Vector that, Charlie!

A quick study in file types, history, metaphors and apple pie

by Brian P. Lawler

In the production of artwork for printing in the electronic era, we use only a few applications:

- **Illustration program**
- **Photo management program**
- **Page layout application**
- **Text editing application (optional)**

These applications allow us to create illustrations, manage photos – adjust their size and cropping, their color, etc. – and to generate a complete document that comprises all of the parts.

Are we following an obsolete metaphor?

The graphic arts applications that were developed in the mid-1980s to do electronically what we had been doing mechanically all follow the metaphor of a *photography-line art-paste-up* production system. At the time we needed these new applications to behave like their real-life counterparts as much as possible.

• Where we used French curves and Rapidograph technical pens to draw line illustrations, we now use *Adobe Illustrator.*

• Where we used a conventional camera to make a photograph, then photographed that photograph with a large process camera to make a halftone negative, we now use either a digital camera or a digital scanner to create an electronic representation of an image.

• Where we once sat at a drafting table, assembling type and line art elements on a paste-up using wax as an adhesive, we now assemble elements on a computer monitor, and we see the illustrations and photos in position rather than seeing proxy images or rectangles of red film as place-savers.

An important question arises as I think of these metaphors in today's world of graphic arts production: *do we need these obsolete metaphors?*

I think the answer is "No!" And, I think the software makers also realize this. Almost no one in the industry today uses a process camera, and it has been years since I saw a working Rapidograph pen.

Most students of graphic arts have not used, nor will ever use a process camera or a drafting table. Even the icons in popular applications are outdated! Who has ever seen a *cropping tool?*

I predict that we'll soon see a change in graphic arts applications where we work in *one application* to prepare artwork – from the creation of the text

to the creation of line illustrations, to the management of photos and color separations.
Just one application!

If you think of it, the lines are already blurring between *Illustrator, Photoshop* and the page layout applications. Photoshop has some of Illustrator's tools and capabilities, and vice versa. Adobe's *InDesign* has some of both. *QuarkXPress* has some illustration capabilities. The merger of graphics applications is already underway.

It will probably be a few years before the transition is complete, but it will happen.

I promise.

### Until then we still have three applications

Illustration programs, like the dominant *Adobe Illustrator,* create *vector art.* Vector art is best described as lines and curves with hard edges that are scalable without harm to the illustration.

Illustrator uses a mathematical system called Bézier math to describe these lines and shapes. Named for a French automotive engineer, Pierre Bézier, the system uses line elements that pass through anchor points to create line illustrations.
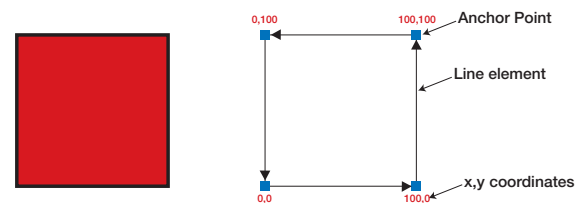

A rectangle drawn by an illustration application is created by the program as four anchor points, each connected by a line element. Programs like Illustrator allow a shape to be filled, or stroked, or both. In this example, the rectangle is filled with red, and stroked with black (1 point stroke).

Simple shapes are drawn by the program as lists of numerical coordinates in x,y pairs. Once the coordinates are defined, the line elements are entered, followed by the instructions to stroke (outline) or fill the shape (or both). As shapes
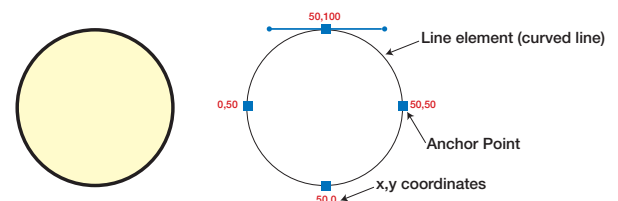
A circle drawn by the illustration application is created by the program as four anchor points, each connected by a line element that is a curved line.

become more complex, another element is added to the mix. Called a *control handle,* this element tells the illustration application how a curve passes through the anchor point and where it's headed, allowing illustrations to have mixed line and curve sections.
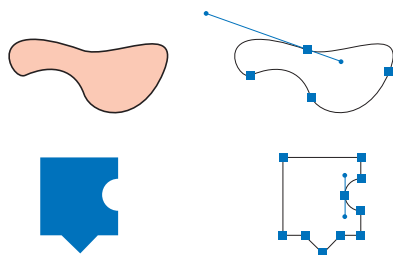
Amorphous shapes and compound shapes are also made with a combination of line and curve elements. All vector illustrations are similar in this respect.

The pairs of x,y coordinates, combined with the mathematical controller for curves and such are together called *vectors.* These vectors are solid mathematical values that even an accountant would appreciate. They don't change (but they can be modified easily).

The code in an Illustrator file that describes a shape is written in PostScript, a language that was developed by Adobe Systems in 1984 to run printers and imagesetters. Though Illustrator is true to its PostScript roots, it uses "tokenized" instructions. The code for the little polygonal shape above is as follows:

```
38.9166 23.5835 mo
38.9166 18.0606 43.3931 13.5835 48.9166 13.5835 cv
48.9166 0.25 li
0.25 0.25 li
0.25 48.9166 li
13.5835 48.9166 li
25.2505 60.2496 li
36.2505 48.9166 li
48.9166 48.9166 li
48.9166 33.5835 li
43.3931 33.5835 38.9166 29.1065 38.9166 23.5835 cv
```

The numeric values are the x,y positions of the anchor points while the token code is shorthand for standard PostScript language instructions: *li* code means *lineto* which translates to "draw a line to" while the *cv* means *curveto* which translates to "draw a curve to..."

We humans never have to see this code however, and that's good, because it looks scary. Instead, we see a little image of a polygon, or a more complex amorphous shape (or whatever).

Why vector art is important

Vector artwork is great stuff because if scales without damage, and it is relatively small in size. A typical illustration is only a few hundred kilobytes in size (this compared to photo images that are megabytes in size).

If you print a vector illustration at a small size, it will reproduce correctly and nicely. Scale it to a very large size, and it still looks perfect. Contrast that to a photograph, and you'll see a great difference.

The ampersand at left is a vector illustration (all high-quality fonts are in fact vector illustrations). Enlarging it causes it to get bigger, and the quality remains excellent. Conventional photographic enlargement would have resulted in a fuzzy and often-unacceptable image when enlarged. I have marked the enlarged section with the red rectangle. Vector illustrations can survive enlargement without damage because the mathematical coordinates

are independent of the printer's resolution. The coordinate system is entered-into the printer's drawing resolution, and the result is an image which is always rendered at the resolution of the printer. Thus *vector artwork is always drawn at the resolution of the printer,* not the file, and not the resolution of the monitor.

If we had a billboard printer, capable of imaging on vinyl at 14 x 40 feet in size, we could print this same ampersand over 14 feet tall, and the quality would still be good – as good as the printer making the image. That is the benefit of vector graphics.

Raster images

In contrast to vector artwork is *raster artwork.* Raster is based on the German word meaning "to screen" which was earlier derived from the Latin word *rastrum* which means "to rake."

Screen is a good description for raster images, because they are literally *screened* into a grid of pixels. Raster images are most often photographs, which come from scanners or digital cameras (though other sources are possible).

In an electronic publishing environment, raster images are the method for handling *continuous-tone* images (analog photographic materials) that have been scanned and converted to digital values.

Unlike their vector counterparts, raster images are not resolution-independent. *This is an important difference!* If an image that is prepared for one size of reproduction is enlarged more than a few percentage points, the image is harmed by the enlargement process and is usually unacceptable.

Resolution rules

The generally-accepted rule of raster image resolution is that you will need a file with twice the *linear* resolution of the halftone screen with which the image will be printed. This resolution is defined as the screen frequency of the printing process in *lines-per-inch* or lpi.

There is a modest amount of excess resolution when an image is scanned at this ratio of 2:1, which allows images to be enlarged slightly, however, it is much better if images are scanned at the correct resolution, and placed in the page layout at full size.

Other terms for raster images

Raster images are known by a number of different names. Among them are *bitmapped images* and *pixel images.* These terms are all synonymous with *raster image.*

What's a pixel?

A pixel is one tiny part of a raster image. Computer pixels are square; televisions and video use a

An image scanned with adequate resolution will not exhibit any visible pixels. The standard of 2:1 pixels per halftone dot is acceptable, allowing some enlargement past 100 percent.

Images with inadequate resolution (above and below) have visible pixels, which makes the reproduction process obvious. That is not the objective of quality printing.

rectangular pixel. Pixel is a contrived word that comes from *picture* and *element*. A pixel in a computer image contains information about the tonality (and perhaps the color) of the same spot in the original image.

Pixels can represent monochrome information, duotone information, color information in RGB (red-green-blue) color, CMYK (cyan, magenta, yellow, black) color or other color spaces. In every case the pixel displays what the computer thinks is the correct color for that tiny part of the original image.

The term *bitmap* comes from the idea that a photograph is comprised or rows and rows of pixels arranged into a pattern (a map) of picture elements.

The bitmap thus represents the original image, but in the digital world.

Understanding the difference between vector and pixel-based (raster) artwork can save a printed project, and will ensure that your graphic arts projects are successful.

■ This is one of numerous graphic arts essays I have written. Topics include Web site design and preparation, color management, trapping, resolution. The other essays are available free on my Web site at: www.thelawlers.com

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A coarse bitmap of pixels shows how these picture elements take-on the color and tonality of the original image. A properly-scanned image is simply a very-high-resolution bitmap of the original, providing enough pixel information that the square pixels disappear into the halftone pattern of the printing process, hiding their own existence.

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