SCANNING GUIDELINES

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OVERVIEW

WHAT'S A SCANNER?

- A machine that lets you input an image into your and save it as a digital file to be enhanced or altered by image editing software for printing, storing or publishing electronically.

- Again, but more precisely: it is a machine that lets you input a 2D image or 3D object (within certain size limitations) by capturing the reflectance (from an opaque surface like paper) or the transparency (from a film negative or positive) and convert it to a digital 2D pixel map that measures light intensity and tonal values. On this map, each individual pixel is a measurement corresponding to the intensity of the reflectance or transparancy of the original object at the location of the original. These measurements can then be exported into image editing software.

HOW DOES A SCANNER WORK?

- Like a camera plugged into a computer.

- Again, but more precisely: with its own software, the scanner-camera takes a picture made up of pixels. Each individual pixel is made up of a series of numbers that describe its intensity and tonal values. These descriptions can then be exported into image editing software. To do all this the scanner uses three things: a projected light, a color separation method and an electronic device (CCD) to receive the optical information about your object and then transform that information into a digital file.

WHAT'S A CCD ?

- A CCD is a "charge-coupled device".

- Again, but more precisely: a charge-coupled device is a group, or array, of light-sensitive analog receivers that capture incident light, measure it, and convert it to digital values. When you lay a 2D or 3D object down on a scanner and start the scan, the projected light illuminates a thin horizontal strip of the object as the scanning corona moves below the object and along its along its surface (the Y-direction) just like a xerox machine. The reflected light from this moving strip is reflected by mirrors into a lens that condenses it as it moves and beams it down onto the CCD array. The CCD array converts the light from analog voltage to a digital value by means of an analog-to-digital (A/D) converter. The converter responds to the intensity of light: white is the highest intensity and highest value; black is the lowest intensity and lowest value.

GENERAL OBSERVATIONS & GUIDELINES:

• Image quality is made up of a number of elements: color accuracy, optical resolution, scale choices, tonal resolution. Not all of these elements are necessary for all scanning applications: color photos need tonal resolution and color accuracy, not high resolution; text and line drawings need high optical resolution, not high tonal resolution and color accuracy.

• Scanning at high ppi (pixels per inch) creates a comparatively large digital file. Danger: overloading your storage system within giving you significant quality improvement. These are secondary dangers, too: scanning a printed image created from halftones at high ppi, for example, increases the moiré pattern and therefore works against the increased quality that you originaly sought by means of the high ppi. (See specific ppi recommendations under FOR TEXT & LINE DRAWINGS, FOR CONTINUOUS-TONE PHOTOS, FOR PHOTO TRANSPARENCIES, below).

• Lay the image or object to be scanned up against the edge at the middle of the scanner glass plate because the optical sharpness of the CCD is best at the middle.

• If the alignment of your image is off, move the original in the same direction that it appears to be *leaning* to correct it.

• Under “Scanning Modes” your options are only two: 16 million colors and 256 shades of gray. Leave all the other options alone (never, for instance, scan using the 256 color mode because not only does the scanner need more time to scan the original and then figure out how to convert it back down to 256 available colors but the resulting file cannot be well edited with image editing software and it can never be converted back up to 16 million colors).

• Do the scaling, tonal manipulation and gamma correction using scanning hardware and software–not image editing software. Good scanners give better results than doing the scaling and tonal manipulation by means of an image editing application after the scan (see the recommendation from the Photoshop manual under GAMMA CHOICES, below).

• Scanner ppi and printer ppi are not the same. Scanners treat an image as an array of pixels. The value of each captured pixel represents one of many shades of gray or several millions of colors. Printers print dots with ink or with toners and the value of each is either black or white, or combinations of three colors (RGB), or combinations of three colors with black (CMYK). Scanner pixels and printer dots are very different animals. Moral: the individual scanner pixel contains much more information than the individual printer dot.

SPECIFICS:

FOR TEXT & LINE DRAWINGS:

Scans of text and drawing have a lot of detail compared to continuous-tone photo images. Scanning text and line drawings and printing them on a black & white printer can be considered on/off processes--that is, either a black dot or a white dot is scanned and printed. Images in text and drawings change more quickly (from blank space to ink,

from white space to black) than imges in continuous tone or even most high contrast photographs. Moral: texts and drawings are built with many sharp edges. For best quality, scan sharp edges with high sampling rates.

Scanning guidelines for text and line drawings:

- Use Grayscale mode for scanning black & white line art–not Line Scan mode. Scanning in Grayscale and then tweaking it with IMAGE/ ADJUST/LEVELS gives control over what you are losing or emphasizing. Adjust the brightness and contrast to eliminate noise and then apply the Unsharp Mask filter at a 50% threshold to sharpen the detail. Then convert to Bitmap.

- An option for color drawings is to scan as B/W, then colorize them because the luminosity of the original line is kept in the colorizing mode (that is to say, the color is applied on top of the line but it does not obscure it).

- Dye-sublimation printers have a hard time creating the sharp edges you need for text and drawings.

FOR COLOR & GRAYSCALE IMAGES:

- For both color and grayscale images, your scanning mode should be RGB color because grayscale images turn out better if you collect the color information in the scan and then convert to Grayscale.

- Again, but more precisely: this is because scanning in Grayscale uses the Green channel only. Capturing in RGB, however, uses the Green, as well as the Blue and Red channels. This allows you to open up the Channel palette, click on each channel at a time and compare the separate channel to your original. When you find which one is best, keep that channel and throw the other two away. Scanning in Grayscale alone does not give you this flexibility.

- The above technique is *especially* useful with old or damaged photographs that sometimes have damage or discoloration on the image or in the margins. Clicking on one of the channels will often “clean” up the image a lot--and this is accomplished not by image retouching that is often time-intensive and tricky, but by the simple choice one channel over the others.

FOR CONTINUOUS-TONE PHOTOS:

- For printing 300 dpi printers, scanning at 100 ppi is fine because the default for such printers is 53 halftone lines at a 45 degree angle-- therefore double at 100 ppi is more than fine.

- For printing with 600 dpi printers, 150 is usually enough at a 1:1 scanning-to-printing scale. It is safe to think of the newer photo-quality inkjet printers as 600 dpi laser printers and to proceed as though that were the case.

- For high-quality photographs with a *lot* of fine detail, there might be a little improvement by scanning at 200-300 ppi if you are then going to be printing on 600

dpi laser printers or on photo-quality inkjet printers--but you have to weigh the downside of increased file size.

- Scanning at more than 200 dpi really does not improve images that print out at their scanning size. Scanning at more than 200 dpi, however, *is* a viable option when you are dealing with radical enlargements (for example, a driver's license photo that you want to increase to life-size).

- When scanning a photograph that you intend to print on a dye-sublimation printer, scan at the printer ppi rating.

FOR PHOTO TRANSPARENCIES:

- Scan at 100-300 pixels for each printed inch. For most originals, scanning at 200 ppi works just fine; only for transparancies with lots of detil is scanning above 200 pixels per printed inch needed.

SCANNING FOR INKJET PRINTERS

- Scan at 150-200 pixels per printed inch. Going above a 200 ppi scan will most probably not be noticed when the print is viewed at normal viewing distances.

FOR GAMMA CHOICES

- Gamma measures the contrast in the midtones of an image. A gamma of "1" means all the input values equal all the output values. A gamma below 1 darkens the midtones and a gamma setting above 1 lightens the midtones.

Changing gamma with scanner software:

- The gamma of an image can be changed. High-end scanners let you to set gamma and black and white points with the scanning software before you make the scan. To capture the widest dynamic range possible, the Photoshop manual, for example, recommends that black and white points be set by the *scanner*, not Photoshop.

- Scan with a gamma of 2.2 if your image will be seen on PC monitors because they have a gamma of 2.2. The new sRGB standard also uses 2.2 and a gamma of 2.2 works well with most inkjet printers.

- Scan with a gamma of 1.8 if the image will be seen on Mac monitors because they have a gamma of 1.8.

- It is hard to lower contrast; you can always increase it; therefore you might go for 1.8 as a general rule when scanning.

TYPES AND QUALITIES OF SCANNERS

1. Handheld = scans in strips up to 4 inches wide which then get stitched with software. Image quality cannot be counted on because it tends to be either uneven or just plain bad.

2. Sheetfed = Ex. fax machines. Generally of limited quality.

3. Flatbed = Most common, most versatile and can be of marvelous quality.

- A good 300 ppi scanner is fine for photos at 1:1 and up to 4X enlargments and for scanning for the Web

- A good 600 ppi scanner is fine for enlargements of photos beyond 4X, and for scanning small originals (ex: postage stamps).

- A good 600+ scanner is fine for scanning 35mm slides & negs for enlargement.

- For high end image setters 200 dpi is good enough.

THREE WAYS IN WHICH PPI IS SPECIFIED

1. Optical resolution (ppi) = also called “true resolution = number of actual pixels captured per inch. This is meaninful in your calculations and when buying a scanner.

2. Hardware resolution = the Y direction (down page) step rate of scanner. Typically this is twice the optical resolution. This is not important in your calculations or when buying a scanner.

3. Maximum resolution = Meaningless because this refers to the maximum number of pixels a scanner or software can generate using interpolation. Interpolation is “making up” pixels and is generated by software, not the image. Don’t be fooled, therefore, by a claim that a scanner has a high maximum resolution when buying a scanner.

SOME USEFUL TERMS

- Sampling rate = the number of samples, in ppi, created by a scanner as if moves up the page. Watch out when buying a scanner: the sampling rate as described might include interpolation (pixel creation or pixel destruction by the software after the fact). Sampling rate is *not* the same as resolution.

- Resolution = the amount of detail a scanner can see in an image or object. Yes, resolution *is* affected by sampling rate (the number of pixel-per-inch samples in the scan)--but *also* by the lens quality, the color separation quality and the large or small amount of distance the corona moves as it advances up the page.

Moral: the appropriate sampling rate depends upon what you are scanning and your

output device(s). Many general guidelines for scanners equate the sampling rate to the printer resolution (ex: the rule that says scan at two times the number of the halftone or line screen of your printing device. Following this rule, therefore, you would scan at 266 ppi for a printer with a 133 line screen = too big a file in some cases (color photos) and not big enough in others (text and drawings). If we *must* have a general rule, then use this: scan at a ratio of 1.67ppi-to-1 lpi. This means that for a 133 line printer you would scan at 222 ppi (133 X 1.67). The overal best rule, however, is to consider the specifics of each image type and the desired result as described above.

Here are other terms you will come across:

- Y-direction sampling rate = The CCD works by repeatedly capturing a horizontal strip (a raster line), of your 2D or 3D image. During this proces, the scanner corona advances a small distance down the page (Y-direction). A 1/1200-inch advance, for example, equals a 1200-ppi Y-direction sampling rate.

- X-direction sampling rate = this is the width of scanner glass window divided by the number of elements in the CCD array. The array is smaller than the copyboard glass, so the optical system focuses light down to the right size for the CCD using reduction optics.

- Optical sampling rate = determined by the X-direction (the width) of the CCD array and magnification of optical system.

DIGITAL CAMERAS:

Most can provide decent quality at 640X480 for a computer monitor.

For Web, use JPEG for continuous-tone photographs, GIF for drawings and text. Scan them at 72-75 ppi.

GREAT BOOKS FOR ADDITIONAL READING:

Janet Ashford and John Odam, START WITH A SCAN, Peachpit Press, 1996

David Blatner, Glenn Fleishman and Steve Roth, REAL WORLD SCANNING AND HALFTONES: THE DEFINITIVE GUIDE TO SCANNING ANDN HALFTONES FROM THE DESKTOP, Peachpit Press, 1998.

Robert G. Gann, DESKTOP SCANNERS: IMAGE QUALITY EVALUATION, Prentice-Hall, 1999.

Dan Margulis, PROFESSIONAL PHOTOSHOP 5, John Wiley & Sons, Inc., 1995.