



## File Format Fundamentals

“**Raster images** use many colored pixels or individual building blocks to form a complete image. JPEGs, GIFs and PNGs are common raster image types. Almost all of the photos found on the web and in print catalogs are raster images.

“**Vector images**, alternatively, allow for more flexibility. Constructed using mathematical formulas rather than individual colored blocks, vector file types such as EPS, AI and PDF are excellent for creating graphics that frequently require resizing.”

– MODassic

Graphic images – such as photographs, illustrations, drawings, logos, and clip art – are a great addition to any printed piece. When combined with text, images measurably increase reader comprehension, retention, and interest when compared to text only. In printing and publishing, graphic images are two-dimensional (2D), while on the web images can be two- or three-dimensional (3D) or multimedia.

### How graphic images are formed

There are two ways to form graphic images: pixel by pixel in a grid (called a bitmap or raster image) or mathematically from geometric objects such as points, lines, curves, and polygons (called vector images). Digital photographs and all images that have been scanned are bitmap images; vector images originate primarily from illustrations or drawing software programs or from plotters used in technical drawing.

Examples of **bitmap file formats** are Tagged Image File Format (TIF or TIFF); Joint Photographic Experts Group (JPG or JPEG); Graphics Interchange Format (GIF), Adobe Photoshop (PSD); bitmap (BPM); Windows Paint (PCX); and pixel image format for Macintosh (PICT). Photo editing or image editing software such as Adobe Photoshop, Corel PaintShop Pro, or Microsoft Paint all work on bitmap files.



Examples of **vector file formats** are Encapsulated Postscript (EPS), Adobe Illustrator (AI), and CorelDRAW (CDR). Popular vector drawing software includes Adobe Illustrator, CorelDRAW, and Macromedia Freehand.

A *metafile* is classified as a vector file format, though it contains both bitmap and vector information (an object – the vector – is filled with a bitmap pattern). Computer Graphics Metafile (CGM) and Windows Metafile (WMF) are both examples of this graphics file format.

Both screen displays and graphics on the web use bitmap image files, and GIF and JPG are the most widely used file formats in this application. Print projects can use either bitmap or vector images; the preferred file formats are TIF (bitmap) or EPS (vector).

### Characteristics of bitmap images

A bitmap image is a matrix of individual dots (called picture elements or pixels), each having its own color. Because pixels are so tiny, the human eye is unable to distinguish them individually, and so perceives the image as having smooth gradations. Only when a bitmap image is greatly enlarged are we able to see the individual pixels.

Although bitmap images can be any color, there are four common categories describing how color is used:

- *Line art* images contain only two colors – black or white. The computer has to use only one bit to assign color to each pixel: on = black; off = white.
- *Grayscale* images contain various shades of gray as well as pure black and white.
- *Multi-tone* images contain shades of two or more colors. A well-known multi-tone is the *duotone*, usually consisting of black and one other color.
- *Full color* images use a color space such as RGB (Red Green Blue) or CMYK (Cyan Magenta Yellow Black) to assign colors to each pixel.

A bitmap does not need to contain a bit of color-coded information for each pixel on every row; it only needs to contain information indicating a new color as the display scans along a row. Thus, an image with much solid color will tend to require a small bitmap (and smaller file size).

Bitmap images are resolution dependent. (Resolution is a measure of the number of pixels used to create the image and is usually stated as dots per inch or pixels per inch.) Computer screens and the web require fewer dots per inch (DPI) to render an image than a printing device; hence an image that has sufficient resolution for a screen display or web application may have insufficient resolution for printing.

In addition, because bitmap images are resolution dependent, it is difficult to alter the size without changing image quality. To make an image smaller, it is down-sampled by throwing out pixels, thereby changing its resolution (fewer pixels = less resolution) and making the image lose sharpness. Up-sampling is used to make an image larger by adding new pixels through a process called interpolation. Interpolation assigns a color to the new pixel based on the color values of surrounding pixels. Interpolation, particularly when many new pixels must be created, often results in a blurry image.

### Characteristics of Vector Images

A vector image is created from many individual, scalable objects (lines, curves, and shapes) that are defined by mathematical equations. Instead of using individual pixels, a vector image describes a series of points to be connected. There can be many points to be connected or just a few control points connected with Bézier curves. Bézier curves were widely publicized in 1962 by Pierre Bézier, a French engineer who used them to design automobile bodies.

The objects in a vector image may be assigned attributes (such as color, fill, or outline) without affecting the object itself. A vector image can be altered (enlarged, reduced, rotated, stretched, etc.) without losing resolution, and any object in the vector image can be altered independently of other objects in the image. Finally, an object can be modified by changing its attributes or by shaping and transforming it. A font is an example of a vector image.

All these characteristics mean that a vector image can be changed without affecting its resolution, making it resolution independent. This makes a vector image a good choice for logos which must be re-sized frequently. And because a vector image consists of points rather than bits, it tends to be much smaller than a bitmap image.

Despite its many advantages, a vector image has one disadvantage: it cannot create a photo-realistic image. Compared to bitmap images, the objects and lines of vector images may look artificial.

### Which Image File Format is Best?

Given the many choices for image files, what is the best choice? The answer depends on your application. If you are using images for screen display or for your company's web site, you may want to optimize the file size. In this case, GIF or JPG is the best choice.

However, when selecting images for a document for us to print, we ask that you use either TIF or EPS. TIF is the leading professional image standard; is supported by Mac and Windows platforms; supports RGB, CMYK, and other color spaces; stores data with bytes in either Mac or PC order; and offers several compression formats. EPS is a Postscript file that also satisfies some additional restrictions that are intended to make it easier for software to embed an EPS file within a Postscript document. EPS files may also include a preview picture of the content for screen display.

# a vocabulary of the graphic arts

**AI:** an acronym for Adobe Illustrator. Files that have the .ai extension are drawing files that the Adobe Illustrator application has created.

**Bitmap:** a display space and color for each pixel in the display space.

**EPS:** Encapsulated Postscript. A graphics file format that is a Postscript file with restrictions. Usually a PostScript file that describes either an illustration or a single page. An EPS file allows a postscript image to be included in other pages. Also, a standard file format for importing and exporting Postscript files.

**GIF:** Graphics Interchange Format. A bitmap graphics format defined in 1987 by CompuServe. It uses a lossless compression.

**JPEG:** Joint Photographic Experts Group. A group of experts that developed and maintain standards for compression algorithms for computer image files. Also a term for any graphic image file produced using a JPEG standard.

**Lossless Compression:** a class of data compression algorithms that allows the original data to be perfectly reconstructed from the compressed data.

**Lossy Compression:** a class of data encoding methods that uses inexact approximations and partial data discarding to represent the content. These techniques are used to reduce data size for storage, handling, and transmitting content.

**LZW:** Lempel-Ziv-Welch. Abraham Lempel and Jacob Ziv are Israeli researchers who in 1977 and 1978 published

papers under the auspices of the Institute of Electrical and Electronics Engineers that serves as the basis for most work on compression. Building on this, Terry Welch patented the compression technique now known as LZW. The patent was owned by Unisys but has now expired.

**Metafile:** a list of commands to draw objects (vector image) and commands to assign attributes to the object (bitmap image).

**PDF:** stands for Portable Document Format. A file format that has captured all the elements of a printed document as an electronic image. PDF files are created using Adobe Acrobat, Acrobat Capture, or similar products.

**PNG:** Portable Network Graphics. A patent-free bitmap graphics format developed as a replacement for GIF.

**PostScript:** a page description language developed and marketed by Adobe Systems.

**PSD:** stands for Photoshop Document. The default format that Photoshop uses for saving data.

**Raster image processing:** the process of converting a graphics file to a raster of addressable dots appropriate to the output device specified.

**SWF:** Shockwave Flash. A vector image format for Macromedia's Flash web software.

**TIF or TIFF:** Tagged Image File Format. A common format for exchanging raster graphics (bitmap) images between application programs, including those used for scanned images.

## T H E I D E A

### *Altering Clip Art for Greater Interest*

A clip art graphic image in vector format can easily be modified to better fit your document. Here are some suggestions for altering clip art for greater interest:

- **Reorient:** clip art that is facing the wrong way can be flopped creating a mirror image or rotated to achieve the orientation you need.
- **Use only a portion:** crop the clip art to reveal only the important part for your application. Remove elements you don't want or don't need. Disassemble the clip art and use a few pieces.

- **Combine two or more images into one:** create a new image out of several other pieces of clip art, or pull out elements and combine them in a new way.
- **Change the color:** convert colored clip art to gray scale or black and white, or add color to black and white clip art.

## *Purchasing Graphic Images*

When purchasing a graphic image, it is generally best to get it in the form in which it was created. For stock photography, this will mean a bitmap file such as JPEG or TIFF; for clip art, a vector format such as EPS or metafile.

Even though we request a TIFF or EPS graphic image for your document, always archive the graphic image in the native format of the graphics software program you are using. Then if you later must edit the file – resize, resample, or save in other formats – you can revert back to the native format to make the modifications.

If you are creating images for the web using JPEG format, it is also a good idea to first save a high resolution archival copy of the file. JPEG uses a lossy compression algorithm. Lossy means “with losses” to image quality, because pixels are thrown out every time the file is opened, edited, and re-saved. A file compressed with a lossy method may be quite different from the original file at the bit level. The best practice is to edit the original file in its native format, then export as a new JPEG.



*Should I use TIFF or JPEG for my photo image files?*



Although JPEG files are much smaller, you'll probably be happier with your photographs as TIFF files. Uncompressed TIFF files for photo images are often very large, meaning the image contains much detail – lots of bytes per pixel. And a TIFF file compressed with lossless compression means no pixels are thrown out in the compression algorithm. Therefore you can always recover each bit of data without corruption.

The JPEG file format is intentionally designed as lossy to make the file compression efficient and produce relatively small files. To do this, JPEG modifies the color values of the pixel. Tiny detail such as minor color details are not retained – in other words, are lost. This produces a substantial file size reduction, but also means that when you reopen the file it no longer contains the same data as before. Moreover, every time the JPEG file is compressed and saved again, pixels (and therefore quality) are lost. Before you exchange file size for quality, be sure the tradeoff is worth it.

*questions and answers*