

# STEVE CAPLIN'S **A** TO **Z** OF DESIGN

## V: Vector vs bitmap

Steve Caplin walks us alphabetically through the concepts essential to success for any jobbing or aspiring designer.



### ABOUT THE AUTHOR

**Steve Caplin** is a designer and illustrator working for a range of national newspapers. His best-selling *How to Cheat in Photoshop*, now in its fourth edition, is published by Focal Press.  
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**When I bought my first Mac back in 1987**, the specification – as well as 512 kilobytes of Ram and an 800K floppy disk drive – included the choice of either MacPaint or MacDraw. Never having heard of either, I asked the salesman what the difference was. ‘MacPaint is a bitmap program,’ he explained curtly, ‘whereas MacDraw is object orientated.’ ‘Do what?’ I replied. ‘It’s a vector application.’ I didn’t have a clue what he was talking about.

Twenty years on, novice designers are still confused by the difference between the two. So, let’s look at what both terms mean, how they work and how they can interact.

Bitmap programs are those that work with pixels, one ‘bit’ at a time. The resulting image is literally a map of the bits that make it up: each square in the grid could initially be either on or off, and so would appear

either black or white. Later, with the introduction of greyscale monitors, these pixels could be one of any of 256 different shades of grey. As colour was introduced, they could be one of any of 256 shades of red, green and blue mixed together.

Bitmap programs include Photoshop, Painter, and the paint half of Canvas. They’re often referred to as painting programs and the analogy is a good one: adding or moving sets of pixels is very similar to painting onto a canvas. We can push pixels around, paint over them and even erase them, but they remain part of the background or layer on which they appear.

If we make a bitmap image double the size, then we make each pixel occupy the space of four pixels on the screen. Because this would produce an unsightly blocky effect, most bitmap applications

use sophisticated algorithms to interpolate between neighbouring colours, producing intermediate values that add new pixels intelligently. Hard edges, though, as well as areas of high contrast within the image, tend to suffer from enlargement; the result is a clear degradation of the image, as interpolated pixels always produce a softer image that appears lacking in focus.

Vector or object-oriented applications work differently. Rather than colouring in the page pixel by pixel, each shape is defined as a set of linked and optionally filled points in 2D space, each point specified by its co-ordinates. In early programs, such as MacDraw,

◀ 01 With the whole of Europe on view, it’s hard to tell at a glance whether this map is in bitmap or vector format.





▲ 02 When we zoom in, the vector version scales everything up smoothly, including the text.



▲ 03 When we enlarge the bitmap version to the same degree, we can see how the pixels are enlarged, producing an ugly result.



▲ 04 Photoshop is able to smooth enlargements, creating a better image – but it's still nowhere near as crisp as the vector version.

the range of shapes was limited to lines, rectangles, circles and polygons. Today, vector applications, such as Illustrator and Freehand, can use far more sophisticated shapes and fills.

In vector programs, each shape we draw is a separate object. It can be moved independently of all the others and scaled to any size. Because the vertices are mathematically defined, making it larger simply means performing the same multiplication on each of the co-ordinates. This means that we can scale vector artwork to any size with no loss of quality whatever. It's largely for this reason that company logos, for example, are always designed in Illustrator rather than Photoshop: the resulting vector artwork can be used on a letterhead, or covering the entire face of a building, without any quality issues as it's enlarged or reduced.

In high-end applications, such as Illustrator, InDesign and QuarkXPress, the mathematical curves are driven by the PostScript language, developed by Adobe in 1984. Most commercial fonts are written in PostScript and this gives them the scalability to be used at any size without degradation. Although Photoshop and

Illustrator are the archetypal bitmap and vector applications respectively, neither program is purely one or the other. Mixing bitmap and vector capabilities is as old a technique as MacDraw itself, which had the ability to fill vector shapes with bitmap patterns: when the object was scaled, the pattern remained the same size.

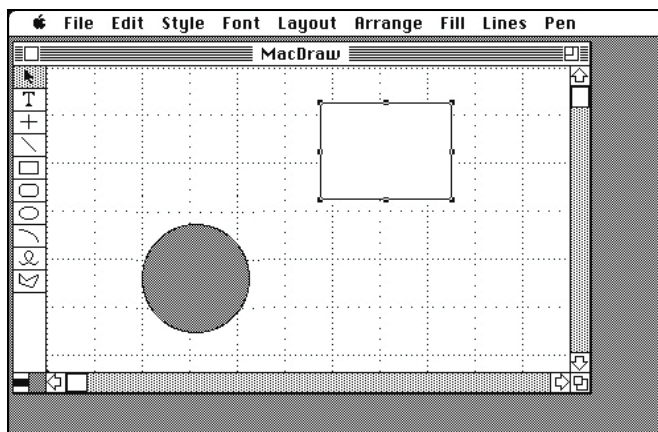
Photoshop makes use of vector functionality in several ways. Clipping paths drawn with the Pen tool are vector objects, as are Shapes layers. The more recent versions of Photoshop make use of Smart Objects, which can be items such as logos drawn in Illustrator. Because they store the original object in vector form, this means that such Smart Objects can be scaled to any size without any loss of quality. Smart Objects can also store bitmap artwork created in Photoshop itself. When scaled down, the original is still used as the basis, so that when they're scaled up again no quality is lost up to the size of the original.

Illustrator has long had the ability to place and work with bitmap artwork, whether it was created in Photoshop or acquired directly from a scanner or a digital camera. Although they're being used in a primarily vector environment, these are

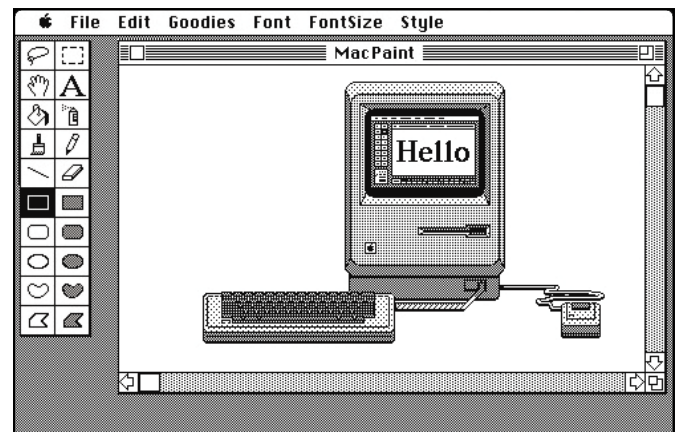
still bitmap images which will suffer a loss of image quality when enlarged.

Part of the confusion between bitmap and vector elements in these applications comes from the way they're displayed on screen. Zooming in to Illustrator artwork will produce crisp, clean edges, regardless of the amount of magnification. But zooming in to vector elements in Photoshop – such as Shapes layers – will show enlarged pixels, just as if we were working with bitmap artwork. That's because Photoshop works on a pixel-by-pixel basis and will not display sub-pixel sizes at any magnification. The Shapes layers themselves can still be enlarged losslessly, but zooming in will give a false impression of their status.

When moving items around in Photoshop, we're limited to multiples of one pixel. By increasing the resolution of the image, we can effectively move items by smaller amounts relative to the overall picture, but we can never get away from that one pixel limit, however far we zoom in. In Illustrator, on the other hand, we're able to move an object or an anchor point by as little as one ten thousandth of a millimetre: even at the maximum zoom level of 6400%, it's impossible to discern this movement.



▲ 05 The early vector application MacDraw used the same technique as Illustrator and FreeHand, where each object is a separate item that can be moved or scaled independently.



▲ 06 The early bitmap application MacPaint painted pixel by pixel, in much the same way that Photoshop does today.