 2011

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Flexo Gravure Int'l

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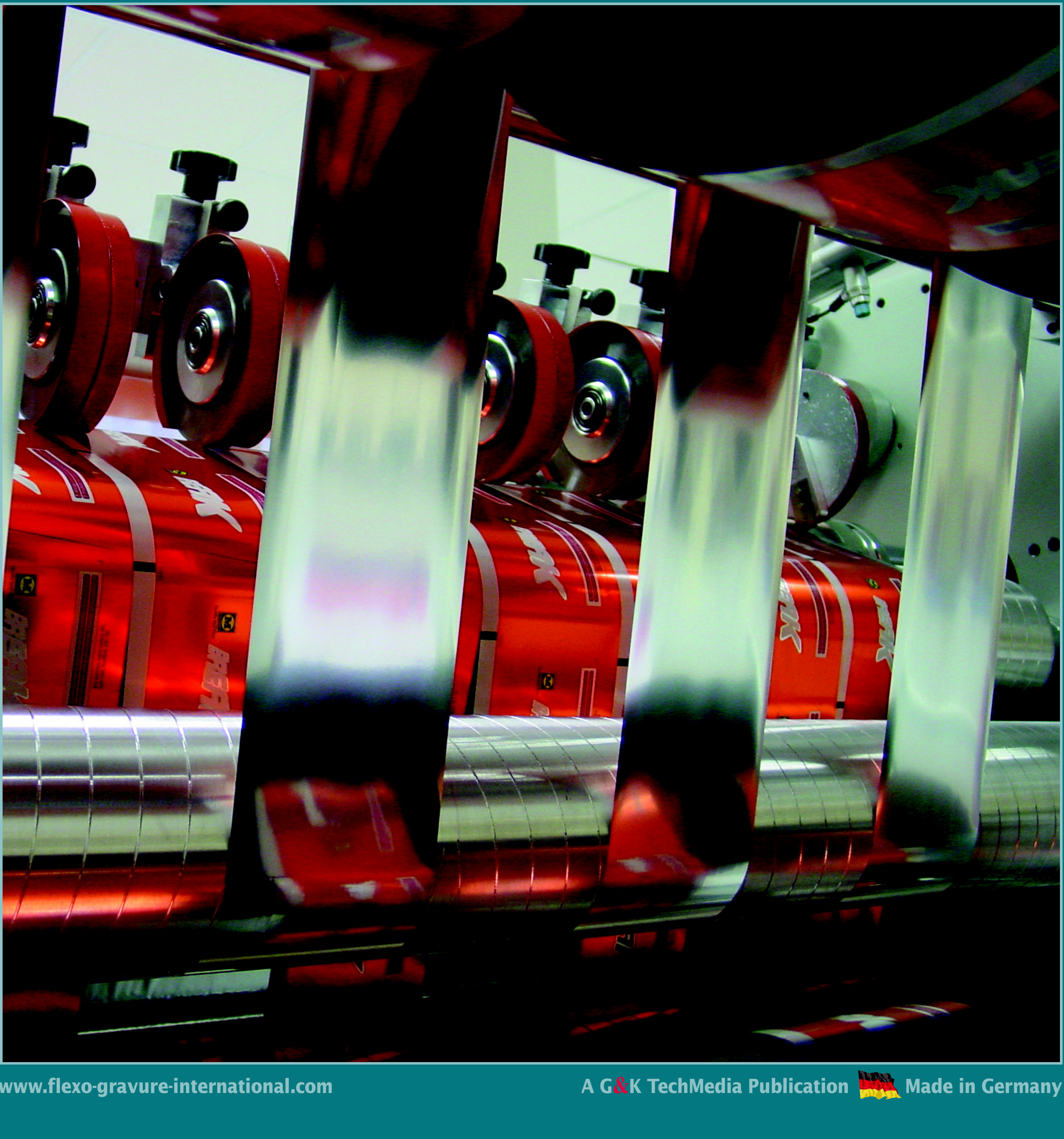

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Best of both worlds

Paul Merkel

The LUX™ platemaking process is a new technology which allows tradeshops and printers to produce dots which incorporate the best elements of both analogue and digital plate technologies, eliminating the trade-offs that the industry has had to accept for the last 15 years.

Flexographic plate technology has improved over time as a result of a continuous stream of improvements. However, there have been a few innovations which could be viewed as discontinuous or revolutionary. The first such change came in the form of photopolymer. Approximately 40 years ago flexo printers were introduced to this technology, sparking the transition from hand cut and moulded rubber to an image carrier that was limited by the image reproduction capabilities of film rather than the handwork of a master craftsman. Turning the clock forward another 25 years or so, the market was introduced to digital photopolymer plates (*figure 1*), which eliminated film and enabled the rapid development of prepress technologies.

Both technologies resulted in a significant, discontinuous step forward for flexo printing. Each change came with significant benefits to be shared with platemakers and printers. However, there were a few concessions that had to be accepted to make these advances. By and large, these compromises were outweighed by the advantages achieved through digital prepress and platemaking efficiency gains. However, recent research has eliminated many of these compromises and may represent the next generation of flexo print capability.

Flexographic printing, like gravure and offset printing, is really a technological trick played on the human eye using dots to represent a continuous tone. How well this works depends on the size of the printed dot, the relative location of the dots and the viewing distance. Viewing distance is outside our control. But dot size and dot placement fall squarely into what we can control.

The introduction of a digital plate had a significant impact on the ability to produce and print small dots. Even more importantly, it unleashed the ability to rapidly create and test new screening technologies and led to rapid improvements in halftone imaging. Techniques such as FM (stochastic) or hybrid screening became realistic options for improving the quality of vignettes, and higher line screens promised better reproduction of more complex graphics.

The digital dot story

The digital platemaking process differs from the analogue process in several important ways, both in the process of platemaking and in the dot structure which results. The analogue platemaking process utilises a physically separate masking layer – the negative – to hold the image. The negative is placed on top of the plate and covered with a translucent screen, which allows a vacuum to be achieved between the plate/negative combination. The purpose of the vacuum is to keep the negative in close contact with the plate during the exposure step. Failure to do so will result in poor imaging. There is a second consequence to conducting the analogue exposure step under a vacuum, the resulting dot has a planar surface. This is a key consequence.

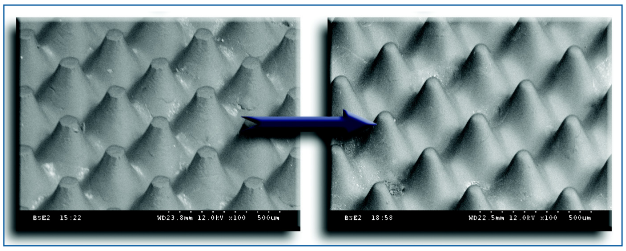
In the digital process, the image is ablated into a carbon layer (black mask) using a laser. This image layer for a digital plate is an integral part of the plate, negating the need for a vacuum to hold the photopolymer and imaging layer in close contact; this allows digital plates to be exposed in the open air. The UV exposure process initiates a chemical reaction in the plate causing the exposed areas to polymerise. This changes the mechanical properties of the polymer and the plate's resistance to solvents. There is an interesting side effect of this conventional digital platemaking scenario. The polymerisation is inhibited by the presence of oxygen, causing highlight dots to »pinch« and to be recessed below print height. As a result the dot is bullet-shaped, with a rounded tip (*figure 2*).

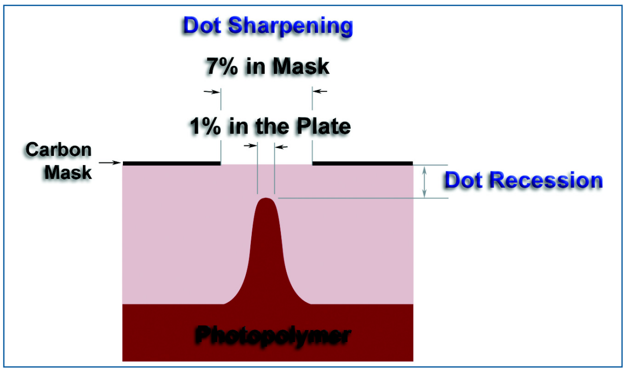
The pinching of the dot, or dot sharpening, is both an advantage and disadvantage. The sharpened dot allows a printer who has good control of their print process the ability to print extremely fine highlight dots. The downside is that the shape of the dot also increases the sensitivity of dot gain to impression and wear. This is intuitive looking at the dot shape; more impression will expand the size of the printed dot and wear will significantly alter the size and shape of the dot's print surface.

In addition to impression sensitivity, this dot shape can also make it tricky for the smallest dots, this »sharpening« of the digital dot can lead to dots with very small tips but also very steep shoulders, which cannot adequately stabilise the print surface (*figure 3*). This can lead to difficulties in vignettes, where the very small dots which are most

Figure 1 (top):
Quality improvement by switching from analogue (left) to digital plate production (right).

Figure 2 (bottom):
Dot sharpening in a digital plate.





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critical to achieving a smooth transition to zero density are also the least stable and most likely to fold over or print »dirty«, creating a harsh break in the area most visible to the human eye, the highlights.

Even with this rounded-tip dot shape, a digital plate made using conventional means is capable of printing award-winning quality. But as flexo printers seek to compete with other print technologies like gravure and offset, the demand for increased resolution, print stability, and vignette quality has reached a level where new technology may be needed to meet future print requirements.

Dot shape effects on post-print corrugated wash-boarding behaviour

One application where a considerable difference has been seen between analogue and digital plates was in corrugated postprint, where digital dots exhibited a greater »wash-board effect« or »wash-boarding« than analogue dots. Given that this effect was different even when the same photopolymer was used for analogue and digital imaging, the dot shape was thought to play a role in this behaviour. Typically the severity of wash-board effect is gauged by eye, so a scientific method was needed to quantify the wash-board effect and allow a true understanding of the role that dot shape has played in this phenomenon. Wash-board effect lines are caused by higher levels of dot gain in rows of dots which print on the liner board directly above corrugation peaks (*figure 4*). It was hypothesised that this was caused by the rounded profile of the digital dot and its sensitivity to impression. Similarly, it was also hypothesised that the solution to this problem might be found in an altered dot shape. Using a dot measuring instrument, it is possible to measure the difference in dot gain between the peaks and valleys of the corrugated board. By building custom hardware and software that allowed continuous scanning of a print sample, it was possible to correct for random noise and reproducibly quantify the magnitude of wash-board effect on different print samples.

Figure 5 shows a graphical representation of such a measurement. The wash-board effect is quantified as an »F-factor« or »fluting factor«, which is simply the peak-to-trough amplitude of the density variations seen across the sample, with random variation removed by the data analysis algorithm. To relate the two F-factors shown in figure 5 (8.30 left, 1.71 right) to common experience, the board on the left would have severe wash-board effect, while the one on the right would have barely discernible levels.

Using these metrics, along with more typical parameters for dot gain and solid ink density (SID) *MacDermid* developed a series of plates with varying dot shapes. Variation in dot profile went from one extreme to the other, and most in between. Print tests were run on post-print corrugated, narrow-web and flexible film. Although most of the dot shapes tested included relatively flat top profiles, there were significant print differences seen between various versions of flat-topped dots. What was learned is that not all flat top dot shapes are equivalent, and that the flat top is only part of an improved dot profile. What appeared to be subtle changes in shoulder angle and edge definition also had a measurable effect on print performance.

The best dot shape

Based on a study of print results obtained in corrugated post-print, wide-web and narrow-web formats, an understanding of the dot shape characteristics which are most favourable for print performance were developed. Four parameters were identified to describe dot structures (*figure 6*). In this way, *MacDermid* could distinguish one flat top dot profile from another.

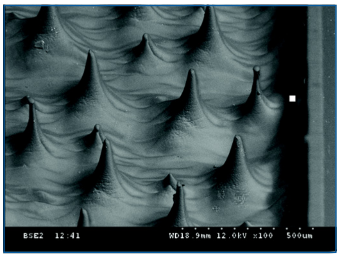


Figure 3:* *Unstable dots.

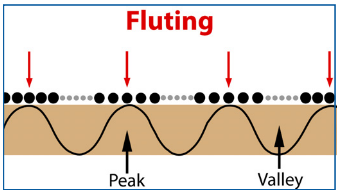


Figure 4:* *The wash-board effect.

Dot surface morphology is the most obvious of the dot characteristics, and it seems that the presence of a flat top provides the expected improvements in dot stability and impression latitude. But along with the planar surface, the crispness of the edge definition was found to be an important geometric quality for print performance. The valley depth between dots, which are far shallower than the plate relief, was found to allow adjacent dots to deform independently, which in the case of wash-board effect reduction, is critical to success. The deeper valleys may also extend the stability of the plate over long runs, as any excess ink due to over impression or high anilox volume now has a larger area in which to accumulate before dot bridging occurs. Finally the shoulder angle of the dot, measured as the angle between the dot surface and a line drawn down the side of the dot, further defines the print surface and prevents unwanted interaction between the printing surface and the underlying support structure.

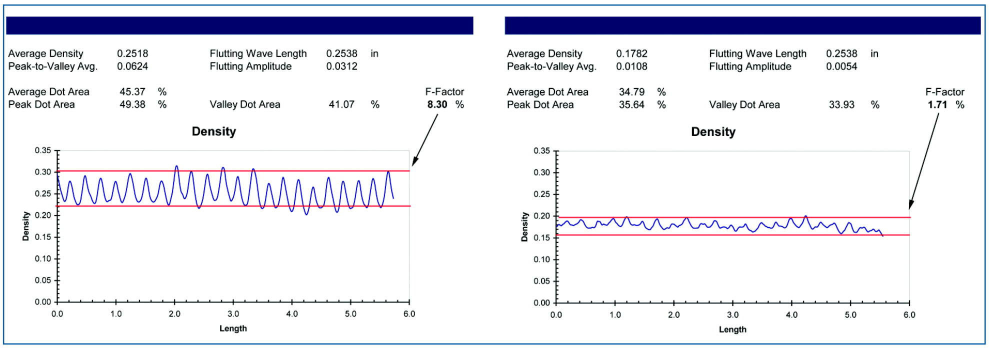


Figure 5:* *Measuring fluting in corrugated print.
Left: High level of fluting; right: Low level of fluting.

The right process

There are many ways to change the shape of a dot: photopolymer formulation, light source, post-emission collimation, and length of exposure to name but a few. Finding the right process meant defining one that was robust, easy to integrate into existing platemaking processes, easy to use every day, flexible enough to work with all incumbent systems (hardware and software), and had the ability to work across all print market segments.

What you see is what you get

In the simplest terms, the *LUX* platemaking process uses a membrane to exclude oxygen during the exposure process. After the laser form the image in the digital mask, a special membrane is laminated onto the surface of the plate. After this, the plate is exposed using the same procedure as conventional plates. After the plate is exposed, the membrane is removed and the plate can be developed normally. The lamination process is simple and robust. The membrane can be peeled off at any time without damaging the digital mask or the plate. The effect on dot shape is profound (*figure 7*), and gives a dot shape with all the structural characteristics needed to ensure reliable print for the smallest dots created.

The *LUX* platemaking process is a 1:1 imaging process. If a 5% hole is lasered into the mask, a 5% dot will form in the plate. In the conventional digital platemaking process, this 5% dot would be »sharpened«, as *figure 7* shows.

The 1:1 imaging process provides improved consistency for the platemaker and the printer. The conventional digital platemaking process requires the trade shop to adjust the size of the highlight dot on the mask to compensate for dot sharpening. For example, a 7% size hole in the mask may be needed to form a 1% dot in the plate. This adjustment is called a bump curve. In this example, the »bump« would be 7% (*figure 8*).

There are two harmful aspects to the bump curve. First, a bump is not a fixed value, it can range from approximately 4%–10%. It will vary depending upon the printing plate used; the line screen of the print job, the specific digital imager, and the exposure unit used. Each platemaking system can be slightly different. This adds a source of potential error if the platemaker selects the wrong bump curve for that specific job. Secondly, the bump curve robs the printer of 4–10% of the available colour gamut.

Measuring the size of the dot in a plate can also be difficult for conventional digital dots. The bullet shape of the digital dot makes it hard for the platemaker to measure the dot size using industry standard equipment and techniques. At what depth is dot size measured in the illustration? (*figure 9*)

The benefits

In short, the process combines the best attributes of an analogue plate with the best attributes of a digital plate. Printers using *LUX* report the following:

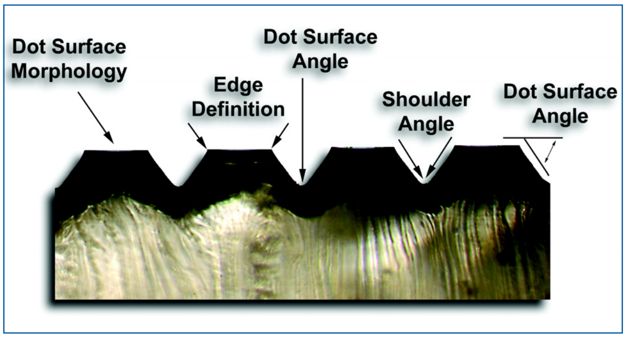
1. Reduced wash-board effect in corrugated;
2. Smoother vignettes with improved fade to zero capabilities;
3. Higher contrast;
4. Dot gain is more stable over broader range of impression;
5. Dot gain is more stable for longer runs.

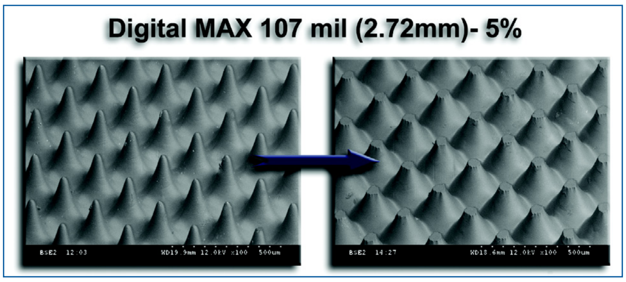
In addition, other benefits are being reported. *LUX* processed plates come up to colour more quickly, saving print time and materials. As a result the print job is more economically and ecologically friendly. Because a *LUX* processed plate can produce a smaller, printable dot, printers report being able to increase the printable line screen without any change to the other parameters such as ink, anilox and substrate. This benefit is not reported by every printer, or on every print job. However, it happens frequently enough to be a real benefit for *LUX*. Printers are quite happy to be able to improve line screen without making a substantial capital investment in anilox rolls.

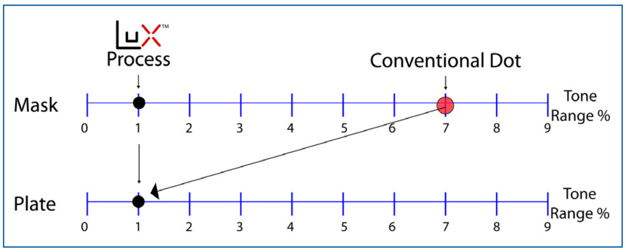
What is different?

There are other »flat top dot« technologies on the market today. Each supplier has taken a different approach to how the dots are created. The dot profiles, while similar, are not exactly the same. Print is what matters though, not dot shape. *LUX* was developed based on an extensive study of the impact of dot shape on print performance and creates dots which have been shown to improve print results. In addition, the process has remarkable versatility and accessibility.

According to *MacDermid*, the process works with all digital imagers, all exposure frames, all plate dimensions, including 52 x 80" (1321 x 2032 mm), all dot shapes (round, square, etc), and all market segments (thick and thin plate). ■







From top to bottom:
Figure 6:
Parameters to describe dot structures.

Figure 7:
LUX effect on dot shape.

Figure 8:
Bump curve adjustment.

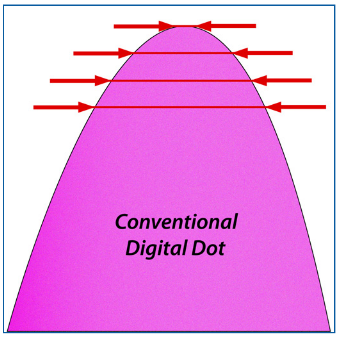


Figure 9:
Where to measure?