Understanding **Resolution**

Dymistifying the confusion

It's not surprising there is so much confusion about resolution, given the many different ways there are to measure and describe it. From PPI to DPI to LPI and Pixel count to Image size to File size. It's not hard to lose track of exactly what you are being asked about your files and what the most correct answer is. David Harradine gives us the lowdown on resolution and how to work out what it all means.

Recently when asked to supply some images to a client I was given quite a bit of room for interpretation when the only requirement I was given was minimum DPI. Assuming by DPI they, in fact, meant Pixels-Per-Inch (which is generally the case), this still tells me nothing about what size the image needs to be, and ultimately leaves me in the awkward position of having to make either them or myself look stupid by asking for further clarification.

This misunderstanding can also surface when discussing digital cameras. I've heard people claim their camera shoots at 300dpi, which is simply not the case. Aside from the fact that, again, by DPI they meant PPI, digital cameras capture a fixed number of pixels, which can be then be expressed at a variety of resolutions. In actual fact, a 6 million pixel digital camera with a 23.7 x 15.5mm sensor, would be capturing something much closer to 3000 pixels-per-inch (PPI).

So lets take a step back and have look at how to describe image size and resolution in a little more useful a manner.

Image size

This Photoshop, Image Size dialogue box (below left) gives us no less than four different interpretations of the size of the image. The first set of numbers in front of the words Pixel Dimensions, are not the pixel dimensions at all, they are in fact the file size, or the amount of storage required to save the file. This figure 18.0M is itself not the whole story about file size, as depending on the compression used when saving the file, it could be slightly or significantly smaller than this. So file size is variable.

The true Pixel Dimensions are the Width and Height as expressed in Pixels. These are the only figures that can tell you anything useful about the size of the image by themselves. Pixel dimensions are the bottom line; they are how many pixels you actually have to work with. Reducing the pixel dimensions means losing data, while increasing the pixel dimensions means creating fake data.

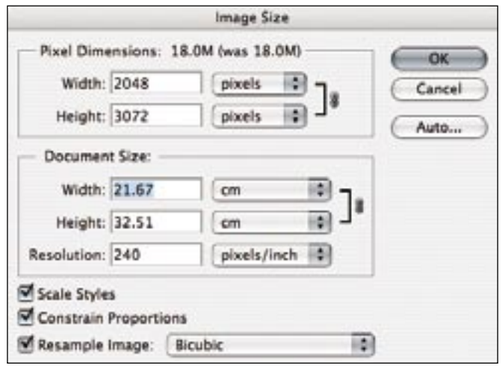
Document size

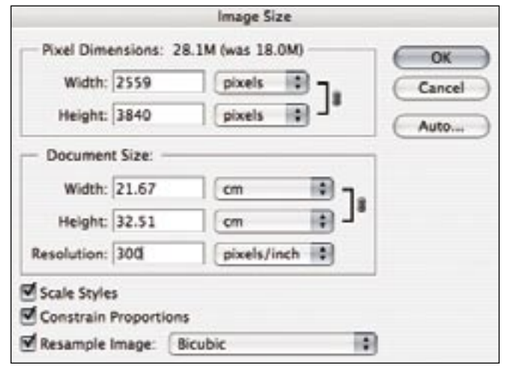
The next series of figures comes under the heading of document size, which could possibly be more accurate if described as output size. These figures describe the size that the image will be in print and the number of pixels that will be expressed over an inch. These figures are not set in stone like the pixel dimensions; they are in fact variable but dependent on each other.

For example, 2048 x 3072 pixels—if output at 240 pixels-per-inch—would produce a 21.67cm x 32.51cm print, as evident in the first image size dialogue box.

However, if I was to simply change the resolution to 300 Pixels-Per-Inch (see below right), I would be artificially increasing the pixel dimensions—because 'resample image' is checked by default in the bottom left check box—giving me an extra 500 or so pixels in the width and 800 in the height.

If, however, I de-check the resample image box to preserve the true 2048 x 3072 pixels and then change the resolution to 300 pixels-per-inch, I would produce a 17.34cm x 26.01cm print. The true pixels have been expressed as a higher resolution—therefore





smaller and closer together, therefore a smaller final output (see image below).
So as you can see, a given number of pixels as created by a digital camera or scanner, has a maximum size it can be printed at a given resolution. Printing it any larger than this will require re-sampling of the image, creating artificial resolution.
Hopefully, you can now see the uselessness of having a resolution figure alone—it requires a height and width reference to make any sense.

Terminology
As mentioned earlier there are many different units of measurement when it comes to image size or resolution, PPI, DPI and LPI, just to name a few. These terms can describe image and device attributes very precisely if used correctly. So lets now have a look at what the various units mean and when and where they are relevant.

• PPI
PPI means Pixels-Per-Inch, and describes a digital image and the number of pixels it contains over a given inch.
However, PPI can also describe the number of pixels-per-inch a scanner can capture at 100% of the scanned artwork's size; as well as the number of pixels-per-inch a monitor can display; or the number of pixels-per-inch required for optimal output on a given printing system.
Optimal print resolution has long been considered 300ppi (for reasons I will discuss below under LPI), but for many digital printing devices, 200ppi is more than adequate. However, many experts now recommend 240ppi for high quality ink jet printing—the reason being that most ink jet printers print at either 720, 1440 or 2880 dots-per-inch (or DPI), which is neatly divisible by 240, and therefore a more compatible formula for converting pixels to dots.

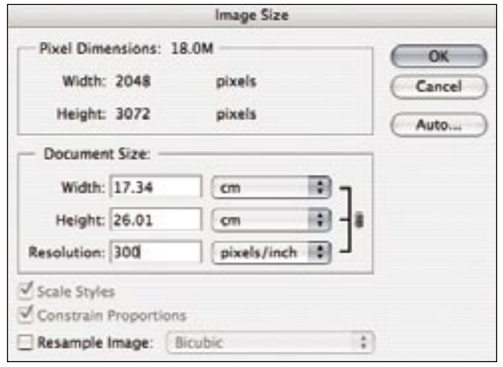
Screen resolution is 72ppi, although this can vary between 60 odd and 120 depending on the size of your monitor and the resolution you have it set at. 72ppi, however, has long been agreed upon as the standard default screen resolution, so even if you try and view higher resolution images on screen, they will just become larger, not more detailed, as the screen can only display 72.

• DPI
DPI means Dots-Per-Inch, and describes the behaviour of an ink jet printer, image setter or plate imaging device. DPI is, ironically, both the most used and least relevant figure in the list of resolution describing terminology. Scanners and images do not have DPI they have PPI. However, for reasons of simplification of marketing many device descriptions will talk in Dots-Per-Inch when they really mean Pixels.

• LPI
LPI means Lines-Per-Inch, which relates to the printing resolution. The halftone dots that appear in traditional printing are arranged in neat lines. LPI measures the number of lines that appear over a given inch—also referred to as Line Ruling and Screen Frequency. An old rule of thumb is that your digital file should have twice as many pixels-per-inch as the printer has lines-per-inch. Standard offset colour printing on coated stock is generally done at 150lpi, which is where the long-standing 300ppi print resolution comes from—150 x 2 + 300. Which of course is very often incorrectly referred to as 300dpi.
LPI will be lower for uncoated papers and newspaper, and much higher for high quality printing on high quality paper stocks.
Many newspapers will output between 80 and 100lpi, depending on their press quality and control, so 200ppi can be more than adequate; whereas many magazines may print their pages at 150lpi and then print the cover on higher quality paper at 175lpi, which can benefit from art work being supplied at 350ppi. Fine art books and super high quality printing may screen as high as 300lpi, which may benefit from 600ppi artwork, making the printers' dot virtually impossible to see with the naked eye. Printing at such high screen rulings requires very high quality paper, presses and operators.

Stochastic Printing
There is an increasingly more common type of screening process called Stochastic screening, which utilises a tiny, fixed size, random dot rather than a halftone pattern. Therefore LPI is not really relevant, although it may well be analogist to between 175 and 200. Stochastic has been around for a long time, but was very difficult to do well in the days of film, as holding such a small dot from film to plate to paper proved quite a challenge for press and operator. With the advent of direct-to-plate printing—which skips the film stage and images the digital file directly to the printing plates—stochastic has become a lot easier to manage and therefore more popular.

Communicating resolution
So in conclusion, in order to accurately communicate resolution you need to know how many pixels-per-inch are required and at what image size. If you are only told 'please supply at 300ppi'—which will more than likely be incorrectly expressed as DPI—then you have no idea what size the image is expected to be on the page.
But remember, when someone is trying to explain to you the size of an image they have on file, all that really matters is how many pixels it has. With that information you can easily work out what size it can be printed and at what resolution. For example to print an image A4 at 300ppi, you would need to supply 2480 x 3508 pixels.



David Harradine is a Photographer, trainer and Adobe Certified Photoshop expert, who regularly presents training seminars around Australia and New Zealand, on Photoshop, Colour Management, Digital Photography and—more recently—Final Cut Pro with Jon Rishworth. To see full details of his current seminars please visit www.whack.com.au.