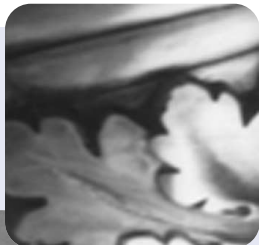


understanding halftone reproduction

Knowing about density values, halftone screens and laser scanning can help you achieve high quality print reproduction.

If the printer's only concern was to reproduce type, his trade would not be nearly as difficult, challenging nor as interesting. The basis of fine printing is in the reproduction of photographs, either in full-color or in black-and-white. Much is written about the four-color process and color separations, but very little is devoted to the black-and-white photographic reproduction known as halftone reproduction.

Halftone reproduction, often taken for granted because of its very abundance, actually requires an understanding of photography, inks, papers, chemistry and the printing presses being used for reproduction.



A halftone reproduction is actually an illusion. Your eyes take in the small dots which make up the halftone (above), but your mind blends them into a smooth image (right).



In its most basic sense, a halftone reproduction is actually only a facsimile, made up of small, regulated dots in a predestinated grid pattern. Our eyes take in the dots and blends them in the mind's eye into a smooth photograph. If you look through a magnifier (loupe) at any printed photograph, you will notice that it is indeed made up of these small dots.

But why can't a photograph be printed on the paper as we see it and why is the halftone process necessary, novice print buyers or artists might ask? Because printing is an all-or-nothing



When halftones are shot, a density guide, or gray scale, that displays the entire range of density values is laid beside the photo being shot. A comparison is made between the original and the resulting halftone to ensure there is no loss of tonal values.

process—either the press puts down an even coat of ink on the paper or it does not. Printing presses cannot differentiate tonalities or densities of black into the shades of grays we see in photographs. With the halftone process, however, the dot pattern and the size of the dot itself and its immediate surrounding white space can be controlled. While looking at a halftone through a magnifier, notice that the bright (highlight) areas are small black dots surrounded by a lot of white (paper). In the middle gray range (midtone), the dots are in the same position on the grid but have increased in diameter with less white surrounding. Finally, in the shadow areas the dots are very large (in most cases overlapping) with very small white areas between. By being able to control the size and placement of the dots, a full tonal range from white through the gray scale to solid black can be achieved, overcoming the ink/no ink limitation of the press.

START WITH THE PHOTOGRAPH

In order to ensure a quality halftone, one must start with a quality photograph (remember GIGO—garbage in/garbage out). Contrast plays the most important role in a quality photograph because it visually defines details, textures, depth and dimension.

Photographs can be separated into three categories: high-key, normal, or low-key. A high-key photograph is one that is made up primarily of highlights, a low-key is made up mostly of shadow areas, and a normal photograph is comprised of equal values of highlights, midtones and shadows. Because the halftone process causes a loss of detail, the original photograph itself must have a full range from white to black to produce an equal result.

To inspect your photographs, take a white sheet of paper and a black sheet of paper and punch holes in the white paper over the white in the photograph to see how "white" it actually is. Do the same with the black paper and the blacks in the photograph. If the whites and blacks are not true in the photograph, there is no way the halftone can have proper contrast.

Although the halftone process can enhance or compensate for one end of the scale, it will invariably do so at the expense of the other end of the scale. For example, to get whiter whites (highlights), the result will be grayer blacks; to get blacker blacks (shadows), the result will be grayer whites or no whites at all, only light grays. And how can you expect anything to look bright and reflective without pure whites?

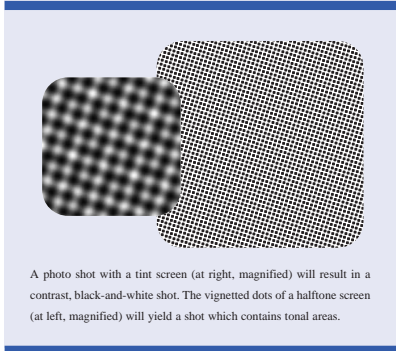
Photographs are either sharp or soft; that is, the gradation from a dark to a light area can either be a hard, crisp, or sharp distinction—or it can be a gradual, almost blurred, soft transition. It is easier to produce quality halftones with photographs that are sharp than it is with photographs that are soft. Send originals to be halftoned larger than the final product; the results will be sharper if reduced rather than enlarged.

MEASURING DENSITY VALUES

Ansel Adams once wrote that if we see the world in a ratio of 1:1000, the camera actually records what it sees on a scale of 1:100. Taking that one step further, when a halftone is produced using a graphic arts camera, the scale is further reduced to 1:20. This is known as adjacent tonal modulation: the compression of a smooth continuous tone (the world at 1:1000) into smaller, more defined and graduated steps (the halftone at 1:20). This compression can be measured with a densitometer, an instrument used by printers, color separators and photo labs to measure the optical density, or tonal values of photographs. The density values will range from 0.0 (pure white) to 2.0 (solid black) in .5 increments. There are some commercial density guides with only ten (10) steps with white reading 0.0 to black reading 1.0, subdivided into 1.0 increments. Most printers use a guide with as many subdivisions as possible for greater accuracy.

When halftones are shot, a density guide, a strip of photographic paper with the entire range, 0.0-2.0, is laid alongside the photograph being shot. A visual comparison is made between the original and the copy made with the halftone to ensure that there was no further loss of tonal values during the

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A photo shot with a tint screen (at right, magnified) will result in a contrast, black-and-white shot. The vignettted dots of a halftone screen (at left, magnified) will yield a shot which contains tonal areas.

halftone process. When tonal fidelity is imperative, a densitometer is used. Readings are first taken from the original and then compared to the reading taken off the halftone reproduction. During the plate-making and printing processes, with as many subdivisions as possible for greater accuracy. The printer will again take densitometer readings to ensure that the tonal range has remained true to the original photograph, now several generations removed.

THE HALFTONE SCREEN

Halftones are reproduced with the aid of halftone screens. These screens can be made of glass or mylar, the latter being the most popular in commercial use. Most screens are known as contact screens because they are put in direct contact with the film or negative paper.

The screen consists of a grid of vignettes dots at a pre-designated measure of dots to the inch. The term "65 line halftone," for example, simply means 65 dots to the inch measured at a 45 degree angle.

The vignettted dots act like a small lens producing one dot when light passes through. Light is reflected from the photo-

graph onto the copyboard, through the camera's lens, in turn through the screen and finally exposes the film or negative paper. The intense light reflected from the highlight areas of the photograph creates large dots; the middle tone grays reflect medium light; and in the shadow areas very little light is reflected. (Note: Since this is working on negative film or negative paper, it is the opposite of what will be seen.) In order for the negative film or paper to record the information, several exposures must be used—a main exposure, a flash exposure, which adds to the shadow areas and a bump exposure, done with no screen over the film or paper, which produces clean white highlights. The relationship between these exposures is very important. Without added attention, halftones will produce only near whites and near blacks, actually in the range of five to 95 percent dots. When printed, the dot range may extend from 10 to 90 percent.

Experience is a critical factor that the operator must bring to halftone reproduction, for every halftone requires different exposure times based on the particular photograph and how it is to be printed.

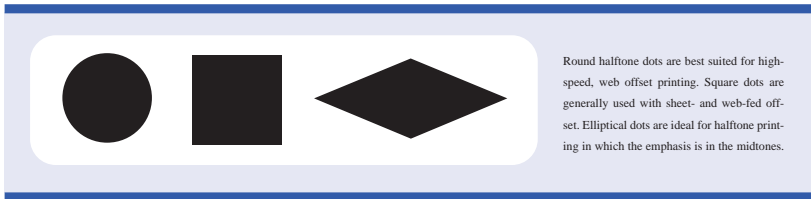
THREE DOT SHAPES

There are three halftone dot shapes available: round, square and elliptical. Each is used for different types of presses or for special types of subject matters.

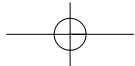
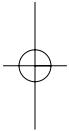
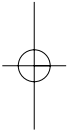
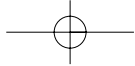
Round dots are best suited for high-speed web offset printing because the uniform round shape extends the midtone range while minimizing highlight and midtone dot gain.

Square dots, the most popular, also known as conventional dot screens, are used with letterpresses, sheet and webfed offset. Square dots are unusual in that the dots are square-shaped in the midtones yet are round in shape in the highlight and shadow areas. The symmetrical square shape minimizes the density variations due to the directional effects and shimmy of the presses.

The elliptical dot, also called chain dot, offers a very smooth gradation in the midtones and is ideal for portraits or other halftones where the emphasis is in the midtones.



Round halftone dots are best suited for high-speed, web offset printing. Square dots are generally used with sheet- and web-fed offset. Elliptical dots are ideal for halftone printing in which the emphasis is in the midtones.



FEATURE

SCREEN VALUES

The number of dots to the inch or the line screen used will determine how closely the halftone resembles the original continuous-tone photograph. The untrained human eye no longer recognizes a dot pattern once it exceeds 120-133 lines to the inch. Very fine brochures, annual reports, magazines and art prints use line screens of 150-200 or even 300 lines (the tightest commercially available screen) to the inch. The idea is to print the smallest dot pattern possible so that the eye cannot perceive the dots at all, and thus will mistake the printed halftone for the original photograph. Currently, there are experiments being done with halftone screens with values as high as 400 to 500 lines to the inch.

The line screen used is determined primarily by two factors: the paper it is to be printed on and the printing press to be used. Uncoated, rough stocks such as newsprint and inexpensive offset papers are very absorbent. This absorbency causes the dot of ink to spread, greatly distorting the actual value of the dots and eating up the white space between the dots. This increase shifts the halftone toward the darker (larger dot) scale. This increase in size is known as dot gain. Finer, smoother grades of paper and coated stocks have better ink holdout so that the dot is not absorbed by the stock and the dot retains its shape with little spread or dot gain. The reflective quality of the paper also affects the visual quality of the paper also affects the visual quality of the halftone. The more reflective the paper, the brighter the whites will appear.

A dull, flat, white paper, on the other hand, will make a halftone appear to have very little contrast. The whites will appear dull and gray while the blacks will seem washed out, with no depth.

The press that the halftone will be printed on will also affect which line screen is used. While most presses can comfortably print 65 to 120 line screens, a more exacting, precise machine must be used when printing very fine screens. More important, the press operator must be experienced, have a highly trained eye and know how to trouble-shoot press problems as they occur. High-quality halftone reproduction is impossible if the ink/water balance is off, if there is an improper pH in the fountain, if the blankets are improperly packed or if an inappropriate choice of plates for the job has been made. The better the press and the printer, the better the make-ready in preparation for printing the specific halftone.

LASER SCANNING

Recently, stand-alone black-and-white scanners have been introduced in the marketplace to fill the growing demand for laser-scanned halftones. The results from these scanners are stunning. The scanner "reads" with a high-beam laser. Therefore, there are no lenses to go out of focus, no screens to get dirty

or scratched, no negatives, no masks, no receiver papers or the necessity of intermediary steps. These scanners can be used as input units to a pagination typesetting station creating a full imaging (type and halftones) station capable of producing hard copy (paper proof), film negatives or positives, even plates with all copy in place and halftones screened and placed in position.

These systems are in great demand because the quality of the halftones is significantly superior to their counterparts produced with conventional copy cameras. Copy cameras "see" the photograph as a whole, distinguishing the highlights, mid-tones and shadow areas. They subdivide the whole into 10-20 gray levels. The laser is capable of subdividing a halftone into as many as 256 gray levels, with computer control of any gray tones. For example, the midtone dots can be adjusted either up or down without affecting ratio or balance of the other areas, highlights and shadows.

Laser halftones scan the photograph raster by raster (line for line), therefore alleviating flaring problems, the "halo" that occurs when a dark area is directly adjacent to a light area. The human eye and the conventional copy camera will see a gray "halo" over the darker area that the laser will not. The scanner is also capable of selecting regular, increased or decreased sharpness. Increased sharpness enhances the edges of dark and light areas, which increases overall detail. Reduced sharpness will soften the halftone; it is also used to soften unwanted photo grain.

One of the more amazing qualities of the scanner is its ability to enlarge or reduce horizontally or vertically, independent of the axis.

If, for example, the original photograph was wide enough but not high enough, the scanner could be programmed to make up the difference. This is not recommended for halftones with human, animals or other objects that might come out looking like a view from the carnival mirror.

Within the computer memories of these scanners are a wide variety of programs capable of copy sharpening, independent midtone control, sizing and cropping backgrounds, outlining and independent horizontal and vertical sizing. Line screens range from 65 to 144 lines. Halftones as well as a variety of special screen selections (mezzotint, posterization, solarization, way lines, straight lines) can be produced with perfect, hard dot output on paper, film or plates.

Remember, the GIGO principle is even more important for scanners. In general, though, you can expect beautiful halftones at only a slightly higher cost (30 to 50 percent) of conventional halftone costs.

Fred Fredrick, acclaimed graphic designer, is now working in Maryland on a non-profit project for homeless children.