

# Understanding Graphics/Images

There are many different types of images. A solid foundation in the terminology associated with these different types of images will help you in working with multimedia.

**Line art** is the term used to describe drawings that contain flat colors without tonal variations. These images generally contain only black and white pixels; however, they could also be drawings that incorporate different colors. An example of line art is shown below.



**Continuous-tone images** are graphics that have tonal variations such as color photographs. A **grayscale image** is a continuous tone image consisting of black, white, and gray data only. This is an image comprised of a range of grays up to 256 levels of gray.

Images can also be classified as **two-dimensional (2-D)** or by adding depth to them they become, **three-dimensional (3D)**. As illustrated in the figure below, three-dimensional images are much more lifelike than two-dimensional images. However they are more difficult to create and they require greater computer resources to work with and display.



In Web pages, graphics can serve as a link just as text serves as a link. These clickable graphics are called **hypergraphics**. They serve as links to other locations within the same Web site or to entirely different Web sites. In addition, they may be set to trigger certain events within the Web site. When a graphic is also a trigger, the mouse pointer will change to a pointing finger when it's placed on a hotspot. Each graphic can contain one trigger or the same graphic may contain several triggers. Graphics that contain more than one trigger are called **image maps**. A single image usually takes less time to download than do multiple images, which is why image maps are commonly used on the opening menu screens of Web pages. However, be aware that image maps are more difficult to create and maintain than single images.

**Clip art** refers to a collection of drawings generally organized by category. Extensive clip art libraries are available with some software packages, on CD-ROM, or for download from the Web sites such as Clipart.com. Clip art is an excellent alternative if you aren't an artist, don't have time to create your own images, or don't have the money to hire a graphic designer. Some graphic images available as part of a clip art library are **public domain**. When images are in the public domain, it means you can use these images at your discretion for no charge (other than what you may pay up front to purchase the clip-art library). Others, however, have restrictions and charge royalties. Royalties are more commonly charged if you plan to use the graphic for commercial purposes. The royalty may be charged each time you use the image or it may be a one-time fee. Be sure to read the licensing agreement carefully before you include someone else's clip art in your multimedia application.

**Original Artwork** – with a little time and effort you can generate your own digital images. There are many drawing, painting, and image-editing programs available for you to use. Some are intended for creating graphics, while others are designed for editing existing images. There are many advantages to creating original artwork. You don't have to worry about copyright and licensing agreements and you don't have to be satisfied with a graphic that isn't exactly what you want. Although there is a learning curve anytime you set out to master a new software program, the ability to create original artwork or edit existing graphics will prove to be an invaluable skill.

## Image Quality

Many factors affect image quality. Some of these factors you can control. DPI and bit depth determine the quality of an image. **Bit depth** describes how much RGB (red, green, blue) information is measured about each pixel. The more pixels you have, the better your image; however, the increase in the number of pixels will also increase the size of your image file.

## Resolution

When it comes to multimedia, resolution can be a pretty confusing term. This is because it is used with several different multimedia elements, and it means something slightly different each time it is used. In other words, there are many types of resolution. There is resolution as it relates to computer monitors which measures either the number of dots per inch (dpi) that the monitor can produce or the number of dots per inch on the screen. There is also resolution as it relates to sound. Right now we want to look at resolution as it relates to the image itself. There are two types of resolution related to graphic images that you need to be familiar with. Both of these affect image quality and file size.

## Color Resolution

Color resolution measures the number of bits of stored information per pixel or how many tones or colors every pixel in a bitmap can have. Color resolution is also called **bit resolution**, pixel resolution, **color depth**, **bit depth**, and pixel depth.

Color resolution will range from 1-bit color (2 colors) to 32-bit color (16.7+ million colors) with the most common ranges being 8-, 16-, and 24-bit color. As shown in the figure below, the total number colors are calculated by raising the two possible states (0 or 1/on or off) to the number of bits stored for each state. The higher the bit depth, the greater the number of colors stored in the image. For example, 1-bit graphics are only capable of displaying two colors, black white. This is because there are only two combinations of numbers in one bit, 0 and 1.

Color Resolution		
32-bit	$2^{32}$	16.7+ million colors plus an 8-bit (256-level) grayscale mask
24-bit	$2^{24}$	16.7+ million colors
16-bit	$2^{16}$	65.5 thousand colors
8-bit	$2^8$	256 colors
4-bit	$2^4$	16 colors
2-bit	$2^2$	4 colors
1-bit	$2^1$	2 colors

An image with a greater color resolution will be more colorful and of higher photographic quality. While 32-bit color depth will produce a higher-quality image, it will also make the file size much bigger because more bits must be stored for every pixel. Therefore, as shown in the figures below, there is a trade-off between color depth and file size.



Grayscale = 110K

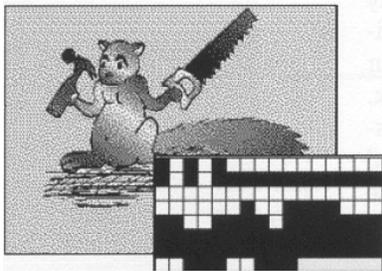


8-bit = 328K

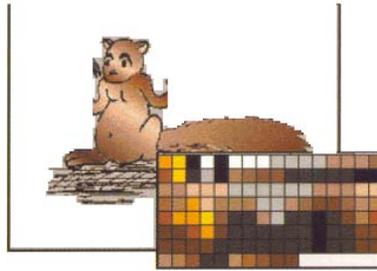


16-bit = 655K

The colors that make up the image are referenced to a "palette." Notice how the palette in the figures below changes as the bit depth of the image changes.



1-bit color = 2 colors



4-bit color = 16 colors



8-bit color = 256 colors



Web-safe color = 216 colors

The main point to remember is that the number of colors available in the palette is determined by the color resolution of the image.

When an image with millions of colors is converted to an image with 256 colors, some colors have to be removed from the image. This is accomplished either by dithering or banding the image. **Dithering** is the process of positioning different colored pixels side by side to create the illusion of some missing color. **Banding** reduces the colors without dithering, which results in areas of solid colors. Although neither of these options is good, dithering is generally a better option.

## Image Resolution

Image resolution refers to the amount of information stored for an image. Image resolution is typically measured in pixels per inch (ppi). Images must be at a certain minimum resolution to avoid a pixelated or out-of-focus appearance. A high image resolution is extremely important if a graphic is to be printed. However, computer monitors cannot display more than 72 ppi.

Therefore, Web graphics should be set to 72 ppi. Setting Web graphics any higher than 72 ppi only makes them larger both in file size and on screen. When deciding upon an appropriate resolution for your image, keep in mind that although a higher resolution will display a superior image, it will also result in a larger file size. This means the file will require more storage space and it will take longer to display. In other words, there is a trade-off for higher-resolution image. When creating images for Web pages, we must be willing to give up some quality in order to

ensure that the graphic file sizes are small enough to download quickly. Most images can be optimized if you do the following:

1. Crop to the smallest area possible
2. Choose and apply the image size (in pixels) that you will need for your final product
3. Reduce the resolution of the image to no more than 72 ppi (pixels per inch) if it will be displayed on a monitor or Web page
4. Reduce the number of colors to the minimum necessary for the image

## **The Final Resolution**

Virtually all computer monitors display graphics at 72 dots per inch (dpi), so any graphics that are displayed on screen should be resized to this resolution. Anything higher than this will take longer to load, but will not improve the quality.

If you are working with vector images, you do not have to worry about resizing. Vector graphics are resolution-independent, which means that the resolution or size of the display does not change the way they look.

## **Image Compression**

As it is, graphics take up a lot of space, and because graphic files take up a lot more storage space than text, it is quite easy to run out of disk space or to spend a significant amount of time waiting for graphic files to transfer or download. For these reasons, you may find it necessary to compress your image files. **Compression** is simply an algorithm that is used to create smaller file sizes. The two types of compression are lossless and lossy.

With **lossless compression**, none of the data is actually lost during compression. Instead, mathematical algorithms eliminate redundant data. If there isn't a lot of redundant data, the file size may not be significantly reduced. Many graphic formats and compression utilities, such as WinZip and Stuffit use lossless compression.

In **lossy compression** some of the data is actually lost. The idea behind lossy compression is that some of the data isn't important to an image and therefore that data is expendable. Although this decreases the size of the file, it doesn't impact the quality of the image. The advantage to lossy compression is that it offers greater image compression than lossless compression. **Lossy** compression changes some pixels while making the file size smaller. The main drawback of a lossy algorithm is that the greater the compression, the poorer the quality of the image. It becomes important to balance quality with file size.

## **Graphics Management**

Graphics are one of the key components of a multimedia experience. Whether they are scans of photographs, vector drawings made in an illustration program, or a bitmapped representation of an object, graphics go hand in hand with audio, video, and text to create multimedia that will captivate viewers and keep their attention.

Many software programs are available for creating and managing graphics. Programs often used by businesses are Microsoft Paint, Adobe Photoshop, Macromedia Fireworks, and Macromedia FreeHand. Image management programs, sometimes referred to as **graphics editors**, are of two types: painting and drawing.

**Painting** or **paint programs** create bitmap images by using pixels (picture elements). Pixels are small squares (usually) with each pixel being assigned a defined color, size, and place in the image. These images get their name because each "bit" in the image is mapped to a specific color. Every pixel is accounted for and defined, unlike vector images. As a result, when you enlarge a bitmapped graphic, it loses quality, because it is designed to be used at a certain size.

Photographs are examples of bitmapped graphics. The sharpness of the image is determined by the density of the pixels, and this density determines the resolution. The higher the resolution, the better your image will appear or print out but the larger the file will be.

**Drawing programs** create images by using mathematically defined lines and curves, or **vectors**, that are treated as individual objects within the images. **Vector graphics** use points and lines to describe the picture. For instance, three points describes a triangle – it does not matter how big or small you enlarge the image, the triangle will always be perfectly smooth, because the three lines are drawn "on the fly." An advantage of vector graphics over bitmap images is that regardless of how much the image is enlarged or reduced (called *scaling*), the quality remains the same. A vector graphic is smoother than a bitmap graphic because the image is mathematically derived for each output device. Once a vector graphic is completed, it can be converted to a bitmap image. (Another name for a bitmap is *raster*, so this process is called *rasterizing*.) Vector graphics are converted to bitmap images for use on the Internet. Shockwave Flash images and animations are vector graphics. Vector graphics are smaller in size than bitmaps, but they are limited because they cannot show gradations of colors as bitmaps can. The most common native vector formats are CDR for CorelDraw, AI for Adobe Illustrator, FH for Macromedia FreeHand, SWF for Shockwave Flash, and WMF for Windows Metafile. **EPS (Encapsulated PostScript)** is a general-purpose vector file format that has both the vector image data and a screen preview in the same file. It is most commonly used for printing purposes.

The type of multimedia project you are creating will determine which types of graphics you will need. For example, if you are creating a cartoon for display on the Web, you will most likely draw the characters and elements in vector format using a software program designed for creating Web animation. Not only do vector images load quicker across the Internet, but their quality is more reliable, since not everybody has the same type of monitor set to the same resolution.

Photographic images, though, use bitmapped graphics. If you need to display a realistic image of a person, event, or location, bitmapped graphics will be much more suitable. Although paint programs are often easier to use, drawing programs give higher-quality results. Some graphics

management programs such as Photoshop and Paint Shop Pro combine both painting and drawing options within a single program.

## **Image File Formats**

Image programs save graphics with specific extensions indicating the file format. The extension is shown by two to four letters following the dot in the name of a file. For example, if a document is named **picture.jpg**, “picture” is the name of the file and “.jpg” is the extension indicating the file format.

Each image management program has a file format specific to that program, called its **native** or default format. For instance, Adobe Photoshop saves images as .psd.. Generally, an image should be saved in its original or native format to use as an archive or backup of that image. By doing this, you can open, edit, and then save the image in a different format without losing any quality. This is an important step in the creation of an image. Once a copy of an image has been saved in its native format, you can change to another file format.

Different file formats are appropriate for different situations, so it is important to understand the distinctions between the various file formats. For example, some programs can only import graphics with specific file formats. Some images look better saved as one format over another, and some images need to be small in order to load quickly on the Internet. Knowledge of file formats enables you to make the best choice.

One of the most common types of bitmapped images is a **BMP (Bitmap)** file. A BMP image is usually used in word processing documents. BMP file sizes are often quite large, even though they are usually limited to 256 colors because they are not compressed as some other formats are. BMP files work well in programs that require the Microsoft Windows operating system.

A bitmap file type that works well in all environments is **TIF** or **TIFF (Tagged Image File Format)**. Like BMP files, these files are quite large and are often used in print documents. TIFF

files are not compressed and can show 16 million colors. Many scanners produce images as TIFF files, and some digital cameras can save photographs in TIFF format as well.

The file formats most often used for Web pages are **GIF (Graphics Interchange Format)** and **JPG** or **JPEG (Joint Photographic Experts Group)**. GIF, pronounced with either a hard or soft "G," is an image file format developed by CompuServe. Because GIFs use only 256 colors, the file sizes are quite small. GIFs are used to create line drawings, images with transparent backgrounds, and animated figures. Because photographs require greater color depth, they lose much of their quality if they are saved as GIFs.

JPG or JPEG (pronounced "jay-peg") is another file type. Using up to 16 million colors, JPG images reproduce the quality, color, and detail found in photographs or graphics using blends and gradients. Most digital cameras save photographs as JPGs to conserve memory space on the camera's storage device.

The **PNG (Portable Network Graphics)** format is one of the most flexible formats on the Web. Unlike GIF or JPEG, the PNG file format supports a number of different color depths including 256 colors (8-bit), as well as millions of colors (24-bit or 32-bit). Like GIF, PNG uses lossless compression, which means that no quality is lost when an image is saved in this format. In addition, the compression scheme used in the PNG format will almost always create slightly smaller files than the compression scheme used for GIFs. The PNG file format supports variable transparency that allows you to store up to 256 different levels of partial transparency rather than just one. PNG also supports interlacing. PNG's interlacing method is conceptually similar to GIF interlacing and visually similar to progressive JPEG, which means that embedded text in an image is typically readable about twice as fast in a PNG image as it is in a GIF image. The PNG file format has one more advantage over GIF and JPEG – the capacity for gamma correction. Gamma correction refers to the ability to correct for differences in how computer monitors interpret color. The biggest disadvantage of this format is that not all applications allow you to easily create PNG files, and not all browsers support this format without plug-ins.

**PICT** Apple Computer introduced the PICT (PICTure) format in 1984. It is a standard format for Mac as graphics software, but the Web does not support it. Modern versions of PICT support 32-bit color. PICT files can be both bitmap and object-oriented images, which is what vector graphics are often called when they are saved or created in this file format.

**TGA** also known as the Targa format, was developed by the True Vision Corporation. It was the first high-quality graphics file format, and is supported by most paint programs. Used for full color, it can use lower color resolution. Windows uses the .tga file name extension for Targa files.

### Sources

- Coorough, C. (2001). Multimedia and the Web. Orlando, FL: Harcourt, Inc.
- Lake, S. E. & Bean, K. (2004). Multimedia and Image Management. Mason, OH: Thomson SouthWestern.
- Shuman, J. (2002). Multimedia Concepts, Enhanced Edition—Illustrated Introductory. Boston, MA: Thomson Course Technology.
- Solomon, A.W. (2004). Introduction to Multimedia. Woodland Hills, CA: Glencoe/McGraw-Hill.
- Vaughan, T. (2001). Multimedia: Making it Work (5<sup>th</sup> ed.). Berkley, CA: Osborne/McGraw-Hill.