Image Type
The two types of digital images are *vector* and *bit-map.*

A vector image is made up of lines, shapes, and other elements, each described mathematically in terms of its position, rotation, placement of corners or curves, and other attributes. Drawing programs such as Adobe® Illustrator® and Autodesk Inc.'s Autocad® generate or manipulate vector images.

A bit-map image is made up of small square picture elements, or *pixels,* arranged in a grid; each pixel's color and grid position are described numerically. Scanners and digital cameras generate bit-map images, and paint or retouching programs such as Adobe® Photoshop® and Corel® Painter® also can generate or manipulate bit-map images.

Color Model
The method used to describe the hues in an image is called the *color model.* Color information is defined for each pixel of a bit-map image or each object of a vector image.

Black and white: Every pixel or object is one of two values, generally expressed as black or white. This is also known as "one-bit color", since the color information can be encoded in a single bit of data—zero for black and one for white.

Grayscale: Every pixel or object has no hue information, only a value for intensity, usually expressed as a range from black (zero intensity) to white (maximum intensity). An older, pre-digital term is "monochrome", used especially in photography. In digital images, grayscale images often are "eight-bit": eight bits of data are used to assign values, allowing for 256 distinct levels of intensity.

RGB (red-green-blue) color: The color model most commonly used for full-color digital images, based on the additive primary colors. It may be "sixteen-bit" or even "twenty-four bit", although the former is more often used.

CMYK (cyan-magenta-yellow-black) color: The color model most commonly used for print, based on the subtractive primary colors, plus black for more convincing dark shades. The intensity of each color ranges from zero (none) to 100% (maximum). Black is called *K* instead of *B* to prevent confusion with blue.

Other color models, such as Lab and HSB, are found in specialized applications rather than in graphic design or art.

Resolution
In general terms, *resolution* describes the level of detail in an image—the threshold beyond which a coherent visual representation cannot be reconstructed.

Vector images are described as "resolution-independent". Because the elements of such an image are described mathematically, the image may be enlarged or reduced at will without loss of clarity, just the way a mathematics student can change the size, but not the shape, of a graphed line or object to meet the conditions of a test question.

In a bit-map image, each pixel represents the minimum unit of visual information available to that image. Enlarging such an image beyond an established standard may have undesireable and possibly even unusable results, as the pixels become large enough to be noticeable and may even come to dominate the image. Below is a list of generally accepted standards for image resolution, measured in *pixels per inch* (ppi) in the US or *pixels per centimeter* (p/cm) in Europe and elsewhere.

Use of Image	**Resolution**
Display on monitors, as for a Web page	72 or 96 ppi
Four-color (CMYK) print publication	300 ppi or greater
Grayscale (single-color) print publication	400 ppi or greater
Black-and-white print publication	600 ppi or greater

File Format
A digital image file format organizes the data describing the image in a fashion understandable to application software. A wide variety of formats exists; the list below covers only the most commonly used.

A digital image file can contain a huge amount of information and may be very large, so file compression may be used to reduce file size. Some methods, termed *lossless,* may preserve image quality at the price of limited size reduction; others, called *lossy,* reduce file size drastically at the cost of compromising image quality, perhaps severely. The rigorous requirements of print demand lossless formats, while the Web's need to load pages quickly favors lossy formats.

TIFF (Tagged Image File Format): TIFF is a robust, time-tested lossless format for bit-map images, and thus is the preferred choice for print publication. LZW (Lempel-Ziv-Welch) lossless compression can reduce file size to some extent.

EPS (Encapsulated PostScript®): EPS is useful for both vector and bit-map images, making it a popular choice for print second only to TIFF. It is versatile and for bit-map images can be lossless, but there is no readily available compression.

AI (Adobe Illustrator): The native format for vector images created in Adobe Illustrator, it is a *de facto* standard but may not be compatible with competitors' programs.

PSD (Adobe Photoshop): The native format for bit-map images created in Adobe Photoshop, it is a *de facto* standard but may not be compatible with competitors' programs.

JPEG (Joint Photographic Experts Group): The most popular format for images created by consumer digital cameras and for images posted on the Web. It is notoriously lossy and thus unacceptable for print use.

GIF (Graphic Interchange Format): Formerly owned by CompuServe®, GIF entered the public domain some years ago. Its lossy treatment of color makes it unsuitable for print.

PNG (Portable Network Graphic): This format was created as an alternative to GIF when the latter was still under patent protection. PNG is more versatile, particularly in its treatment of transparency, but because it is intended purely for Web use, its lossy color handling is inadequate for print use.

PDF (Portable Document Format): This is a special case; Adobe created PDF to be a universally readable format for use in all manner of documents. It is indeed useful and versatile, but it is really more of a wrapper around the contents. Individual pieces of a PDF file may be TIFF or JPEG images, and unless a full professional copy of Acrobat® is available to inspect and manipulate the PDF file, there is no way to know what those contents are, and one is dealing with a pig in a poke. In short, this is a useful format if one can control every step of the process, and should be avoided otherwise.

Image type

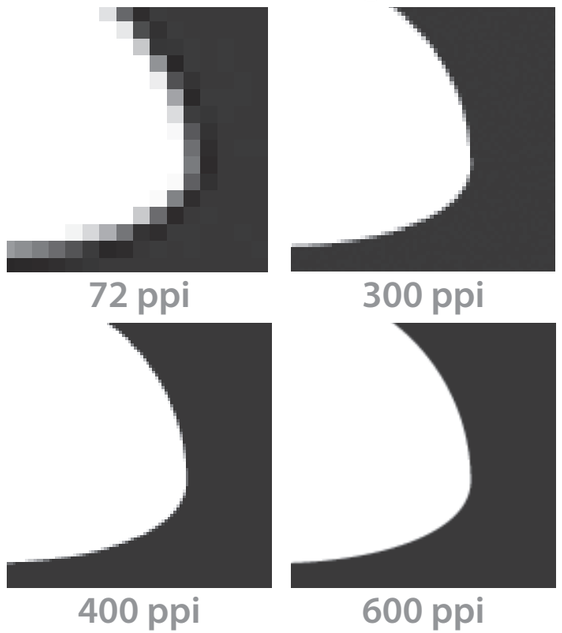
Vector Bit-map

Color model (enlarged 8 ×)

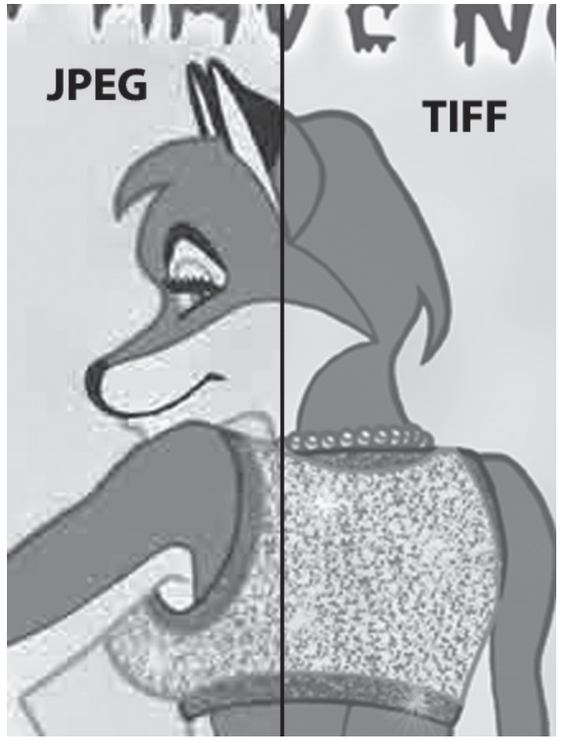
Black and white Grayscale

RGB and CMYK not shown due to printing limitations

Resolution (enlarged 8 ×)



File formats: lossy vs. lossless



A "lossy" format such as JPEG can compress a digital image to a small file size, but at the cost of image or color quality; a "lossless" format such as TIFF preserves image quality, but at the price of large file size

Lossy—preferred for Web
JPEG: Joint Photog. Experts Grp.
GIF: Graphic Interchange Format
PNG: Portable Network Graphic

Lossless—required for print
TIFF: Tagged Image File Format
EPS: Encapsulated PostScript
PSD & AI: Adobe native formats

Cheat sheet courtesy of Catspaw DTP Services
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The printing process

Printing a publication through a professional print house is unlike producing an art print or other document on individual sheets of paper via a desktop computer and printer. A printing press can range from several feet in any dimension up to the size of a tourbus, and can cost millions of dollars.

Paper stock used in large presses arrives at the print house in the form of gigantic spools, often wider and larger in diameter than a man is tall and weighing tons. A spool is fed into the press at the input end, and as the stock proceeds through the press, each color is printed on the paper until all are in place. Printing speeds are counted in *impressions per minute,* and a good press may achieve speeds in the hundreds.

As the printed paper exits the press, it is cut into large sheets called *signatures* and stacked. When the stack is large enough, it is taken away, perhaps by forklift, for folding and chopping. Looking at a signature, which may contain four, eight, sixteen, thirty-two, or even sixty-four pages, can seem confusing, since the pages appear to be in random order.

In fact, the arrangement of pages, called the *imposition,* is calculated so that, when the signature is folded properly, all the pages fall into correct order. Chopping cuts off the edges so that the folds are removed, leaving a stack of paper a couple of inches larger in each direction than the final page size. Consecutive signatures are assembled into *blocks,* each containing a complete copy of the book or other document.

From there the blocks go to trimming and binding. The trimmer cuts the block to its final size, called the *trim size,* and the bindery assembles the block and cover into a finished product, which is then shipped out to the distribution system.

All of this takes places as quickly as possible, because time is money, especially when dealing with large machines that take hours to warm up, cool down, or repair if something goes wrong. In light of this, the level of precision that printers can achieve is nothing short of amazing—but it is not perfect.

Lining up all the colors, called *registration,* is critical to a quality product; poor registration can result in blurry, unreadable images, so tolerances must be barely visible fractions of an inch. Proper trimming is important as well, but the physical properties of paper and of machinery dictate that tolerances are more on the order of a sixteenth of an inch.

As a result, the actual trim of a given page may vary by as much as an eighth of an inch. For that reason, any art intended to reach the edge of the page must include a *bleed.* The bleed is extra image area beyond the trim, to allow for variation from copy to copy. In the US, the standard bleed is one-eighth inch; elsewhere it is three to four millimeters. Without a bleed, there would be a white edge where the actual trim fell outside the intended trim, which looks unsightly and unprofessional.

Thus if a magazine has a trim size of eight inches wide by ten and a half inches tall, a full-page advertisement or illustration that has a "full bleed" or a "four-corner bleed"—that is, it bleeds off all four sides of the page—would have to be eight and a quarter inches wide by ten and three-quarter inches tall, to account for the eighth-inch bleed on each edge.

One other consideration is *live area.* This is the portion of the page within which all important text or visual information must fall. Generally it is defined as the area inside the margins of the page, though for full-page artwork the margins may be smaller than for normal text pages.

Rich black

Generally speaking, even in a CMYK color document, the text will be printed in solid black, what a printer would call 100% K. However, a large block of black-only ink appears dull and lifeless, so to achieve the effect of a deep, vibrant black, graphic designers and printers use what is called *rich black.*

There is no formal definition for rich black; each design or print house may have its own version. In general, though, a rich black starts with 100% K and adds judicious amounts of the other three colors. One example might be 40% C, 30% M, 20% Y, and 100% K.

It is important not to be overzealous, however. Putting too much ink on paper can soak it, causing smearing, streaking, or even buckling in the press. As a rule of thumb, the total of all colors should not exceed 200%, and anything beyond about 240% may result in disaster such as expensive repairs to the printing press. The print house's pre-press department checks for problems like that before sending the job to press.

Spot colors

There are, of course, other inks than the normal CMYK. Mixed inks of specific tints or hues are available in profusion, many of them based on color catalogs such as those produced by Focoltone®, Pantone®, Toyo®, or Trumatch®. In the printing industry, such inks are called *spot colors.* Spot colors are used most often in applications where CMYK may not be suitable for cost or technical reasons.

A magazine publisher may not want the expense of four-color printing if most of the pages in an issue contain no photographs or other full-color art. Since two-color printing costs only a little more than one-color printing and a page of nothing but black ink looks boring, a spot color may be added to various design elements for visual interest.

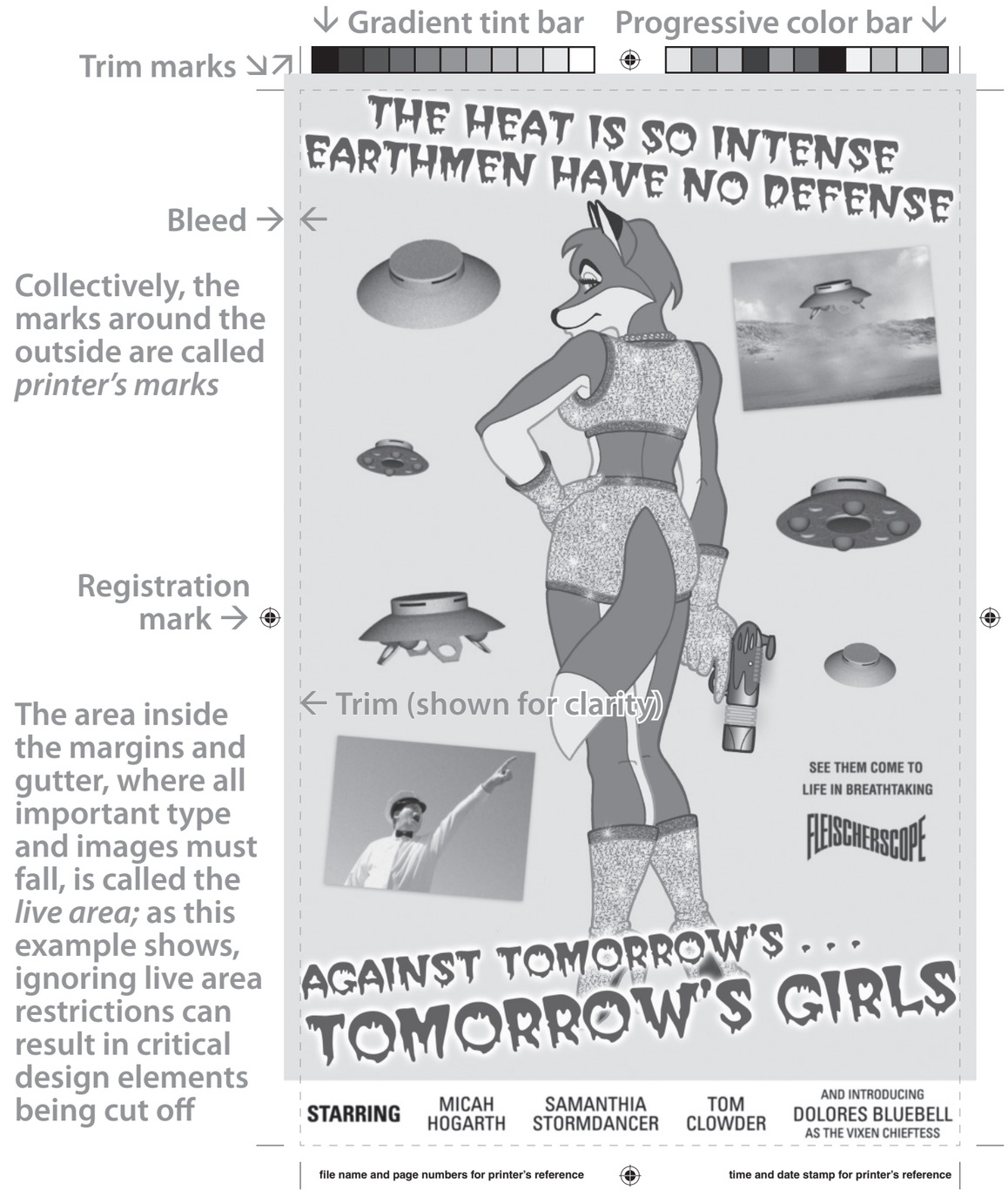
The coarse, low-definition silk-screen process used by T-shirt and DVD manufacturers does not work well with CMYK bit-map images. CD and DVD faces in particular may involve a multitude of colors. Silk-screening on any object that is not white requires that the first color be a bright white completely covering the printed area, called a *white flood,* which counts as a color for printing and (usually) billing purposes.

Switching color models

If the artwork's final use requires RGB color, create the artwork in RGB. If the artwork's final use requires CMYK color, create the artwork in CMYK. Swapping color models back and forth can cause real problems. The range of possible colors is larger in RGB than in CMYK, which can cause color shifts when moving from the former to the latter. Moreover, RGB black is not the same as CMYK black or "rich black".

The industry-leading applications from Adobe, Illustrator and Photoshop, use distinctive values for blacks that have been swapped from one color model to the other. These values, unfortunately, do not yield good results, and in print can appear muddy or oversaturated with ink. They are red-flag warnings that the artwork's color model has been swapped, so the art should be examined carefully for other difficulties.

CMYK to RGB: 100% K turns into 35 R, 31 G, 32 B.
RGB to CMYK: 0 R, 0 G, 0 B turns into
74.9% C, 67.84% M, 67.06% Y, 90.2% K.



Art by Dave Bryant, copyright 2007
Flying saucer 3D model by Christina "Smudge" Hanson
Ray gun design by Baron Engel
*Photo of Baron Engel by Watts Martin • Beach photo: Image*After*
With apologies to Donald Fagen

Cheat sheet courtesy of Catspaw DTP Services
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