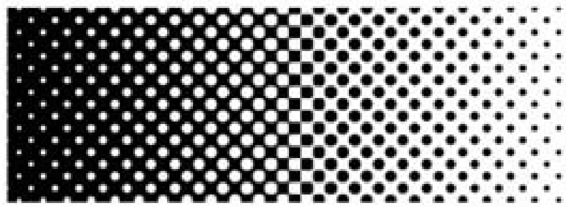
What is Photo Lasering?

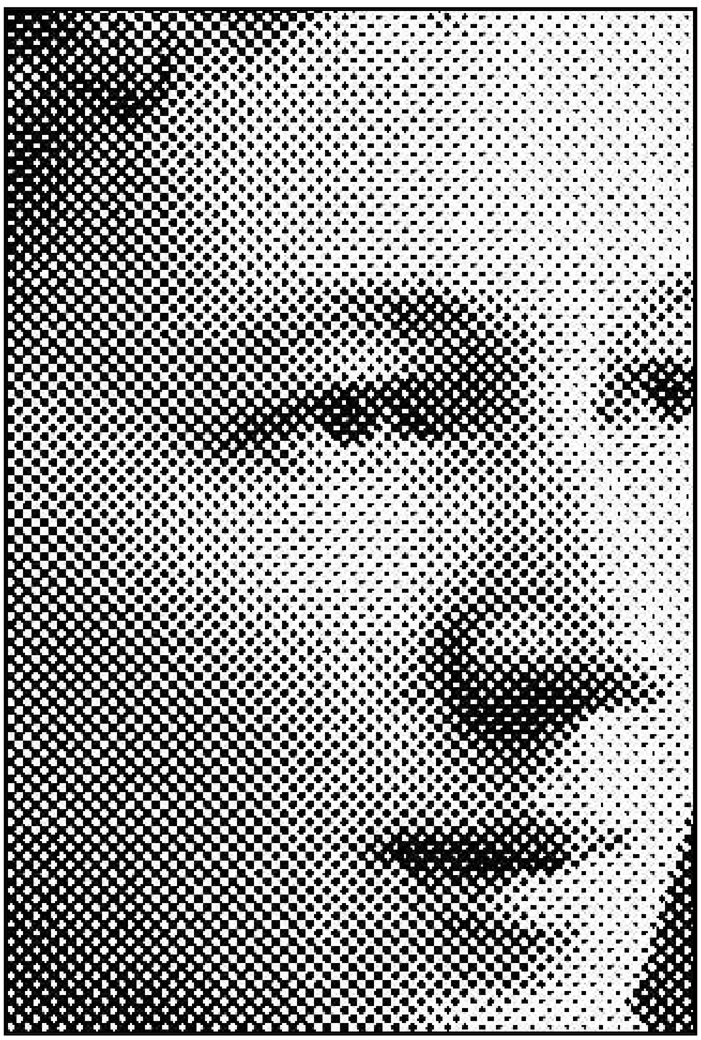
Photo lasering begins with a photograph. The photo is scanned, opened in an imaging program, adjusted for exposure and sharpness, and imported to a graphics program. It is then positioned and sized, perhaps with text or other images, and sent to a laser for engraving.

What makes this conversion from photo to engraving possible is the halftone screen. As in printing, the halftone screen converts the continuous tone gray values of the photograph to a series of large to small solid black dots that simulate the gray tones of the photograph. There are variations on the traditional halftone screen that will also work for photo laser engraving, but to avoid confusion, only the traditional screen method will be discussed.



Halftone Screen

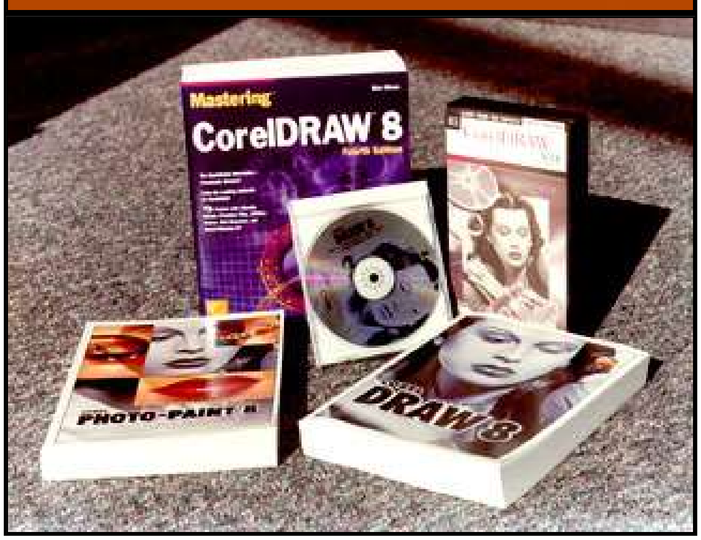
When we look at a magazine photograph, we are convinced we see different shades of gray when actually we are looking at solid black ink only. This black ink is printed in the form of tiny dots in patterns that are usually invisible unless magnified. In a traditional halftone screen, the dots are evenly spaced. Because they vary in size, you experience the illusion of looking at shades of gray.



The laser, in its raster engraving mode, will engrave anything on the page that is read as black, including these tiny halftone dots. Because of this, it is possible to have a photographic or other grayscale (shades of gray) image engraved into the surface of a plastic laminate material. The result is quite unusual, because the engraving is permanent and not subject to fading since inks are not involved. The trick is rendering halftone dots accurately in order to achieve a good representation of the original. The following explains in greater detail how to achieve good results.

What You Need to Get Started

In addition to the basic lasering equipment mentioned in the "Intro to Lasering" section, it is also necessary to have a flatbed scanner. Imaging software such as Corel Photo-Paint or Adobe PhotoShop can provide added control over the image.



Digital cameras that record an image as a file, and slide scanners and video devices that capture stills are also available. All of this equipment provides excellent ways to acquire images.

Beginning Techniques

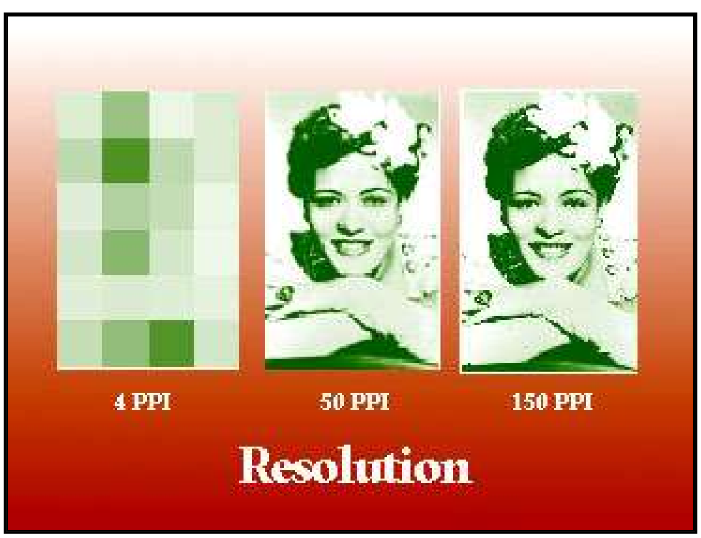
Scanners convert photographic images into digital information. Visually, the transformation results in a horizontal/vertical grid of pixels (tiny squares of solid color) arranged in tones, shades, and colors to simulate the original. Once the image has been scanned, it is possible to change the color information in any or all of the pixels to alter the scanned image. This alteration can take place one pixel at a time. Considering that a 5" x 7" photo scanned at a resolution of 300 PPI (pixels per inch) would contain 3,150,000 pixels, it would be much easier to work with the alteration tools available in photo-imaging software such as Corel Photo-Paint. This is especially true considering that each pixel could be changed to any one of millions of colors.

These tools also make it possible to alter many of the photo's properties, such as brightness, contrast, and color intensity. Today's graphics software can take a very poor original and transform it into a high quality image. In addition, it is possible to completely alter the photo through the use of sophisticated selection tools and filters. These tools allow a subject in the photo to be silhouetted, reduced, enlarged, flipped, rotated, copied, and pasted into another photo. Learning to use such software can really increase versatility and productivity when working with images, and it sets the stage for creative exploration.

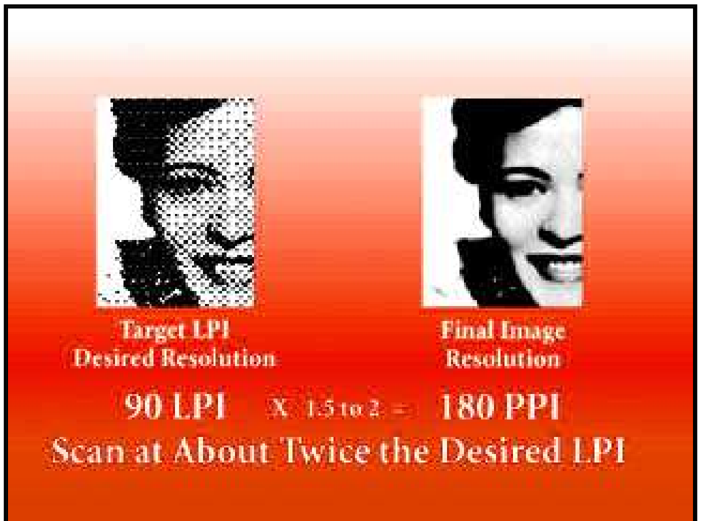
For the purpose of photo laser engraving, it is only necessary to convert a color image to grayscale, adjust the brightness, contrast, and sharpness, invert the image (turn it into a negative), and control the resolution. Most scanner software has the ability to do this and in a limited way can be used as an alternative to the more sophisticated imaging software already mentioned. The ease and depth of control provided in a software program, such as Corel Photo-Paint, makes it worth the effort to learn.

The original photo to be laser engraved can be either black and white or color. Regardless of the original image, however, it should be scanned as a grayscale image or scanned as color image and converted to grayscale using the imaging software. All scanning software is essentially alike, since the image is first previewed, the desired portion of the image is then selected using a cropping tool, the type of image is designated (color, grayscale, or black and white), the resolution is determined, and the image is scanned.

Resolution is figured by the number of pixels that can be counted linearly in an inch, that the scanner creates in order to represent the image. A resolution of 4 PPI (pixels per inch) means that each pixel is 1/4" in size. Since each pixel can only contain one solid color, then scanning a 5" x 7" photo at this setting will not produce anything recognizable other than a grid of colors. By scanning the same photo at 72 PPI, it will be recognizable and actually look pretty good at its original size; however, details will be lacking if the photo is enlarged. As the PPI number increases, the pixels become increasingly smaller and more numerous and the image more detailed. However, the electronic size of this file will also dramatically increase. Scanning a color 8" x 10" photo at 1200 PPI is ideal in terms of detail captured, but the file size might not be practical for your computer.



When the image is sent to the laser, any resolution over 300 PPI does not improve the rendering of the halftone screen. If an image is to be lasered the same size as it was scanned, the resolution should be 250 to 300 PPI (1.5 to 2 x 150 line screen desired LPI). If the image is to be reduced before it is lasered, the original resolution can be less. If it is to be enlarged, the setting should be higher. The actual PPI of the final image sent to the laser, after enlarging or reducing, should be between 250 and 300 PPI. If a coarser (90 LPI) halftone screen is desired, the resolution of the laser ready image should be between 135 and 180 PPI (1.5 to 2 x the LPI (90) = 135 to 180 PPI).

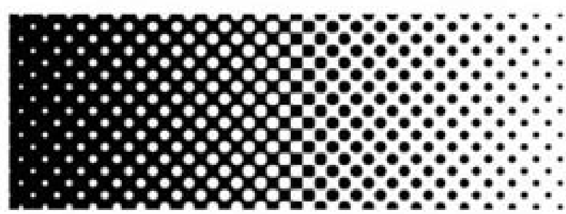


In most cases, the dimensions of the scan will automatically remain the same as the original and so will the exposure. However, both aspects can be changed using the scanning software or the higher-end imaging software. If only the scanner is used to adjust the image, it should be saved in a format compatible with the graphics software that will be sending it to the laser. If imaging software is used once the image is scanned, it will automatically appear ready to be adjusted or manipulated by that software. It should be saved in a compatible format as well.

In either case, the objective is to make the on-screen image look as close as possible to the desired outcome. Learning to use the imaging tools is a key factor to being successful.

Halftones

In a perfect world, once the image is adjusted properly, it would be sent to the laser, automatically transformed into a halftone image, and the laser would burn all of those dots to produce a nearly perfect copy of the adjusted on-screen image. Unfortunately, this does not always happen. However, as technology improves, we seem to be getting closer to that ideal.



Halftone Screen

Originally, a halftone screen was a mesh screen through which a high contrast camera (capable of shooting black or white only with no grays) would photograph a grayscale image. The screen would force the camera to interpret light gray areas as various sized but evenly spaced tiny black dots. Midtone areas would appear as equally sized dots of black and white in checkerboard fashion. Dark areas would appear as mostly black with variously sized, evenly spaced tiny white dots. The lighter the gray, the smaller the dots would be until they disappeared into pure white. The darker the gray, the smaller the white dots would appear on a black background until they disappeared into pure black.

Coarse-through-fine mesh screens were developed, with the fine mesh screens capable of much better reproduction. These screens were designated in lines per inch (LPI) with most newspaper screens running around 60 to 100 LPI and most good magazines around 150 to180 LPI. Today the same effect is achieved digitally using no real screens or photography, and the outcome is identical. An image can be sent to the laser as a grayscale image, and it will automatically be converted to a coarse or fine-screen halftone. It can also be converted during scanning or in the imaging software and sent to the laser as if it were a normal black and white image.

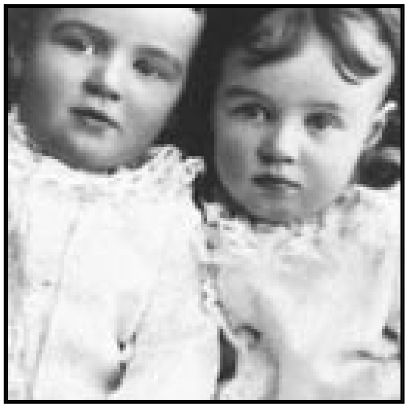
Regardless of how the halftone is achieved, the image should, at this point, consist of black dots ready for lasering. Each sweep of the lens across the page will render portions of all the halftone dots in its path. It will take several sweeps before one halftone dot (depending on its size) can be rendered from top to bottom. A coarser screen contains larger sized dots overall that are easier to render clearly. The finer screens (180 LPI) contain extremely tiny dots in the light gray areas, but also produce a highly detailed natural looking image since the halftone dots are too small to be seen without magnification.

For quality engraving, the smallest available lens size is recommended. A 1.5" lens produces a beam that is only .003" in diameter, meaning the smallest dot size that can be rendered is .003". Every time the arm completes its sweep, it jumps down one notch. The distance of that jump is dependent on the DPI setting in the software (1000 DPI = .001" jump, 500 DPI = .002" jump, 250 DPI = .004" jump, etc.). The PPI setting (pulse per inch) indicates how many times in an inch the laser will fire (1000 PPI = .001" distance between pulses, 500 PPI = .002" distance between pulses, 250 PPI = .004" distance between pulses, etc.).

Note: Some machines do not allow the PPI to be changed or may refer to it different terms or as a numbering system. If a machine allows the PPI (under a different name or numerics) to be changed, just think in terms of low, medium and high to correspond to the 0-1000 PPI settings noted above.

Since the beam is .003" in diameter (1.5" lens) and at 1000 DPI and PPI settings, it will fire at only .001" intervals in either direction. There will be an overlap of stroke diameter between both path sweeps (vertical) and pulse firings (horizontal). This combination of small beam diameter (small lens) with high DPI and PPI settings produces the greatest potential for success in rendering a fine (180 LPI) halftone screen. For coarse screens (larger dots), these settings can be lowered to 500 or 333 DPI and PPI.

The more accurately the halftone dot is rendered, the clearer and sharper the reproduction will be. Issues that can affect this rendering are lens size, DPI/PPI settings, power/speed settings, accuracy of the mechanics of the laser, and lens focus.



For a first attempt, it is probably best to choose photos that are mostly light. Use LaserMax White/Black and select a mid-range DPI setting (500 DPI). Scan the image at least 180 PPI (sometimes designated as DPI) or up to 300 PPI if it is likely that the image will be printed in the future at higher resolution and plan to print it at the original size. If possible, use imaging software to make the scan look as close to the original as possible in terms of exposure. Send this to the laser with the settings listed below (see Settings). Be sure to indicate this is a halftone rendering in the print driver settings (see laser instruction manual). Place the material on the bed and begin lasering. You should get an excellent reproduction of the original except the halftone dots will be larger and visible to close scrutiny. Consult your laser documentation for specifics and request technical help from the company if your laser driver is newer than the documentation. Changes in the dialogue box settings may have been made.

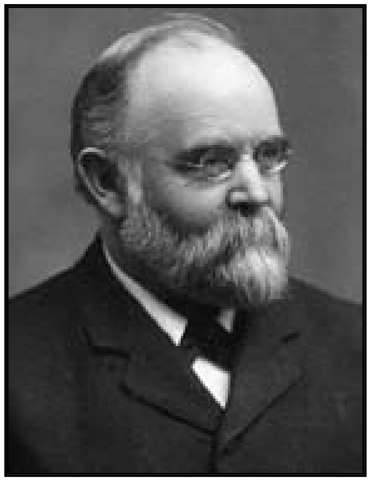
Advanced Techniques

Material Selection

One major difficulty when lasering photos is engraving too much of the sheet area. This is actually preventable by using some simple strategies, but it is important to first evaluate the photo being reproduced.

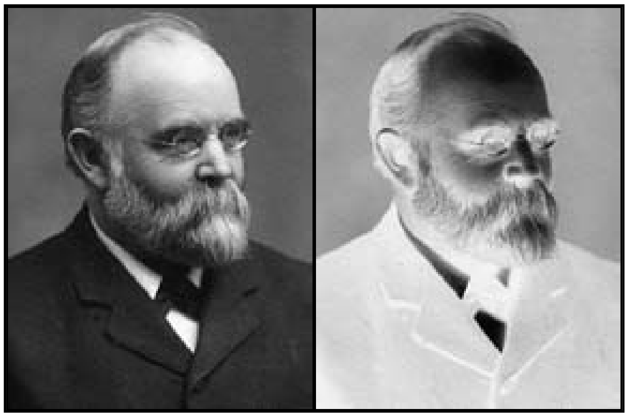
Photographs consist of very subtle shades of gray that can shift imperceptibly from one tone to the next. It is important to determine if the range of tone is evenly distributed throughout the photo or if the photo is predominantly dark or light. Since the laser only engraves what it reads as the black parts of any image, it will render anything it sees as black even if that means burning away most of the white cap material to match the onscreen image.

A predominantly dark photo will contain a majority of dark halftone dots covering most of the surface of the photo, meaning that the laser will have to burn all of that surface area. Too much burning may result in a degraded image and/or overheating and warping of the acrylic substrate. Photos with an even distribution of grays will work better but may still cause some distortion.



Predominantly light photos seem to present fewer problems, since the halftone dots are generally smaller and cover less of the surface area of the image. Lasering such images onto a lighter colored laminate over a dark substrate makes the most sense since the laser will burn through the light colored cap to reveal the dark core underneath that corresponds to the dark areas of the photo.

Since predominantly dark photos contain fewer light tones, it makes more sense to convert the photo using imaging or scanning software to a grayscale negative. What appeared as light in the photo will now appear as dark on the monitor and will be in the minority compared to the now mostly white areas of inverted shadow. This smaller amount of black will minimize the amount of lasering required. If engraved onto the same light over dark material, it will produce the same negative reading image. If it is lasered onto a material with a dark surface over a light background, the same file will produce a right reading image, since the black of the image will burn through the dark surface to reveal its lighter core. This essentially causes another conversion back to a positive proof.

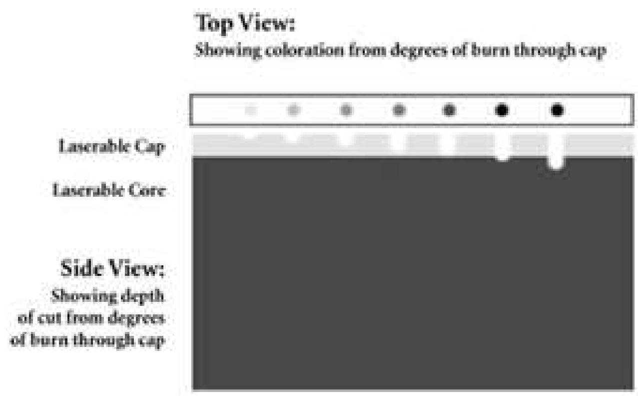


Images containing an even distribution of lights and darks will still require substantial surface lasering. If the results are poor after lasering, it may be necessary to use the imaging software to alter the photo so that it favors either a lighter or darker tonal quality. Again, if the photo is transformed to a mostly light one, it should be lasered onto light over dark material. If it turns out darker, it needs to be inverted and lasered onto a dark over light material.

Islanding

A well-known situation in the printing industry sometimes occurs when laser engraving photographs. At the extreme ends of the grayscale (5% and 95%), the halftone dots (light grays = tiny black dots, dark grays = tiny white dots on solid black) get lost in the shuffle. When this happens at the press, the dots representing the light gray tones are so tiny that they drop out somewhere between film output and printing. The white dots, representing the darkest grays, fill in with ink. The result is an increase in the size of 100% white and black areas of the photos. Some important detail can be lost in the shadows and highlights when this happens. For instance, what started out as a subtle highlight on a person’s forehead suddenly becomes a gaping white crater. The same problem occurs when lasering photos even to a greater degree.

This situation is compounded when lasering photos because of the cap thickness. Even though the cap is only .001" thick, it is possible to remove only a portion of it without breaking through to the core. When this happens, the cap will change colors slightly based on the depth of the cut. The progression moves from untouched cap material, to various degrees of cutting into the cap, to breaking through the cap with the tiniest dot size, to gradually increasing dot sizes.



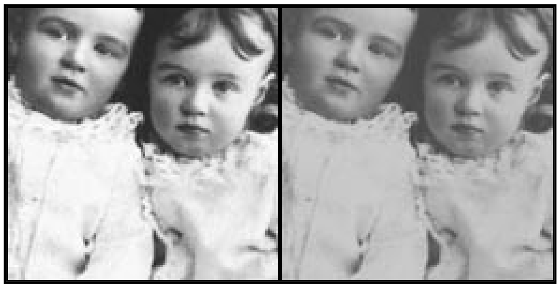
Controlable Depth of Cut through Cap

In addition, the laser seems to ignore a large percentage of the smallest dots that usually occur in printing, and this can result in 'islanding'. Like the example mentioned above, a subtle highlight on a person's forehead not only looks like a white crater, but that crater retains a smoothness that is decidedly different than the surrounding sea of lasered dots. The effect is visually disturbing and quite distracting, causing those white areas to be perceived as islands and not at all integrated with the surrounding image. Don't try to envision it, you'll recognize it.

This also happens if the image has been inverted and lasered onto dark over light material. In this case the tiniest halftone dots are in the lightest areas of the negative. When lasered through the dark cap, tiny white dots will be revealed in the final product. If these dots do not render, then equally distracting dark islands will occur in the shadow areas of these photo engravings.

Fortunately, newer machines seem to do a better job of translating the halftone screen and rendering the dots, but the following suggestions can remedy the above situation without too much trouble.

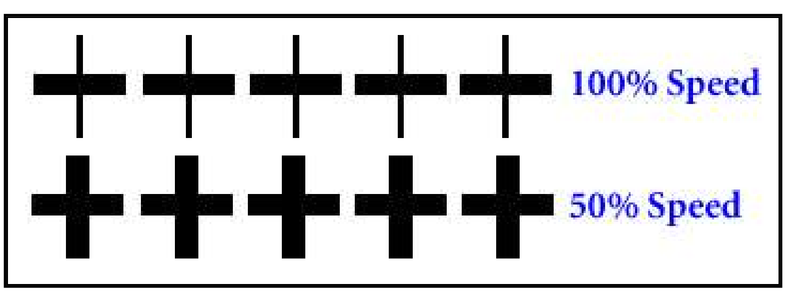
Using either imaging software (Corel Photo-Paint) or the scanner's software, it is possible to separately adjust both the contrast and brightness of the image. Normally these tools are employed to maximize the exposure of the on-screen image, but sometimes what looks great on the screen does not look great after lasering. If that happens, it is necessary to distort the on-screen image to improve the lasered image.



The goal, whether working with a positive or negative image, is to darken the lightest areas of the photo. By lowering the contrast first, the light gray areas will darken and the dark gray areas will lighten. Slightly lowering the brightness setting will further darken both the dark and light gray areas. All the shades will still be in proportion but definitely darker, and the photo will seem very dull and dark. However, doing this will cause the laser to drop out fewer of the light grays and will even cause the areas that would normally be pure white to lightly laser, but not cut through, the cap. The result will create a more normal appearance in the final product. The amount of adjustment will depend on the laser used and the image.

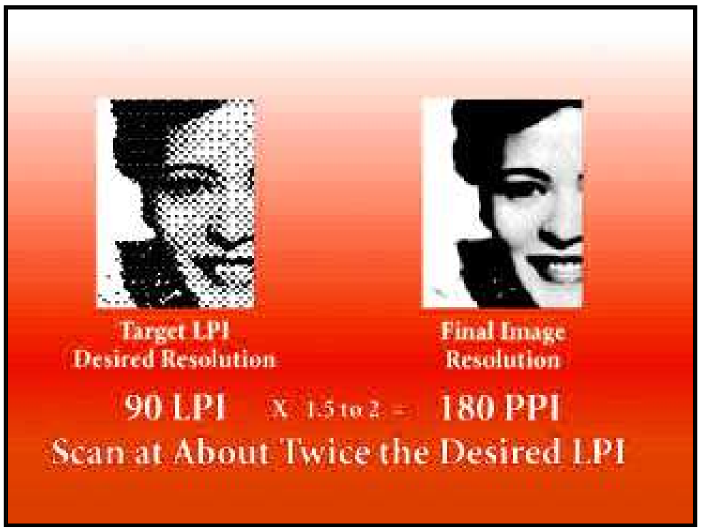
Fine Dot Rendering

Normally, when raster engraving, the speed is set at 100% to maximize production time. When fine detailing is necessary, there is a phenomenon to be considered. As the laser arm sweeps in a horizontal direction at extremely high speeds, the laser fires and shuts off as dictated by the original artwork. This requires fraction of a second timing and normally produces excellent results; however, when tiny details are being rendered, there can be discrepancies between the horizontal and vertical axis. Occasionally the horizontal renders at full thickness, but the vertical strokes appear significantly thinner. The high horizontal speeds do not allow the pulses adequate time to burn through the cap, thus leaving the strokes looking incomplete. By cutting the speed in half, the situation is resolved, and the vertical and horizontal strokes are equal in weight.



For high quality rendering, the recommended speed should be dropped to 50%, and the power setting needs to be adjusted to a corresponding percentage that will allow the cap to be burned through. Higher power settings than needed will distort the dots and will, in turn, alter the tones in the photo. There is also the danger that some dots will be burned away completely. If quality is paramount, engrave photos at 25% speed. It is strongly recommended that each machine should be tested at different speeds to examine the clarity of the halftone dots they produce which can be examined using magnification. The clearer the rendering, the better the photo will appear.

For a high-resolution image, the DPI and PPI both should be set at their maximum setting. For most lasers, setting the DPI at 1000 automatically means that a 180-line screen will be produced. This means that the image being sent needs to have an actual size pixel resolution of 270 to 360 PPI in order to successfully be formed into a 180 LPI halftone. (Rule of thumb - Final image after cropping and sizing needs a pixel resolution of 1.5 to 2 times the desired halftone screen.)



Obviously the lens needs to be in focus to render clear halftone dots. The other factor that can spell disaster or success is how well the lens moves. The more play in the lens head due to bad bearings or poor mechanics, the more likelihood there is of distorted rendering of dots. This is often the cause of a problem known as banding.

Settings

A note about settings is critical. As mentioned above, successful photo lasering depends on an accurate rendering of the halftone dots. If a high-resolution rendering (180 LPI) is necessary, the dots will be very tiny, and great care will be needed to insure accurate rendering. The following suggestions should help.

Lens — Use a lens with the smallest possible focal length, preferably 1.5".

DPI — The higher the number, the finer the detail (preferably 1000).

PPI or Rate - The higher the number, the finer the detail.

Speed — 100% is preferred but sometimes in rendering very fine detail, the speed doesn't allow the pulse to burn deeply enough. This can cause the smallest dots not to render or to be quite distorted. By slowing the speed to 50% or less, this very fine detail has a much better chance of rendering.

Power — The power is dependent on the speed setting but should be the only setting that is adjusted to arrive at final settings. The goal is to be able to render the smallest dots using the least amount of power. If the speed is 100%, use 30% power as a starting point. If the speed is 50%, a 15% power setting is preferred. Increase the power if the dots are not cutting through the cap. If the image is too dark on the light over dark material or too light on the dark over light material, reduce the power setting. Since halftone dots are being rendered, then once the settings have been established for one photo, the settings should not need to be changed from photo to photo.

Fabrication Tips

Dust

See Intro to Lasering/ Fabrication Tips, particularly the section Removing Engraving Dust. This is a common problem with photo laser engraving especially when rendering high-resolution images.

Warping and Focus

If too much of the cap surface is being burned away, there is a danger of product warping. To help counter this possibility, spray the laser bed with a light mist of water, lay the material into the water, and clean up around the edges. Use masking tape to secure the edges not in contact with the ruler guides; however, it may be helpful to secure those as well.

Taping the edges, particularly on large sheets, should prevent the exhaust from lifting the edges and causing the sheet to be out of focus.