Digital Technology Group, Inc.
Tampa – Ft. Lauderdale – Carolinas
www.dtgweb.com

The Resolution Question

DPI, PPI, LPI, Megapixels, ahhhhh! If you don't have a good understanding of some, or all of these terms, don't feel bad, most people are just as confused. In this article we will try to explain what each of these terms really mean, how they are used in photography & printing, and how they relate to each other.

We'll start with their definitions and a few other important terms…

Dots – Dots are output by printers and are either circular or elliptical in shape and are usually one of the 3 subtractive primary colors, Cyan, Magenta, Yellow, and sometimes Black. They can overlap each other or have gaps between them (depending on resolution).

Pixels – Pixels are square elements in an image file that can be any color in the spectrum or, in an image sensor (CCD) they are usually Red, Green, or Blue. They butt up against one another with no overlap or space in between.

DPI (Dots Per Inch) – The ratio of the number of dots (or ellipses) that a printer can lay down in a linear inch. DPI is used to rate the resolution or quality of inkjet printers, laser printers and sometimes image-setters (the higher the number the better). These dots in some cases (inkjet printers) can overlap each other so be careful when judging the quality of a printer based just on it's DPI rating. Scanner manufacturers most of the time, incorrectly, use DPI as a way of rating the resolution of their scanners.

PPI (Pixels Per Inch) – The ratio of the number of square elements that an image or sensor (CCD) contains in a linear inch. PPI is used to rate the resolution or quality of scanners or image files (the higher the number the better). PPI is the actual term that scanner manufacturers should be using to rate the resolution of their scanners (most, mis-use the term DPI). You will also notice that in Photoshop your files are correctly given a pixel per inch or pixel per centimeter rating, not DPI.

LPI (Lines Per Inch) – The ratio of the number of halftone lines (made up of spots) in a linear inch. LPI is used in traditional press-work and is used to rate the resolution or quality of traditional printers (printing presses). Can also be referred to as line-screen, line frequency, or screen frequency.

Megapixels – The number of elements (pixels), in millions, in an image or digital camera chip (the higher the number the better). The Megapixel rating in a digital camera is derived from multiplying the number of horizontal pixels in the chip by the number of vertical pixels.

Optical Resolution – Sometimes referred to as "Hardware", "Physical", or "Actual" resolution.

Interpolation – Using software to artificially add pixels to a file or image therefore increasing its resolution and size in megabytes. Interpolation in small amounts can actually be very helpful but it's no replacement for actual hardware or optical resolution.

Digital Cameras & Megapixels

Since most photographs these days are captured with digital cameras, let's talk about megapixels first. One of the first "specs" you'll see when looking at a digital camera is its megapixel rating. While it's not the only thing that determines the quality of the camera it is the most important. Again the megapixel rating is the total number of picture elements (pixels) that a camera has on its chip. The higher the number the greater the detail and the larger you can print the files.

Many people ask, "What is the DPI (should be PPI) of the files from my camera"? The answer is, it depends. A digital camera doesn't really have a PPI rating because it can be any PPI depending on how big, in inches, that you make your files. The larger in inches, the smaller the PPI. We'll use a 6 Megapixel camera as an example. That would mean the chip is 3000 pixels wide by 2000 pixels high. If you wanted a 10"X 6.66" print, then the file would be 300 PPI. At 14"X9.33" the file would be approximately 214 PPI. It is important to say that this is the true, physical or optical resolution of the camera and your files, not interpolated.

Interpolation

Interpolating your files (if you were to check the "Resample" option in Photoshop's Image Size command) is using software to physically add pixels to an image therefore increasing its size in megabytes. Figures 1-3 show Photoshop's Image Size dialog box for an image in its original state, one resized without interpolation (resample unchecked), and one resized with interpolation (resample checked).

Figure 1 – Original Image Size

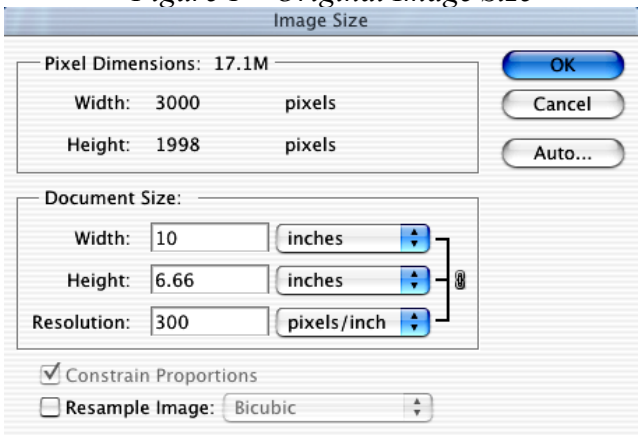


Figure 2 – Resized, no interpolation

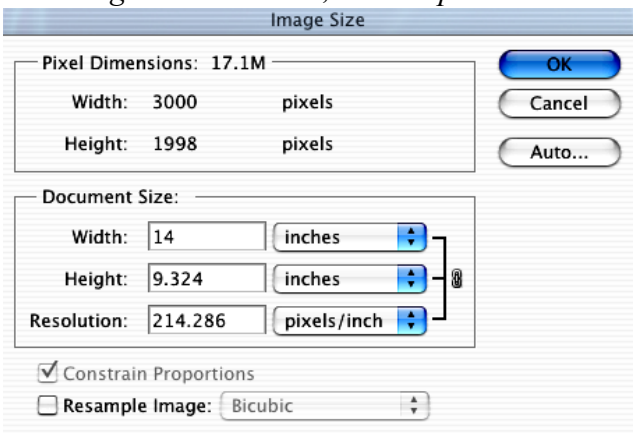
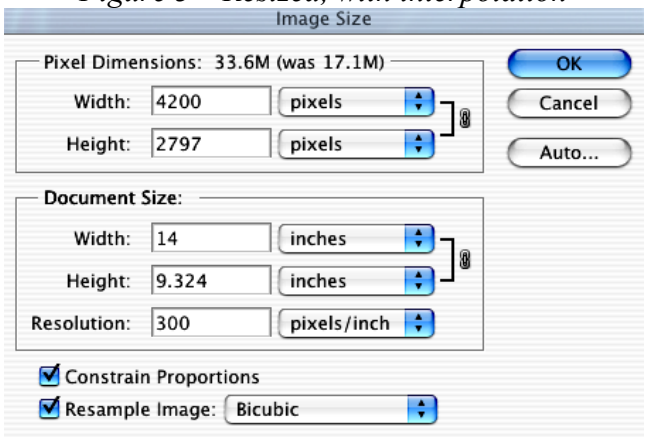


Figure 3 – Resized, with interpolation



Pay attention to the section labeled “Pixel Dimensions”. You’ll notice that the original image (Figure 1) is 17.1MB and is 3000 by 1998 pixels. In Figure 2, I’ve resized the image to 14x9.3 without checking the resample box. You can see that the resolution went down so the size can go up. This is resizing an image’s output size without interpolation. I can do this repeatedly without altering or degrading the file because it’s not changing the pixels at all. You can verify this by looking at the Pixel Dimensions and size in MBs. In Figure 3, I’ve resized the image to the same 14x9.3 dimensions but this time checked the “Resample Image” box. This is resizing an image’s output size with interpolation. You’ll notice that the resolution did not change so Photoshop is adding pixels to reach that size and resolution. Again you can verify this by the larger MB size (33.6) and increase in the number of pixels.

Interpolation in small amounts is acceptable and in some cases desirable allowing us to output larger prints. However, repeated interpolation, especially resizing up and down can degrade an image substantially. The bottom line is that there is no replacement for true, optical resolution.

PPI vs. DPI

The most common mistake people make when dealing with scanners, files, and printers is thinking that DPI and PPI are the same. As seen from the above definitions they are not, and it is important to start using the terms correctly. Pixels are NOT equal to Dots. For example, if they were the same, to get a good quality 8x10 out of an Epson printer your file would have to be 11,520 pixels by 14,400 pixels or, 498 Megabytes! A 16x20 would require a 2 Gigabyte File!

Printers use dots. Scanned files, digital camera files, and raster files use pixels. Unfortunately the industry has not helped this confusion, as the manufacturers of scanners often incorrectly use the terms themselves. Even professional scanning companies incorrectly use DPI to “spec” their scanners.

Recommended Resolutions for various types of printing

Because dot size & shape can be vastly different from printer to printer, there are no “set-formulas” to equate Pixels to DPI and LPI. So, we are going to suggest some good, general guidelines for converting them for you. Why is this important? Because if you send a file to a printer with too few pixels the print will not be as sharp or it will look “pixilated”. If your file has too many pixels it will take up more storage space on your hard drive, take longer to “retouch” in Photoshop, and take longer to print. On the following page are suggestions for some of the more common output devices.

The following recommended resolutions are for the best quality at small print sizes (under 20 inches). As you go larger in size you can lower the resolution because the print will be viewed from a further distance. Remember this is a very subjective thing and not an exact science.

Inkjet Printers

Epson Photo Quality Inkjet Printers.....240ppi at output size
Encad, HP, or quality "sign" type Printers.....150ppi at output size

Continuous Tone Photo Printers

Thermal (dye-sub) printers.....300ppi at output size
Fuji Pictrographer printers .....400ppi at output size
Lightjet .....300ppi at output size
Kodak Pegasus LED printers .....250ppi at output size

Desktop Laser Printers/Copiers

300 DPI Laser Printer .....100ppi at output size
600 DPI Laser Printer .....150ppi at output size
1200 DPI Laser Printer.....300ppi at output size

Traditional Printing Press (just double the linescreen)

133 Linescreen .....266ppi at output size
150 Linescreen .....300ppi at output size
200 Linescreen .....400ppi at output size

Remember, these are good, solid recommendations for the best print quality, but are flexible. If you are using a service bureau or lab for your printing, consult with them as they will have specific guidelines for resolution for their printing equipment.