



**GRC 101**  
INTRODUCTION TO  
GRAPHIC COMMUNICATIONS

Information  
Sheet No.

**502**

# RESOLVING THE RESOLUTION DILEMMA

## CCDs, Pixels and Image Resolution: Resizing Up and Scaling Down

One of the first questions asked by photographers interested in making the transition to digital imaging is, What is a sufficient resolution? There is no simple answer to this digital images are much more application-specific than photos captured on film.

An interesting, low-res shot might be fine for the Internet and other online applications, but it probably wouldn't work for making prints, and certainly isn't good for creating enlargements.

To work effectively with digital images, it's important to understand image resolution.

Probably the most important rule of thumb for a digital photographer is that the optimum image resolution is the resolution of the original.

But there are times when image sizes and resolutions have to be modified. So it's important to understand how to rescale images, or as it's more commonly called to res images up or down. There are two interrelated factors involved when outputting images: resolution and size..

### CCD Sensors & Resolution

Resolution consists of the number of individual dots that make up the image. Digital camera resolution is, more precisely, the resolution of the charge-coupled device (CCD) sensor that's used to capture the electronic image. Digital camera CCDs don't capture images digitally.

They are analog image-capture devices. Analog video cameras utilize the same type of CCDs to take pictures as digital cameras do.

CCDs consist of individual electronic image sensors, which are arranged in rows across the chip.

Each sensor is considered an individual picture element. Multiplying the sensor dimensions provides the CCD resolution. There may be tens of thousands, or even millions of sensors.

Determining resolution isn't difficult. A CCD with 480 rows of 640 sensors each has a total resolution of 307,200. A CCD with a sensor dimension of 1200x900 has a resolution of slightly over one million. Most consumer cameras have one CCD. Colors are differentiated by specific filters. Professional digital cameras frequently have three CCDs, one for each primary RGB color.

The individual CCD sensors generate a continuous or analog electronic signal that corresponds in intensity to the intensity of the light that falls on it. Digital cameras convert these signals to a numeric value, which also corresponds to the intensity of the light reaching the sensor. With most digital camera models, each analog sensor position is converted into one digital image pixel.

Most higher-end consumer models already have a 3-megapixel (or 3-million-pixel) resolution.



There are various models on the market already with 4-megapixel resolution, and a 5- megapixel consumer camera should be available by the time this is in print..

## Interpolation

Technically speaking, pixels are digital. So there are no pixels until the analog- to-digital conversion process occurs. That's an important distinction because some digital cameras are being marketed as having pixel resolutions that exceed the actual number of sensors in the CCD.

In the past, several digital camera manufacturers tried to convince people that their models had higher resolutions than they actually had by advertising an expanded resolution. For example, on one camera model, the resolution was automatically kicked up by proprietary software when the images were being transferred from the camera to the computer.



More recently, some camera manufacturers are relying on a type of hardware interpolation to increase resolution (increasing the resolution through software is called interpolation). Utilizing sophisticated algorithms, the electronics in those cameras intelligently create digital data between the actual sensors during the analog to- digital conversion process. There's still some debate whether the resulting resolution is true or interpolated.

Original image size and resolution are issues when generating photo-realistic prints or preparing images for publication. Resolution can be expressed as a total, such as 1200x900 pixels for the total dimensions of an image, or as dots-per-inch (dpi), sometimes also referred to as pixels-per-inch (ppi). A 4x3-inch photo with the above pixel dimensions would have a 300 dpi resolution (the size of the image divided into the total pixels)..

## Image Size

Whether expressed as a whole or as dpi, resolution is not a particularly big issue when images are used online. Monitors can generally only display images at 72 dpi, so it doesn't take a very high resolution to display an attractive on-screen image. Some programs will display an image by size rather than by resolution, so the display size is correct. But with other programs that determine display by resolution, a digital photo with a 300 dpi resolution would actually appear about four times that size because of the 72 dpi monitor-display capabilities.

Such programs display an image as large as it needs to be to accommodate 72 dpi. The horizontal 1200 dpi image would be displayed as more than 16 inches wide; 1200 pixels divided by 72 pixels-per-inch. The 4-inch-wide print and 16-inch-wide screen image are the same resolution.

There's a distinct mathematical relationship between resolution and size. A 1x1-inch photo with a 300 dpi resolution has the same number of pixels as a 2x2-inch photo with a 150 dpi resolution.

For most printing and publishing, 300 dpi resolution images are mandatory at the sizes that they are going to be reproduced.

Image resolution can be changed by modifying the size and keeping the same dpi, by maintaining the size, but changing the dpi, and by altering both size and dpi. The impact of changing the dpi and/or size of an image on that image depends upon image use. Changing the dpi of an electronic photo on-screen changes its size. Changing the dpi of an image intended for printing doesn't affect the size, but it does have an impact on the quality. The lower the dpi, the lower the quality..

## Re-sizing Images

If an image must be scaled, it's better to scale down than to res up. For example, if two similar digital images are available, one with considerably higher resolution and one with lower resolution than what's required, reduce the resolution and/



or size, rather than increasing the pixel count of the lower-res image. In most situations, the image quality is better when the resolution is reduced.

One notable exception is when there are very fine lines in the composition, such as strands of hair, fine tapestry weavings, or distant telephone wires. Sometimes, when reducing the pixel count of such shots, those fine lines don't line up afterwards when



pixels are removed.

(A close-up detail of the mural image. This illustrates image imperfections that get worse as image sizes are increased.) Reducing the pixel count of a digital image is relatively easy, and most image-editing programs do a fine job. But increasing resolution is another matter. Most imaging programs like Adobe Photoshop and Ulead PhotoImpact can increase resolution. Software image interpolation isn't ideal, as it's basically adding pixels.

But the more sophisticated the software, the better the results.

Rather than making the image appear to be a higher-resolution shot, the resulting artifacting and staircasing (the jaggies as they're sometimes called), make the image look like it's actually a lower resolution, because the imperfections are increased. Fortunately, image editing programs that rely on that rudimentary form of interpolation aren't being used much any more.

More sophisticated software packages like Photoshop intelligently add pixels with color values and intensities that have been determined mathematically through complex calculations.

They take such things as transitions and gradations into account to reduce banding and come up with more natural-looking images.

There are also some programs available that are specifically designed to optimize image file size changes. Altamira's Genuine Fractals is a good ex-

ample. It utilizes very sophisticated software routines to increase image size. If there's sufficient digital data available in the original image, Genuine Fractals can increase image size with very good results.

Obviously, there's a lot more to know about resizing digital images and changing their resolution, but keeping some of these considerations in mind can make the process easier.