Linotype-Hell

Technical Information

Technology Update: Diamond Screening

Frequency modulated (or FM) screening is one of the hottest topics today in the graphic arts. Though there are still many unanswered questions about this technology, many things are becoming clearer. This article updates you on some key findings regarding Linotype-Hell's Diamond Screening.® For a general overview of FM screening technology, please refer to the Linotype-Hell technical information article entitled *Diamond Screening.*

The role of the laser spot

FM screening uses microscopic marks to reproduce an image. Since these marks are made by a laser, we will refer to them as laser spots. However, there is a distinction between the size of the mark that a laser produces on film and the width of the laser beam as described in the imagesetter or recorder specification. The actual size of the laser spot as measured after development on film depends on a number of factors, including, the laser intensity setting, the film material, and film processing. As these factors are changed, an imagesetter with a laser beam size of 20 microns may make marks either larger or smaller than 20 microns. Laser spot size for numerous devices is shown to the right.

Laser spot sizes

Device	*Diameter in microns*
Linotronic 330	20 microns
Linotronic 560	30 microns
Linotronic 630	Variable, as low as 13
Herkules	Variable, as low as 7.5
Linotronic 930	Variable, as low as 5.2
R3030 PS	Variable, as low as 5.2

Diamond Screening laser spots

In most halftoning methods, laser spots are grouped together to form halftone dots, but FM screening methods work differently. Rather than grouping dots to form darker tints, FM screening methods reduce the average distance from laser spot to laser spot to do so. The result is that FM screens are made up of many tiny laser spots rather than halftone dots of varying sizes. The chart below compares the size of halftone dots at a 150 line per inch screen ruling and laser spots used for Diamond Screening.

A 1% 150 line per inch halftone dot is slightly larger than the 15 micron laser spot size at 1693 addressability.[1] Since many printers consider their minimum printable dot to be a 2% or 3% dot at 150 lpi screen ruling, there will be a lot of printers who will have some trouble consistently holding the

[1] Addressability is the more accurate term for what is commonly described as resolution.

Halftone dot sizes

Dot % at 150 lpi	*Diameter (in microns)*
1%	17
2%	25
3%	30
4%	33
5%	37

Diamond Screening laser spot sizes

Addressability setting	*Diameter (in microns) 1X*	*4X*	*16X*
~~846 dpi~~	~~30~~		
1270 dpi	20	40	
1693 dpi	15	30	
2540 dpi		20	40
3386 dpi		15	30

Note: At higher addressability settings, multiple laser spots may be grouped to form the base laser spot. In these cases, either 4 or 16 laser spots are grouped together. The spot sizes shown here apply to Linotype-Hell's newest recorder, Herkules.

tiny laser spots that FM screening methods use. It would be like printing an image composed entirely of 1% halftone dots. Strict controls will be necessary to assure that these laser spots on film make it through platemaking and onto the paper.

From film to press

Users of Diamond Screening (or any FM screening method) will need to re-think the procedures used for film preparation, scanning, proofing, platemaking, and printing.

Film preparation

Film materials – Film materials used in imagesetting are considered high contrast. This means that where the laser hits them, they are exposed and will turn black upon development. But even among high contrast films there are differences.[2] There will always be some zone between exposed and unexposed areas that is not as black as fully exposed areas. (See Figure 1.)

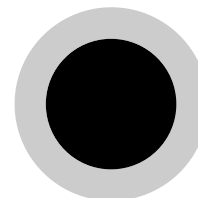

Figure 1 - The contrast of a film plays an important role in the size of the area between unexposed and fully exposed film.

[2] Contrast is described in greater detail in the Linotype-Hell technical information article entitled, *Graphic Arts Film Materials.*

Contrast is particularly important with FM screening methods because of the tiny size of the laser spots. This is not as critical a factor with conventional amplitude modulated (AM) screening methods.[3] With these types of halftones, multiple laser spots are clustered together to make halftone dots. These larger halftone dots are less influenced by variations in the exposed/unexposed zone than the tiny FM laser spot.

[3] Throughout this document, the term 'AM screening' will be used to describe conventional halftones (i.e., those halftones that have a screen ruling and that create darker tints by increasing the size of the halftone dot.)

One example of a very high contrast film is Kodak™ 2000. This film has good edge definition and produces a very hard dot. This makes it easier to make consistent proofs and plates.

Dot etching – Though few people actually do it, it is possible to wet etch AM screens output on imagesetter film. This is not possible with FM screens. The laser spot is just too small. It will disappear entirely on wet etching.

Calibration – Calibration for Diamond Screening is similar to that of other screening methods: measurements are taken from a test strip and fed back into the raster image processor (RIP) to linearize the output.[4] This feedback loop may be performed by any calibration utility, including the calibration portion of the Linotype-Hell Utility. However, the AutoCalibration feature of the Linotype-Hell Utility may not be used with Diamond Screening.

[4] For more information on calibration, please refer to the Linotype-Hell technical information article entitled *Calibration,* which appears in the 1992 Linotype-Hell technical information notebook.

Some users have been concerned that a 50% tint patch of an FM screen appears darker than a 50% tint patch of a 150 line per inch AM halftone (even though they both measure exactly the same on the densitometer). Some have even suggested abandoning densitometer measurements, and eyeballing the measurements instead. This would be like trying to compare a 50% tint of an 85 lpi halftone and a 300 lpi halftone. The eye would have trouble accurately comparing the two because of the large difference in screen ruling. The same holds true with comparisons of tint values of FM and AM screens. A densitometer or dot area meter is the only accurate method for measuring any kind of dot percent. If you are concerned that a tint will print too dark, then a dot gain adjustment is in order. (See more on dot gain on page 56.)

Addressability – Diamond Screening may be output at an addressability setting of as low as 846 dots per inch (dpi). At 846, the size of the laser spot is 30 microns. This laser spot size will be easier to print than the 15 micron spot size. Keep in mind that while good results may be achieved for images at 846 dpi, the results for text may not be acceptable for all quality levels. On newsprint the difference may not be noticeable, but it will be noticeable on higher quality paper stocks. In cases where the text is solid and freestanding, and, where the addressability setting does not meet text quality requirements, it may be appropriate to output text on a separate plate at a higher addressability setting. This plate would then be used for a second, text-only plate exposure.

Users should be aware that graininess is possible in FM screens as the laser spot size increases. The level of graininess becomes unacceptable to many viewers once the laser spot has exceeded 40 microns.

Scanning

UCR and USM – Generally, Under Color Removal[5] (UCR) and Unsharp Masking (USM) may be handled in a similar fashion as before. But increased levels of UCR can help maintain the fine detail of textiles or other highly textured subject matter (particularly in the neutral colors). With increased UCR, the detail is carried by the black separation rather than the cyan, magenta, and yellow separations. As a result, detailed areas are less subject to color shifts caused by registration problems. (When detail is held by multiple colors, shifts in the registration of any single color may be visible.)

[5] UCR limits the amount of colored ink that appears in neutral areas and replaces it with black ink.

Similarly, slightly higher levels of Unsharp Masking (USM) may help to pop out fine detail. Since Diamond Screening is good at reproducing detail, it is not surprising that users may choose somewhat higher levels of USM to highlight that increased level of detail. However, one of the purposes of USM is to combat the defocussing effect of AM screens.[6] With this complication out of the way, there will certainly need to be some experimentation, based on customers' quality requirements, to determine what levels of USM are needed for particular types of images.

[6] The defocussing is caused by the evenly spaced halftone dots that are used. A halftone screen, in effect, limits you from seeing much detail that is finer than the screen ruling itself.

Scan resolution – The common rule of thumb for scanning is to scan at a resolution equal to two times the screen ruling. With FM screens, there is no screen ruling, so the determination of the scanning resolution becomes solely based on quality. And, like levels of USM, this will depend on customers' quality requirements. While some have claimed that lower scan resolutions may be used with FM screens, it is unlikely that users who are looking to show off high levels of detail will choose to scan at lower resolutions. (If you are currently scanning at 300 dpi for a 150 lpi screen ruling, continuing to scan at the same resolution for FM screening will provide better results.)

Proofing

Reproducing tiny laser spots is as much a problem for the proofer as for the platemaker. Obviously, the proofs must be done from the films; digital proofs do not reflect the screening method, which of course is critical here.

Exposure settings that have been developed for AM screens may not be appropriate for FM screens. There is less room for error. Most proofers would not notice slight variations in a 1% halftone dot, but with FM screening methods, the entire image is composed of laser spots that are about that size. Thus, the exposure becomes critical.

Color proofing systems which use toners (like DuPont Cromalin®) should be avoided because the toner particles are too large to hold the fine detail of Diamond Screens. Linotype-Hell is working with the major proofing vendors to fine tune proofing methods to work with Diamond Screening.

Platemaking

Plate exposure – The plate material must be able to hold 6 to 8 micron lines on an UGRA Plate Control Wedge.[7] The light intensity of the plate exposure must be very consistent across the entire surface of the plate. The vacuum in the vacuum frame must also be very consistent to assure even and thorough contact of the film to the plate material. The platemaking process, because it transfers such fine detail, will be extremely sensitive to edges of stripped in material, dust particles, and scratches.

[7] The UGRA Plate Control Wedge may be purchased through the Graphic Arts Technical Foundation (GATF), 412-621-6941.

Printing

Printing characteristics – Diamond Screening has a stable ink/water balance on press. There is no midtone jump because there are no AM halftone dots to link together and cause tonal jumps.[8]

[8] For more information on midtone jump, please refer to the Linotype-Hell technical information article entitled *Digital Halftone Dots,* which appears in the 1992 Linotype-Hell technical information notebook.

Dot gain – Dot gain for AM screens is 18%, according to BVD/FOGRA (a European standard). The comparable value in German tests with Diamond Screening was 19%, with a greater deviation from the BVD/FOGRA standard in 3/4 tone and shadow areas. Dot gain on newsprint is considerably higher, as much as 20% higher than normal. In general, dot gain can be expected to be somewhat higher for FM screens. This makes sense because research on dot gain with AM screens has shown that dot gain increases as screen ruling increases.[9] With FM screens, though the concept of screen ruling is gone, their fineness is comparable to extremely high screen rulings.

[9] Dot gain will also vary depending on whether positive working or negative working plates are used. In positive working systems there is usually some dot loss during platemaking. This tends to compensate for increased levels of dot gain on press. In negative working systems, dot gain may occur in both steps, which results in a higher level of dot gain.

Printing AM and FM screens on the same press sheet – While it is not impossible to do this, there are a number of considerations that may make it unfeasible. Dot gain values will be different for each type of screen, and this must be properly adjusted for. Any on-press adjustments based on inking levels are likely to influence the two types of screens differently. (Of course this would also be true if you chose to print halftones with significantly different screen rulings on the same page.) However, problems with inking levels can be avoided by imposing the job so that ink fountains may be adjusted separately for the two types of images. Finally, plate exposures that may be good for an AM screen, might not be appropriate for an FM screen.

Conclusion

While commercial FM screening methods have only been introduced this year, they are by no means entirely new. The theory behind FM screening has been in development for well over ten years. In fact, some of the earliest research on frequency modulated screening was done in cooperation with Hell back in 1982 by Professor Karl Scheuter and Dr. Gerd Fischer of the Technische Hochschule in Germany. Linotype-Hell holds two patents from that early research. The algorithms used in Diamond Screening are different than the algorithms used in this early work and are significantly faster.

One of the difficulties in creating a visually pleasing FM screen is in producing a pseudo-random distribution of pixels. A truly random distribution would produce clumps of pixels and rivers of open space. The implementation that Linotype-Hell has used in Diamond Screening uses a certain amount of blue noise[10] to produce visually pleasing output.

[10] Those of you with an interest in this topic should refer to Robert Ulichney's 1987 MIT Press book *Digital Halftoning,* which not only describes blue noise, but also white, pink, and brown noise.

Linotype-Hell believes that Diamond Screening will be appropriate for certain markets. It will certainly not eliminate the need for other halftone screening methods. Users of the technology must be able to maintain the tiny laser spot from film all the way to the press. High quality, photorealistic reproduction will be the first market to take advantage of this technology, probably with more than 4-color printing. Other markets may pick up on this technology for reasons related to reproducing detail, lack of moiré or rescreening problems, or even the ability to output at low addressability without a corresponding loss in gray levels.[11]

[11] FM screening methods are not totally free of addressability concerns. As with any screening method, to produce 256 levels of gray you need an area of at least 16 by 16 pixels.

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