

Preparing Halftones for Use in T_EX

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Abstract

At the 1987 TUG meeting in Montreal, I discussed the issue of incorporating halftones into T_EX documents as part of the process of publishing kennel club yearbooks. At that time, the modestly-priced scanners and software did not do an acceptable job, especially when the original was a color photograph.

In the intervening five years, advances have been made in both scanner technology and image processing software.

This is an update, showing what can be expected today when incorporating photographs into T_EX documents using the PC platform and low (300 dpi) resolution PostScript printers. Techniques I have used are presented.

Ancient History

Five years ago, I described the production of kennel club yearbooks using T_EX. There are two phases to the production of these annuals. The first is the preparation of the dogs' pedigrees. I showed that T_EX, combined with a database program, could automate this step, remove the drudgery and produce very attractive, accurate pedigrees.

The second phase was the addition of the dog's photograph to its pedigree. For several reasons, most production errors occurred in this phase. I briefly looked at the technology available at that time to see if the yearbook editor could do this electronically as well as make the camera-ready copy of the pedigree. Without known exception, these annuals are printed in black and white, but the owner-submitted photographs are color prints. Five years ago, modestly-priced software and scanners were not up to the task of producing acceptable images from color prints.

In the past five years, we have witnessed remarkable changes in hardware and software. Whereas an eight megahertz '286 computer was the norm for personal computing then, a twenty-five or thirty-three megahertz '386 or '486 machine is the norm today. The scanner I used for the original work had 400 dpi (dots per inch) resolution and no true grey scale capability — greater for OCR (Optical Character Reader), but poor for processing halftones. When it was used to scan color photographs, on a scale of one to ten, I would have to give its performance a negative value.

Modern History

Although my involvement with kennel club yearbooks has ceased, I have maintained an interest in producing high quality halftone images for use in documents typeset with T_EX. I presently produce newsletters for two organizations and numerous publications for my church. The publications frequently are illustrated with halftones. Hence, I thought I would share with you an update to my experiences in this area. As before, I am describing an environment attainable with a modest investment. There certainly is equipment and software that will do far more than I will illustrate — but not within every man's budget.

Hardware. There has been a proliferation of scanners: flatbed scanners, hand-held scanners, autofeed scanners. Most of them have an upper resolution of 300 to 400 spi (spots per inch), although some have double or triple that number. As we shall see later, as in Dalmatians, more is not necessarily better. Virtually all the new scanners are grey scale scanners. The number of grey levels vary. Sixteen or 256 are the most frequently encountered values. Color scanners are being marketed at retail prices that overlap those of grey scale scanners. The color scanners available today in the modest price range use CCD (Charge Coupled Device) technology. This is not necessarily the best technology for color scanning, but is the most affordable.

It does not take long for one to realize that with all this information being generated by the

scanner, it is going to take a lot of memory to process it. Fortunately, today's personal computers have abundant memory and high processing speed. Most people who are going to be processing digital images on a PC-compatible computer will probably be using a '386 or '486 computer with a clock speed of 25 MHz or higher and equipped with two to four megabytes of RAM. With some images requiring over a megabyte of storage, a large hard disk is mandatory if any quantity of images are going to be stored for a period of time.

Since one will want at the very least to preview a scanned image and mostly likely will want to edit—crop, size, retouch—the image, a high resolution display will be part of the system. When a scanned image is displayed on a monitor with 1024 x 768 pixels, one sees a high quality image that is truly representative of what the final image will look like. In some cases, the video representation is better than the hard copy will be!

All of this hardware should cost under \$4000 and maybe as little as \$3000. The computer with a 130 megabyte hard disk and high resolution display is available at street prices at, or close to, \$2000. I prefer a flatbed scanner which is more expensive than a hand-held one. Even so, a high quality one is available for less than \$2000.

The astute reader is going to notice that I have not discussed printers. There have been a few printer enhancement products introduced in the past year or so. I am avoiding those because they introduce a device dependence that is an anathema to \TeX users. While one could argue that PostScript makes one device-dependent, it is sufficiently widely accepted as to constitute a standard. Therefore, I am restricting myself to output for PostScript devices.

Software. The developments in image-processing software have caught up with the hardware. The software I had five years ago was very limited in its capabilities. The year after I gave my paper, Astral Development Corporation released Picture Publisher, the first greyscale image editing software for the desktop computer. Two years later, they released an upgraded version with color capacity. As the first of its kind—and an excellent product—it became the benchmark for all the image editing software that has followed. Last year, Micrographix acquired Astral Development Corporation. This spring, Micrographix released version 3.0 of Picture Publisher. It requires Microsoft Windows.

Most of the other image processing programs for the PC also required MicroSoft Windows. Here

is a quick rundown of the ones of which I have knowledge.

- ZSoft Corporation, one of the early developers of paint-type programs introduced Publisher's Paintbrush last year. They also have a less-expensive program, PhotoFinish.
- Image-In Incorporated has two programs they describe as a "darkroom on a desk": Image-In-Color and Image-In-Color Professional.
- Aldus, through the acquisition of Silicon Beach Software, now has PhotoStyler for Windows.
- Computer Associates has been showing a pre-release beta version of CA-Cricket Image.
- Not all the programs require Windows, however. Mathematica Incorporated has a program called Temptra.
- PixaFoto, like Temptra, does not require Windows. It has its own Windows-like graphical user interface. It does, however, require a special graphics (TIGA) board. This product is from PixaArts Corp.

Once one has chosen and acquired a program, one tends to stay with it unless it is unsatisfactory for the purpose, or fails to stay with the state of the art. Although I own a couple of image processing programs, I find myself using Picture Publisher for all my work.

From this quick survey, tools that are affordable are certainly available. Now the question is how well do they work?

If one is after the highest quality halftones, the best original is still a black and white photograph. The absolute highest quality is going to be achieved by preparing a plate using traditional methods. Given that it is getting increasingly difficult to obtain black and white prints, one may have no choice but to use color photographs. I believe—although I do not have any proof to back up this statement—that a color transparency will reproduce better than a color print.

Halftones prepared from black and white or color prints using digital techniques can be acceptable, depending upon the purpose. I have been using scanned photographs in two newsletters for the past year. It has taken some experimenting to determine the best way to handle different situations. Lets start at the beginning: scanning the image and obtaining the initial digital image. I have a scanner that is capable of 600 spi. This resolution is going to produce very big files. Table 1 shows the memory requirements for an 8 by 10 photograph at a number of scanning resolutions. Fortunately, we do not need all those spots. The resolution we need will be determined by the printer resolution,

Scanner Resolution spi	Greyscale	Full Color
50	0.196 M	0.589 M
75	0.441 M	1.323 M
100	0.784 M	2.353 M
150	1.765 M	5.295 M
200	3.139 M	9.416 M
300	7.061 M	21.182 M
400	12.551 M	37.652 M
500	19.614 M	27.652 M
600	28.242 M	

Table 1. Image Memory Requirements

which we will express as dpi. Table 2 gives the scanning resolutions Micrographix recommends for each printer resolution. The scanning resolution is approximately 1.5 times the screen ruling.

Bob's rule No. 1:
Do not use a higher scanning resolution than you will need for your final output device.

If you are going to use your desktop laser printer, don't waste time and memory scanning at resolutions greater than 80 spi. If you will ultimately be sending your files to a service bureau using a 1270 dpi imagesetter, then use a scanner resolution of 192 spi.

At this point, we also have to decide, since we have a color scanner, whether to scan the photograph as a color image or as a greyscale image. Remember, we will be printing our final document in black and white. Color images will be three times bigger than their greyscale counterparts. While it is fun to edit and manipulate a color image, it does not affect the quality of the output if we do

Printer Resolution (dpi)	Screen Rulings	Scanner Resolution (spi)	Grey Levels Simulated
300	53	80	64
400	62	93	83
600	84	126	102
1000	101	152	196
1270	128	192	196
2540	150	225	256+

Table 2. Suggested Scanner Resolutions

the conversion from color to greyscale when we scan the photograph. Truthfully, it will be easier to apply proper contrast and/or brightness corrections that may be necessary during image editing if we are working with the greyscale image.

Bob's rule No. 2:
Scan your original as a greyscale even if it is in color if you will be printing the final copy in black and white.

What about sizing? It is unlikely that the photograph is going to be reproduced full size in the final document. I prefer to adjust size when I am scanning. It does not affect the image quality and it makes the file size smaller (assuming that I am reducing the size of the picture).

Which brings up an interesting point. If you tried to enlarge an image electronically with earlier scanner software, you were apt to wind up with weird pictures—candidates for the Museum of Modern Art. I have successfully enlarged a photograph by a factor of two when scanning it without any perceptible digitizing in the image.

Akin to sizing is cropping. Perhaps there is unwanted or unnecessary detail in the photograph. Crop it out when you scan the photograph. If you do not get it cropped enough, you can always refine the cropping on the editing desk.

An advantage to doing the sizing and cropping at this time is that the software will do all the adjustments to the scanner resolution necessary to maintain the target resolution. So, set the resolution according to the table and the scanner driver will take care of the rest.

Bob's rule No. 3:
Size and/or crop the photograph when you scan it.

Once you have scanned the image, you can touch it up, adjust the contrast and brightness, do the final cropping and sizing, and save it as an encapsulated PostScript file. I recommend that you make some trial runs on the output. Certain colors will blend together when changed to greyscale. With a good program like Picture Publisher, you can select areas of the image and change the grey value. This is a good way to bring out detail that would otherwise be lost. Manipulating the image

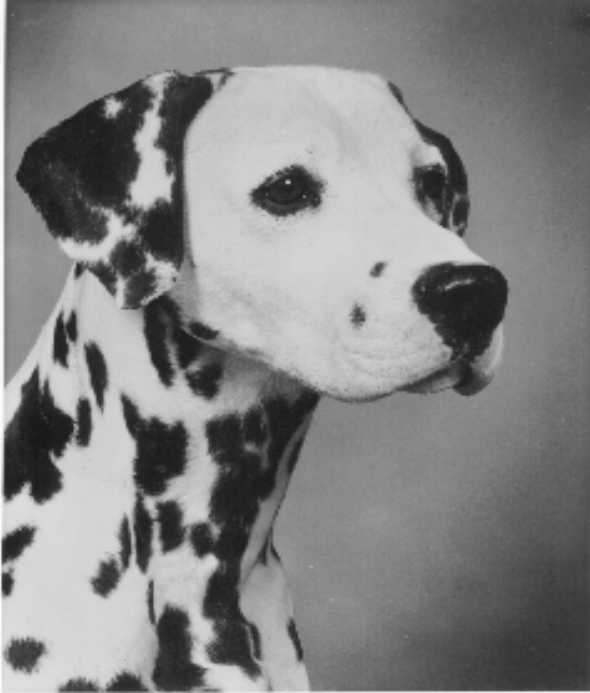


Fig 1. Fashion

this way can be time-consuming and you probably will not resort to it unless necessary.

Now it is time to view the progress. Let's start with the only photograph from five years ago that gave acceptable results — and borderline at that. It was a black and white photograph of a Dalmatian. Using one of today's scanners and Picture Publisher, she looks a lot better. This illustration was reduced from an 8 by 10 original.

The next example was taken at the beach. The foreground is sand and a little seaweed. The background is water and sky. Sneakers is brown and white with black shadings. The image was cropped from a 4 by 5 color photograph. Five years ago, she would have disappeared into the sand.

The third example is a photograph of a German Shepherd Dog. She is tan and black. She was posed on grass with some evergreen trees in the background. There was a lot of light on her chest — the sun was probably low in the sky. The original was also a color photograph. In this case, the image was enlarged slightly from 2.25 inches to 3 inches.

Lest you think I am prejudiced, the fourth illustration includes some humans. Like the first example, it was prepared from an 8 by 10 black and white photograph.

All four originals were scanned at 80 spi (see Rule 1). The area of the original to be used was masked and the desired image width was set to 3 inches before scanning (see Rule 3). Therefore, the

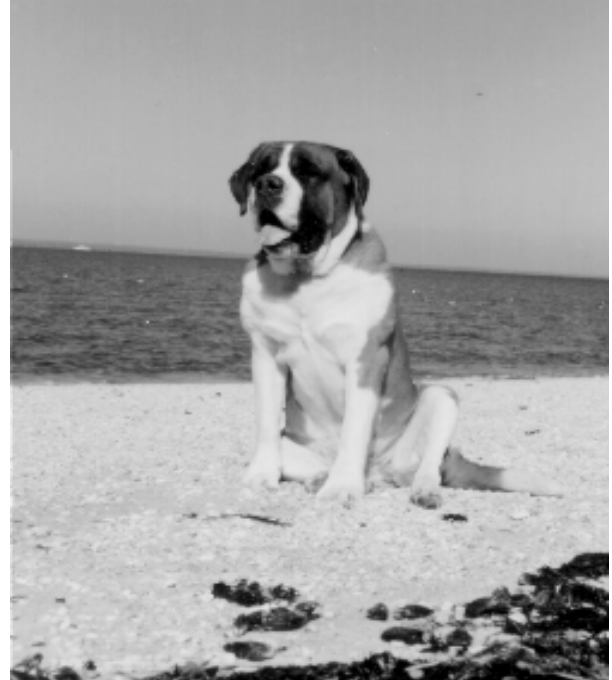


Fig 2. Sneakers

scanner driver took care of adjusting the scanner resolution. The two color photographs were scanned as greyscale images (see Rule 2). All four were printed "as scanned". No contrast or brightness adjustments, retouching, filtering or masking was done.



Fig 3. Illsa



Fig 4. Fashion with Judge and Handler

All four images were printed on a 300 dpi printer. Overall, it reminds the viewer of the quality of photographs in the typical daily newspaper of a decade or two ago. As I was preparing this presentation, a number of printer manufacturers were announcing or shipping PostScript printers with increased resolution at prices competitive with today's 300 dpi printers (QMS, for example, now supports 600 dpi on a number of their entry-level printers). The quality of these images would be greater on such a printer.

Depending upon the nature of the publication, one can prepare acceptable halftone images for inclusion in \TeX documents today with a modest investment in equipment and software. Perhaps not up to the standards set by *The National Geographic*, but useful for many purposes. The best quality halftones will still be obtained with traditional technology.