Information Management Resource Kit

Module on Management of Electronic Documents

UNIT 2. FORMATS FOR ELECTRONIC DOCUMENTS AND IMAGES

LESSON 8. FORMATS OF ELECTRONIC PICTURES

NOTE

Please note that this PDF version does not have the interactive features offered through the IMARK courseware such as exercises with feedback, pop-ups, animations etc.

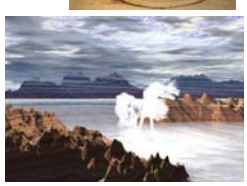
We recommend that you take the lesson using the interactive courseware environment, and use the PDF version for printing the lesson and to use as a reference after you have completed the course.

Objectives

At the end of this lesson, you will be able to:

- understand the main characteristics of **digital images**;
- identify the features of the main **Bitmap** and **Vector-based** image formats; and
- understand the principle of **conversion** between different image formats.

Introduction



Electronic pictures are electronic snapshots taken of a scene or scanned from documents, such as photographs, manuscripts, printed texts, and art works.

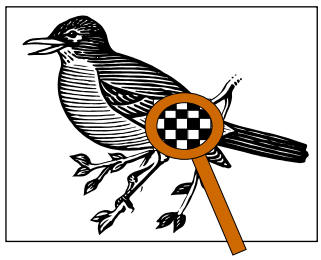
When you insert images in an electronic document, you need to consider two main factors: the quality of the image and its size in Kb. In fact, if you use large images the document download and transfer could be slowed down.

On the other hand, the higher the quality, the larger the image becomes.

In this lesson, you will learn how to balance these two factors.

Let's start with the basic concepts…

Bitmap



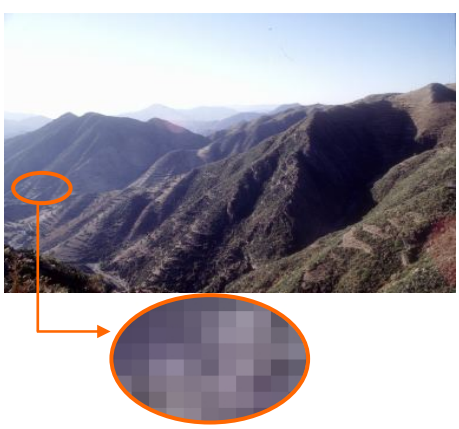
■ = 0

□ = 1

The photograph or scanned image is sampled and mapped as a grid of dots or picture elements (**pixels**).
Each pixel is assigned a position and a **tonal value** (black, white, shades of gray, or colour), which is represented in **binary code** (zeros and ones).
For example, in a black and white image (without grays), each pixel is assigned 0 (for black) or 1 (for white).
The binary digits (**bits**) for each pixel are stored in a sequence by a computer and are often reduced to a mathematical representation to decrease file size. The bits are then interpreted and read by the computer to produce an **analog version** for display or printing.

The digital image that you obtain is called a **Bitmap**.

Resolution



The quality of a bitmap image is determined primarily by its **resolution**, which is the ability to distinguish fine detail.

A good indicator of resolution is often the **sampling frequency**, that is the frequency at which a digital image is sampled.

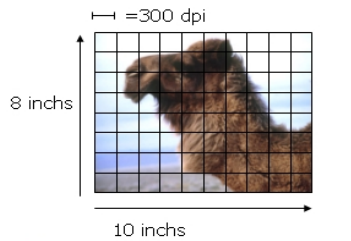
This is why dots-per-inches (**dpi**) or pixels-per-inches (**ppi**) are common and synonymous terms used to express resolution for digital images.

Generally, but within limits, **increasing the sampling frequency** also helps to **increase resolution**.

Pixel dimensions

How can you determine the **size** of your bitmap image?

You need to calculate its **pixel dimensions:** the horizontal and vertical dimensions expressed in pixels.



Pixel dimensions: 3,000 x 2,400

This may be determined by **multiplying the width and the height** of the image respectively, **by the dpi**.

For example, this is a 10" x 8" picture scanned at 300 dpi.

The pixel width is: 10" x 300 = 3 000
The pixel height is: 8" x 300 = 2 400

The pixel dimensions of this digital image is therefore: 3 000 pixels by the 2 400 pixels.

Colour Encoding

The basic function of colour encoding is to provide a digital representation of colours. The colour value of each pixel is defined by a **group of bits**:

Bi-tonal (bitmap) images usually have **1 bit =** 2 tones (2^1)

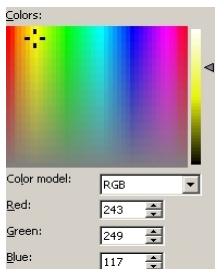
Gray-scale images usually have **2-8 bits or more** = 4-256 tones (2^2-2^8)

Colour images usually involve **8-24 bits or more** = 256- 16.7 million tones (2^8-2^{24}). In a 24-bit image, the bits are often divided into three groupings: 8 for red, 8 for green, and 8 for blue. Combinations of those bits are used to represent other colours. A 24-bit image displays 16.7 million colours (2^{24}).

With the increase in the number of bits used, the variety of subtle shades available increases, as does the brightness of the resolution.

Colour Encoding

Colour encoding involves specifying the numerical representation of a colour**.** A **colour model** is an orderly system for creating a whole range of colours from a small set of primary colours.



For example, the **RGB colour model** has a gamut of the primary colours **Red, Green, and Blue**. It is an additive colour system, since it combines transmitted light to produce a range of colours. Mixing two primary colours it creates complementary colours. For example, red and green are mixed to obtain yellow. Both **scanners** and **monitors** use the RGB colour model.

The **CYMK colour model** is made up of **Cyan, Magenta, Yellow, and Black**. It is a subtractive system, since it uses coloured pigments and dyes that reflect light, taking colour away from white light. All of the colours in the printable portion of the colour spectrum can be achieved by overlapping the four colours. **Printing** and **photography** are based on this model.

Exercise

The properties of this image are listed on the right hand side. Can you determine to which parameters they correspond?

colour model	=		a
colour value	=		b
Pixel dimensions	=		c
Resolution	=		d

30 dpi	a
24 bits	b
RGB	c
288 by 255 pixels	d

Click each option, drag it and drop it in the corresponding box.

When you have finished, click on the confirm button.

Key Bitmap Formats

Usually, scanned images are saved in tiff format; then, to reduce the file size, you can save it in other formats (e.g. GIF, JPG, PNG) which use compression techniques.
There are standard and proprietary compression techniques. In general, it is better to use a standard supported one, since it lends itself to long-term use or digital preservation strategies.

There are two main types of compression:

LOSSLESS

Lossless schemes abbreviate the binary code **without discarding any information**, so that when the image is decompressed it is bit-for-bit identical to the original. This type of compression is also called **non-destructive**. Lossless compression is most often used with **bitonal images** of **textual material**.

LOSSY

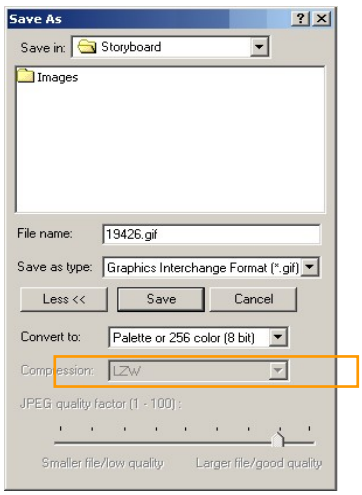
Lossy schemes utilize a means for averaging or discarding the least significant information, based on an understanding of visual perception. This type of compression is also called **destructive compression**, since it can have a pronounced impact on image quality, especially if the level of compression is high. However, it may be extremely difficult to detect the effects of lossy compression, and the image may be considered visually lossless. Lossy compression is typically used with tonal images.

Key Bitmap Formats

GIF (Graphics Interchange Format) is the oldest web-friendly graphic format and is used to store multiple bitmap images in a single file for **exchange** between platforms and systems.

It is supported by most graphical software applications and scanner and video software. GIFs are recognized by all web browsers. The format supports black and white, gray-scale, and colour images **up to 256 colours** (8-bit).
It is a safe choice for any web image but is **better for text, drawings and illustrations with flat colours.**

Key Bitmap Formats



The image data stored in a GIF file is always compressed using a **lossless** compression scheme called LZW. GIF compresses by scanning **horizontally** across a row of pixels and finding solid areas of colour.

The LZW algorithm reduces strings of identical byte vales into a single code word and is capable of reducing the size of a typical 8-bit (256 colours) image by 40% or more.

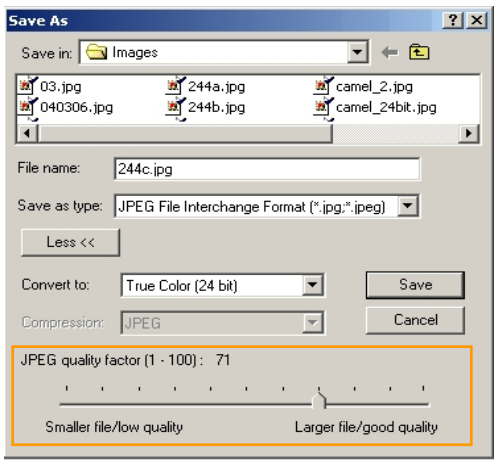
Key Bitmap Formats

JPEG / JPG (Joint Photographic Experts Group) is not really a file format. Rather, it is a method of encoding data used to reduce the size of a file and is most often used with TIFF file format.

JPEG is designed for compressing either full colour or gray-scale images of natural, real-world scenes.

It is a good format for displaying **photographs** in web-compatible format, since it supports millions of colours and can be compressed quite small.

Key Bitmap Formats



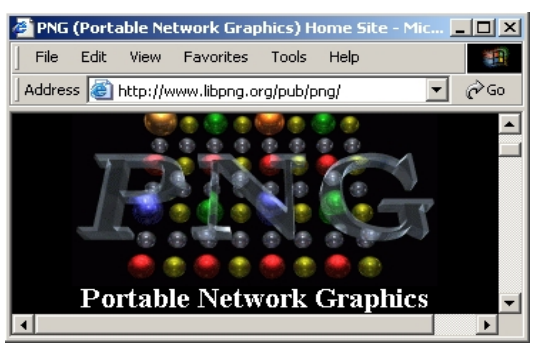
JPEG provides a compression method for continuous tone image data with a pixel depth of 6 to 24 bits. It is primarily a **lossy** method of compression. It is possible to choose by **how much to compress** a file, however, the smaller the final file, the greater the information that is lost.

However, some forms of JPEG compression are considered **visually lossless**. In general, a JPEG file will compress a photographic image to 2 to 3 times smaller than a GIF.

Lossy compression makes JPG files a **poor choice** for archiving or for other applications where you might later need the **full image quality**.

Key Bitmap Formats

PNG (Portable Network Graphics) is a relatively new **standard** from the World Wide Web Consortium designed to replace the GIF format. Used to transmit and store bitmapped images, it has several **advantages over GIF**: variable transparency, cross-platform control of image brightness, and two-dimensional interlacing.



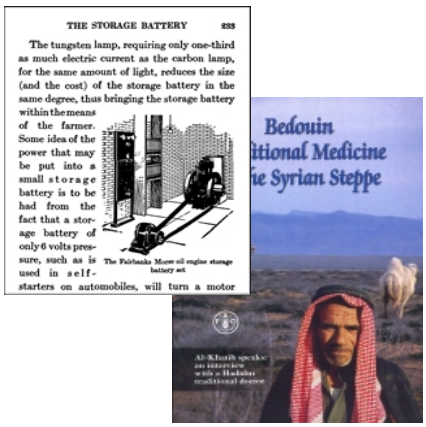
It supports 48-bit true colour or 16-bit gray-scale.

It is a good choice for **archiving bitmap images** and is web friendly.

It compresses across rows and columns of pixels, often allowing for greater compression than GIF by 5% to 25%.

This **lossless** compression method is fast, well documented, and available at no cost.

Key Bitmap Formats



TIFF (Tagged Image File Format) is an old standard designed to store black and white images created by scanners and desktop publishing applications.
Today it is probably the most versatile, widely supported, and reliable bitmap format. TIFF's extensible nature allows it to store multiple bitmap images of any pixel depth: bitonal, gray-scale, palette colour, and true colour.

It is a good choice **for archiving** bitmap images, but not for publishing on the Web, as TIFFs can result in large file size.

TIFF can be **compressed in several ways** and is **not platform dependent**. It can also be stored as uncompressed data, but the files are quite large.

Key Bitmap Formats

JPEG is:

☐ a lossless compression method

☐ a lossy compression method

☐ designed as a compression method for TIFFs

☐ a compression method for images with a pixel depth of up to 2 bits.

Click on the answers of your choice

Bitmap vs. Vector Based

Not all pictures are made of pixels, and a good example of non-pixel based images are the **Vector based** ones.

Vector data come in the form of points and lines arranged on a grid; the relationships between these points and lines determines the shapes, forms and colours displayed. Vector files contain mathematical descriptions of one or more image elements, which are used to construct a final image.

They can represent **cartoon-like drawings**, but are inappropriate for photo-realistic images. It is the choice for **CAD** (Computer Aided Design) and **GIS** (Geographic Information System) programs.

Bitmap vs. Vector Based

Here are the differences between bitmap and vector based images:

	Bitmap	Vector Based
Origin	Describe shapes as a pattern of **pixels**, like a puzzle.	Describe shapes **mathematically** and are drawn using points, lines and curves on a grid.
Text	May include text, but **cannot be edited**.	May contain text with font information that **can be changed**.
Shape	Consist of thousands of pixels that are arranged in a **"bitmap" rectangle**.	Are **not restricted** to a rectangular shape.
Resolution	Resolution **dependent**: higher resolution produces higher quality images, since more information is captured.	Resolution **independent**: you can increase and decrease the size to any degree and the lines will remain crisp and sharp both on screen and in print.
Formats	GIF, JPG, PNG, TIFF	CMX, CDR, DWG, AI, CGM, DXF, WMF, EMF, EPS, FH
Programs for editing/ browsing	Adobe Photoshop, Corel Photo-Paint, Paint Shot Pro, Publisher, Ulead PhotoImpact, Microsoft Paint ...	Adobe Illustrator, CorelDRAW, AutoCAD, Macromedia Freehand, Xara Serif Draw Plus, Harvard Draw, Creature House Expression ...

Bitmap vs. Vector Based

These are some software to work with vector file formats:

Adobe Illustrator® is a program primarily used to create what is often called "outline art" (also known as a "vector graphic"). For example, think of a typical company logo, a starburst shape in an advertisement, etc. "Outline art" because you simply draw the outline of a shape, assign it a fill and the drawing program automatically fills in the shape as a solid or as a blended and degradated colour.
Formats: AI, WMF, EPS.

CorelDRAW® is powerful software for graphic design, page layout, photo editing and vector animation. It offers live feedback, extensive compatibility and a full range of output options.
Formats: CDR, CMX, WMF, EPS.

AutoCAD® is a 2D and 3D design and drafting platform that automates design tasks, and provides digital tools. Architects, engineers, drafters, and design-related professionals use AutoCAD to create, view, manage, plot, share, and reuse accurate drawings.
Formats: DXF, DWG.

Bitmap vs. Vector Based

Formats like EPS, WMF and EMF are **interchange formats**, that is they can be **used across different software packages**.

EPS

Encapsulated Postscript file (EPS) is a standard format for importing and exporting PostScript language files in all environments.
It is usually a single page PostScript language program that describes an illustration. The purpose of the EPS file is to be included as an illustration in other PostScript language page descriptions.

WMF/ EMF

In general, a metafile is a list of commands that can be played back to draw a graphic. Typically, a metafile is made up of commands to draw objects such as lines, polygons and text and commands to control the style of these objects.
Microsoft Windows Metafile (WMF) is a 16-bit metafile that can be used by Windows 3.x, Windows 95, 98 and Windows NT to display a picture.
A **Microsoft Enhanced Windows Metafile (EMF)** is a 32-bit metafile that can be used by Windows 95, 98 and NT (not Windows 3) to display a picture. It can contain a much broader variety of commands than a "regular" Windows metafile.

Bitmap vs. Vector Based

SVG (Scalable Vector Graphics) is a new graphics file format and web development language based on XML which is being developed by the World Wide Web Consortium. It is a language for **describing** two-dimensional **graphics in XML**.

SVG benefits from XML's **strength and widespread use**. Any existing XML parser can read SVG, making exchange easy.

A major drawback to SVG is that at this time it is not fully supported by any browser. Users of web browsers must use **plug-in** technology, such as the Adobe SVG plug-in, to view SVG images.

Bitmap vs. Vector Based

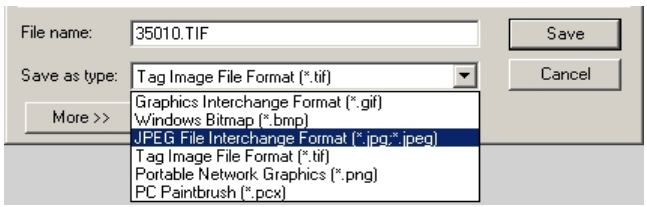
This table summarizes the typical usage of each format:

Print table

	DESIGNED FOR...	USAGE ON THE WEB
TIFF	Creating, editing and storing high-resolution images for printing. Ideal source for conversion to low-resolution formats	Not suitable because TIFFs can result in large file size, and are not web compatible
GIF	Displaying images with large, flat colour areas (e.g. logos, diagrams, charts) in web-compatible format	Very suitable, supported by all web browsers
JPEG	Displaying images at more than 256 colours (e.g. photographs) in web-compatible format	Very suitable, supported by all web browsers
PNG	Replacing and improving GIF on the Web and, to some extent, TIFF for editing and preservation	Supported by a number of browsers with exceptions (updates on www.libpng.org/pub/png/pngstatus.html#browsers)
WMF EMF	Exchanging and storing vector-type images	An exchange format unsuitable for direct access outside of Microsoft Office applications
EPS	Importing, exporting and reusing PostScript language files in all environments	A production and exchange format unsuitable for direct access
SVG	Displaying vector images on Web XML-based media	Not yet fully supported by web browsers, plug-in is needed

Conversion between Image Formats

Conversion **from one image format to another** can be carried out easily. In general, conversions from bitmap to bitmap, vector to vector, and metafile to metafile are not difficult.
Conversion from combinations of these formats to others is possible, with the exception of bitmap to vector conversion, which is almost impossible.
Having a **master file** of an image in the appropriate format will ensure good results when conversion becomes necessary.



Format conversion can often be done simply by exporting or saving the file in **image editing programs**. In addition, some **conversion tools and applications** devoted to format conversion are Hijaack (for Windows), PBMPlus (for Unix), DeBabelizer (for Mac).

Conversion between Image Formats

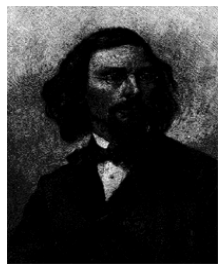
Scaling refers to the process of **resizing** an image from a digital master without having to rescan the original document. Because the digital master is almost always of a **format** and **size** inappropriate for web browsers, scaling creates an "access version". The goal is to speed delivery to the desktop without compromising too much image quality.

The program and scripts used for scaling will affect the display quality.
For instance, scaling can introduce moiré (wavy patterns) in illustrations when resolution is reduced without paying attention to screen interference (e.g. the right image was scaled without using a blur filter):

Conversion between Image Formats

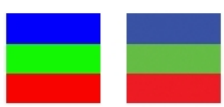
Scaling programs are also used to reduce the **bit-depth** of an image and different processes result in substantially different quality.

Note the difference in image quality between the two derivatives that were created using different conversion software.



Conversion between Image Formats

RGB supports a much greater range of bright, saturated colours that would not normally appear in printed photographs and illustrations (neon colours, for example). Converting an RGB image with bright colours to CMYK will produce the following darkening and flattening of some colours:

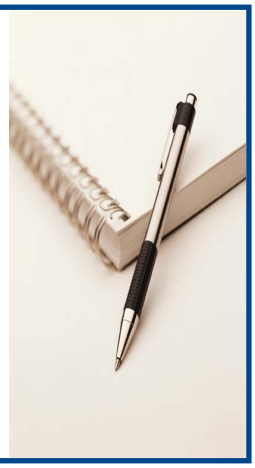


RGB ⇨ CMYK

When scanned or digitally photographed, printed documents are captured as RGB images. Thus, conversion from RGB to CMYK is not advised unless the image is to be printed.

Summary

- **Bitmap** images are digital images made up of a number of **pixels**.
- The quality of a digital image is determined primarily by its **resolution.**
- The colour value of each pixel is defined by a **group of bits**.
- Bitmap images can be compressed using the **lossless** or **lossy techniques**.
- The most commonly used bitmap formats are: GIF, JPG, TIFF, PNG.
- **Vector based** images are based on mathematical descriptions.
- The most common exchange formats for vector based images are: EPS, WNS, EMS.
- **SVG** is a new graphics file format and web development language based on XML.
- In general, **conversions** from bitmap to bitmap, vector to vector, and metafile to metafile are not difficult; conversion from combinations of these formats to others is possible, with the exception of bitmap to vector conversion, which is impossible.



Exercises

The following five exercises will help you test your understanding of the concepts that were covered in the lesson and provide you with feedback.

Good luck!

Exercise 1

The pixel dimensions of a 5x7-inches photograph scanned at 600 dpi are:

- ○ 1,200 x 4,200 pixels
- ○ 3,000 x 4,200 pixels
- ○ 3,000 x 1,500 pixels

Click on the answer of your choice

Exercise 2

PNG images:

- ☐ often allow for greater compression than GIFs
- ☐ use a lossy compression method
- ☐ use a compression method supported by multiple platforms
- ☐ use a compression method that is proprietary

Click on the answer of your choice

Exercise 3

The LZW compression scheme is:

☐ lossless

☐ used for png images

☐ used for jpg images

☐ used for gif images

Click on the answer of your choice

Exercise 4

Can you match each exchange format with its corresponding features?

EPS

WMF

EMF

Enhanced metafile that can be used by Windows 95, 98 and NT, but not Windows 3. a

List of commands that can be played back to draw a graphic. b

Standard format for importing and exporting PostScript language files. c

Click each option, drag it and drop it in the corresponding box.

When you have finished, click on the confirm button.

Exercise 5

Moire is the result of:

- ○scaling
- ○image compression
- ○digitizing
- ○filtering

Click on the answer of your choice.

If you want to know more...

Bitmap vs. Vector Based
Moving Theory Into Practice: Digital Imaging Tutorial, Cornell University Library/Research Department, 2000-2002: http://www.library.cornell.edu/preservation/tutorial/.

Digital Image Basics by Jonathan Sachs (Adobe PDF format): http://www.dl-c.com/basics.pdf

Glossary of Image Basics: http://ldt.stanford.edu/helplab/image/glossary.html
"Encyclopedia of Graphics File Formats, 2nd Edition" by James D. Murray, William vanRyper (O'Reilly, 1996)

"Non-Designer's Scan & Print Book" by Sandee Cohen and Robin Williams (Peachpit Press, 1999)

Main Bitmap Formats: GIF, JPG, TIFF, and PNG
TIFF Revision 6.0 Specification: http://partners.adobe.com/asn/developer/pdfs/tn/TIFF6.pdf

The Unofficial TIFF Home Page: http://home.earthlink.net/~ritter/tiff.
JPEG/JGIB Homepage: http://www.jpeg.org.

W3C overview of JPEG: http://www.w3.org/Graphics/JPEG

Portable Network Graphics (PNG) Homepage: http://www.libpng.org/pub/png.

W3C overview of PNG: http://www.w3.org/Graphics/PNG

Graphics Interchange Format (GIF) Version 89a: http://www.dcs.ed.ac.uk/home/mxr/gfx/2d/GIF89a.txt.

If you want to know more...

Main Vector Based Formats: EPS and WMF
The GraphicsSoft section of the "About.com" website is an entire section devoted to image formats, tutorials, and software reviews. Here students can take an online tutorial of CorelDraw or other graphics software packages, and can also click on related links about vector file formats and get detailed information.

http://graphicssoft.about.com/

The University of Melbourne has an online GIS tutorial that includes a section on vector-based GIS formats. This is a good discussion of "intelligent" vector files.
http://www.sli.unimelb.edu.au/gisweb/GISModule/GIST_Vector.htm

Conversion Between Image Formats
Converting Images: How to handle common graphics format conversion situations:
http://graphicssoft.about.com/library/weekly/aa000420a.htm

Moving Theory Into Practice: Digital Imaging Tutorial, Cornell University Library/Research Department, 2000-2002: http://www.library.cornell.edu/preservation/tutorial/.

Emerging Formats: SVG
Scaleable Vector Graphics (SVG) 1.0 Specification: http://www.w3.org/TR/SVG.

SVG Toolkit: http://sis.cmis.csiro.au/svg/