

# **Vector Graphics**

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### WHAT'S COVERED

In this lesson, you will be introduced to the concept of vector graphics and their unique approach to storing graphic data. You will learn about their ideal applications and uses overall and on the web, as well as their unique benefits over raster graphics. You will be introduced to the different graphic file formats available for storing vector data. Lastly, you will revisit the SVG HTML tag and its use in creating vector graphics.

Specifically, this lesson will cover the following:

- 1. Introduction to Vector Graphics
- 2. Application and Use
- 3. Vector Benefits
- 4. Vector File Formats
- 5. SVG Tag

# 1. Introduction to Vector Graphics

Vector graphics are a different class of graphics that are calculated mathematically by the computer, use an internal coordinate system, and are rendered in real time. Remember that raster images begin at a specific height and width in pixels, and the data within the grid of pixels is what determines the image's content. Vector images do not begin at any specific height or width, but instead they use an internal coordinate system for recreating the image. The biggest benefit of vector graphics, next to the relatively small file size, is the fact that they can be scaled to any size without suffering distortion or loss of quality.

Another great benefit of vector images is that every element in the graphic is a separate object. As a result, each object can be accessed and manipulated individually in order to change or modify the final image or composition. This allows you to make changes such as resizing elements, rearranging them, or changing their color, and those can be exported as a raster image. The raster image file cannot be modified in the same way; however, the original vector file is still editable.

### IN CONTEXT

Think of a vector image as a technical drawing, like the blueprint of a building, as opposed to someone sketching an image of a house. All of the measurements in the blueprint originate from a single point in the drawing called the datum or origin (typically the upper left corner of the drawing) and are to scale. If you multiply all the measurements by the same value, the small blueprint can be used to build a full building.

With such a coordinate system, you can see how the image could be reproduced at any resolution and all the computer has to do when drawing the image is to multiply the coordinates with the scale amount.



When dealing with vector files provided by a client, it is important that you maintain an editable version of the file. For example, when you receive a .svg file from a client and you need to make changes or modifications, you will typically use the "Save As" or more likely the "Export" feature of your image editing software. "Save As" will save a copy of the file using a new filename and will leave the original file untouched (unless you accidentally clicked the "Save" option, which saves your current progress back onto the original file!). "Save As" also gives you the opportunity to change the file type if need be.

However, when you are working with a vector image and you want to take that image and create a raster version, you will likely use the "Export" feature, which will save a copy using a different name, allow you to choose a graphic file format, and allow you to adjust the compression settings if available. This creates a usable file while retaining your original vector file.

This is the general process for working with vector files:

- 1. Keep the original copy safe; place it on cloud storage for safekeeping.
- 2. Copy the original file into a project folder (a "working copy").
- 3. Open the working copy and make any necessary edits to the vector content.
- 4. Use the "Save As" feature to save a new copy of your edited working copy. Append something to the end of the filename to differentiate it from the original. For example, if you rearrange the logo into a horizontal orientation, call the copy something like "sampleLogo\_horiz."
- 5. Finally, export usable raster versions using the graphic editing software's "Export" function and export them as the desired raster file format.



### **Vector Graphics**

Digital images created from a series of geometrically defined points, lines, and shapes.

### Coordinate System

A system that uses one or more numbers to uniquely determine the position of a point or other geometric elements.

#### Rendered in Real-Time

The process of calculating and producing an image from vector data, or other, wherein the computer reproduces an image using its vector data, each time it is loaded.

# 2. Application and Use

Vectors are used throughout computer systems. For example, the text that you are reading is made using vectors. All typeface text stored within your computer's operating system are vector files. Icons are often made with vector graphics as they need to be resized according to the use case. This enables icons like social media icons to be easily resized. Icons like the hamburger menu and all icons from the Font Awesome service are made with vector graphics.

The clarity and quality of vector graphics make them an excellent candidate for logos as well. Company logos are often designed using vector graphics and saved in the correct format. This allows a company to resize the vector image for various use cases such as the header logo on a site, the header logo for the letterhead, and even an email signature, all without worrying about the image quality.

### IN CONTEXT

While company logos are almost always designed and created using vector graphics, they are often put to use as raster image types. This is due to the historically low compatibility of vector image file formats in different software. As such, vector images are often scaled to the desired size and then rasterized into a raster image, such as a JPG or PNG.

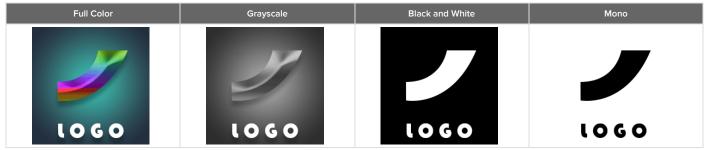


View the following video for more on modifying vector graphics for use in a top navigation bar with Figma:

## 3. Vector Benefits

The main benefit of vector graphics is the scalability and file size. However, additional benefits include being able to easily manipulate and edit the **composition**, colors, and style of a logo or other image. Company logos are not always in full color and often need to be presented in **monochrome** or simple two-tone colors such as black and white. When an image is **rasterized**, it is not as easy to make such changes to the image without resulting in an image that looks edited or **"photoshopped**," as they say. With vectors, you can easily go into the code or the graphical editor, select a shape or element, and change its fill color, **stroke** color and thickness, etc. The image can be saved as a vector file, separate from the original design, and can then be used in special cases for marketing and branding.

### ⇔ EXAMPLE



Logos are also often rearranged to provide variety in the size and shape of the overall image. The previous logo is square in shape, but it could be rearranged to be more long and horizontal to fit on letterheads or pages on the website that use a smaller header section.

## ⇔ EXAMPLE



Another benefit of vector graphics is that depending on the file format, the vector image could include animations and even interactivity. SVGs can include JavaScript code and CSS animation properties to provide animation capabilities. Additionally, JavaScript can be added to provide functionality so that when a user clicks or interacts with the vectors, they can respond by changing, modifying animation, showing new elements, and much more.

One last benefit of vector graphics is that they have the ability to incorporate raster graphic data as one of the elements in the composition. Unfortunately, doing so does not lend the benefits of vectors to the rasterized content. If you scale a vector image that contains raster data, the raster data will become distorted just like any raster graphic, while the surrounding vector content will remain sharp and clear.



### Composition

The final result of multiple components or elements that make up the whole.

#### Monochromo

Any graphic that only contains a single color or uses two colors to give the impression of only using a single color.

#### Rasterized

A graphic, vector or otherwise, that is converted into a fixed height and width and saved using raster graphic techniques.

### Photoshopped

A quality, usually negative, of an image that makes it appear to have been edited or manipulated using Photoshop or any other graphic editing software.

### Stroke

An element of graphics, particularly vector graphics, that applies a visual line or border around an object's edge and contains a color and thickness in pixels.

## 4. Vector File Formats

The following are the different vector graphic file formats, each with its own benefits and features.

Extension	Name	Description
SVG	Scalable Vector Graphics	Scalable Vector Graphics is one of the most common vector formats for web design. The format is small and incorporates all of the best features of vector graphics, with one exception: SVGs are not ideal for printing as the format was designed to be displayed on computer screens. SVGs are supported by most web browsers.
EPS	Encapsulated PostScript	Encapsulated PostScript is an older standard for vector graphics and was designed by Adobe as a solution for large-scale printing. EPS files are also ideal for sharing with third-party vendors, such as, and especially, printing companies. EPS files are not ideal for incorporating raster graphics.
CDR	CorelDRAW	CorelDRAW is a proprietary graphic creation software that uses a proprietary CDR file format to contain vector and raster data. While all of the features of vectors are still present, the file format does not benefit from wide compatibility.
Al	Adobe Illustrator	Similar to CorelDRAW, Al files are designed specifically for the Adobe Illustrator software. The Illustrator application was designed around vector graphics. Also, similar to CDR, Al files do not benefit from wide compatibility.
PDF	Portable Document Files	Portable Document Files (PDF) are a very common format that supports both raster and vector data. The PDF format is ideal for sharing documents, printing, or publishing them on digital channels. However, PDFs are designed for uniformity and security and thus are not ideal for maintaining your original design as they are not very editable.

There is some level of compatibility between different software applications for editing and creating vector graphics. For example, you can create a CoreIDRAW vector, save it as a CDR, and then open the same file using Adobe Illustrator. You might lose some data or access to certain aspects of the vector elements, but, overall, you will be able to open the files. The same goes in reverse: An Al file can be opened in CoreIDRAW, but again with caveats.

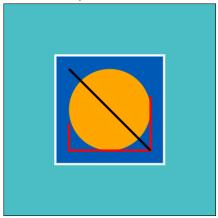
The good news about proprietary vector formats is that they are great for maintaining the original design while exporting copies of the file in a variety of formats. Your Al file can be saved as an SVG, EPS, or PDF. Likewise, CorelDRAW CDR can be used to maintain an original vector design and then a copy can be exported as an Al, SVG, EPS, or PDF.

# 5. SVG Tag

The <svg> tag is an HTML element that defines a container for SVG graphics. SVG can be used for drawing various objects such as boxes, circles, text, and graphics.

## ⇔ EXAMPLE Markup code:

### ⇔ EXAMPLE Output:



As you can see from the source code above for the .svg image file, the image is created by creating different elements and giving them their starting point, height and width, color, stroke thickness, etc. Each tag between the SVG tags creates a different visual element.



Did you notice the inclusion of a <!DOCTYPE> tag? It looks different, doesn't it? The code above is a complete code set for a .svg image file. It is important to note that the <!DOCTYPE> tag is just a tag used to define the type of document. In this case, the document is a .svg image file, so we use different attributes in the <!DOCTYPE> tag to declare it as such.

Older <!DOCTYPE html>. However, look at the examples below of some of the older doctype declarations:

EXAMPLE SVG doctype declaration:

<!DOCTYPE svg PUBLIC "-//W3C//DTD SVG 1.1//EN" "http://www.w3.org/Graphics/SVG/1.1/DTD/svg11.dtd">

⇒ EXAMPLE HTML 4.01 doctype declaration:

<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN" "http://www.w3.org/TR/html4/loose.dtd">

EXAMPLE XHTML 1.1 doctype declaration:

<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.1//EN" "http://www.w3.org/TR/xhtml11/DTD/xhtml11.dtd">

```
<rect x="25" y="25" width="200" height="200" fill="SteelBlue" stroke-width="4" stroke="white" />
```

EXAMPLE First, it sets the starting points, 25 pixels right (x="25") and 25 pixels down (y="25") from the top left corner (the top left corner coordinates are x = 0, y = 0).

```
<rect x="25" y="25" width="200" height="200" fill="SteelBlue" stroke-width="4" stroke="white" />
```

⇔ EXAMPLE Then, after specifying the location of the rectangle's top left corner, it specifies the height and width of the rectangle, again, extending to the right and down from the rectangle's point of origin, its top left corner.

```
<\!\!\text{rect x="25" }y\text{="25" }w\text{idth="200" }height\text{="200" }fill\text{="SteelBlue" }stroke\text{-width="4" }stroke\text{="white" }/\!\!>
```

The height and width values of the rectangle are relative to the origin of the rectangle itself, not the origin of the entire image.

EXAMPLE Next, it adds a fill color with a value of "SteelBlue" green and a stroke-width of 4 pixels, and the color of the stroke is "white."

```
<rect x="25" y="25" width="200" height="200" fill="SteelBlue" stroke-width="4" stroke="white" />
```



Did you happen to notice the unfamiliar attributes in the circle element: cx, cy, and r? These are the horizontal (cx: "circle x") and vertical (cy: "circle y") coordinates of the center point of the circle. The r attribute is the radius, which determines the size of the circle. Remember that the radius is just from the center point to the perimeter, so if you want a circle that is 100 pixels across (100 pixels in diameter), then your r value will be 50.

When creating an SVG, there are different elements that can be added to create objects such as rectangles, circles, lines, and gradient colors. The following table contains a list of possible elements that can be added to an SVG:

Element	Tag	Description
Rectangle	<rect></rect>	This draws a rectangle. A square is a rectangle, so you can also create squares using the rectangle element.
Circle	<circle></circle>	This creates a round circle.
Ellipse	<ellipse></ellipse>	This creates an oblong circle.
Line	<li><li><li></li></li></li>	This creates a single straight line.
Polygon	<polygon></polygon>	This creates multiple straight lines connected together to create a unique polygon.
Polyline	<polyline></polyline>	This creates multiple straight lines connected end to end, but not closed.
Path	<path></path>	This creates a line or a shape using Bezier controls. Bezier controls are an algebraic formula for manipulating the curve of a line. Paths are used to create and manipulate smooth curved lines.
Text	<text></text>	This creates a block of text.

Additionally, visual effects can be added as an attribute or as a separate effect. The following table provides a list of visual effects.

Sample	Visual Effect	Description		
	Filters	Filters can be applied to individual or groups of vector elements that can have a wide range of color and lighting effects. There are about 19 different types of filters that affect the targeted graphic element differently.		
		To apply filters to an SVG element or group of elements, you first need to create a filter canvas and add the filter element tags and values as needed. Then, to apply the filter to an object, add the filter attribute to the object's tag and point to the filter's id value using the url(): filter="url(#lightMe1)".		
Example code:				
<svg 2000="" http:="" svg"="" width="14&lt;/td&gt;&lt;td&gt;&lt;/td&gt;&lt;td&gt;xmIns=" www.w3.org=""></svg>				

<feDiffuseLighting in="SourceGraphic" result="light" lighting-color="white">

<fePointLight x="30" y="30" z="20" />

</fediffuselighting>

<feComposite in="SourceGraphic" in2="light" operator="arithmetic" k1="1" k2="0" k3="0" k4="0" />

<circle cx="50" cy="50" r="50" fill="green" filter="url(#lightMe1)" />

### </svg>



Blur

This applies a blur effect, like an out-of-focus photo, that you can control.

### Example code:

<svg width="150" height="150">

<filter id="f1" x="-50%" y="-50%" width="200%" height="200%">

<feGaussianBlur in="SourceGraphic" stdDeviation="2" />

</filter>

<circle cx="75" cy="75" r="40" stroke="green" stroke-width="4" fill="yellow" filter="url(#f1)" />

</svg>



Drop shadow This adds a customizable shadow that makes the element appear to be hovering over the background.

### Example code:

<svg width="150" height="150">

<filter id="f1" x="-50%" y="-50%" width="200%" height="200%">

<feOffset result="offOut" in="SourceAlpha" dx="10" dy="10" />

<feGaussianBlur result="blurOut" in="offOut" stdDeviation="5" />

<feBlend in="SourceGraphic" in2="blurOut" mode="normal" />

</filter>

<circle cx="75" cy="75" r="40" stroke="green" stroke-width="4" fill="yellow" filter="url(#f1)" />

### </svg>



Linear gradient color

This creates a linear color gradient that blends from one color to another or more. Gradients create effects like when you look at a sunset, the lower sky is a bright orange-yellow and then fades into darker orange, red, and then to the dark blue sky.

### Example code:

<svg width="150" height="150">

</

<stop offset="0%" style="stop-color:rgb(255,255,0);stop-opacity:1" />

<stop offset="100%" style="stop-color:rgb(255,0,0);stop-opacity:1" />

</lineargradient>

<circle cx="75" cy="75" r="40" stroke="green" stroke-width="4" fill="url(#grad1)" />  $\,$ 

### </svg>



Radial gradient color

Radial gradients create a similar effect but in a radial or circular pattern. Imagine being in space and looking at a distant sun; the yelloworange radiates out from the center, fading into yellow, and then to black space.

### Example code:

<svg width="150" height="150">

<radialGradient id="grad1" cx="50%" cy="50%" r="50%" fx="50%" fy="50%">

<stop offset="10%" style="stop-color:rgb(255,0,0);stop-opacity:1" />

<stop offset="100%" style="stop-color:rgb(255,255,0);stop-opacity:1" />

</radialgradient>

<circle cx="75" cy="75" r="40" stroke="green" stroke-width="4" fill="url(#grad1)" />

</svg>



### **Gradient Colors**

A technique of color that gradually transitions from one color to another.

An SVG element that draws a rectangle. Also used to draw a square.

### Circle

An SVG element that creates a round circle.

An SVG element that creates a round circle that does not have equal height and width dimensions.

### Line

An SVG element that creates a straight line.

### Polygon

An SVG element that creates a shape consisting of multiple straight lines in a closed configuration.

#### Polyline

An SVG element that creates a complex line consisting of multiple straight lines connected end to end, but not closed overall.

#### Path

An SVG element that creates a line that uses algebraic Bezier formulas to create smooth curves.

#### Text

An SVG element that creates a block of text.

#### **Filters**

Techniques of directly manipulating how an image appears on the screen by manipulating colors, brightness, and other aspects to create a specific look or visual effect.

#### Blur

A visual effect, like an out-of-focus photo, that you can control.

### **Drop Shadow**

A visual effect that adds a customizable shadow that makes the element appear to be hovering over the background.

#### Linear Gradient Color

A visual effect that creates a linear color gradient that blends from one color to another or more.

### Radial Gradient Color

A visual effect that creates a radial or circular pattern gradient.



### SUMMARY

In this lesson, you were introduced to vector graphics and their unique capabilities and benefits. You were introduced to the application and use of vector graphics as well as their benefits. You learned about the different vector file formats for storing vector graphics, including the SVG HTML tag.

Source: This Tutorial has been adapted from "The Missing Link: An Introduction to Web Development and Programming" by Michael Mendez. Access for free at <a href="https://open.umn.edu/opentextbooks/textbooks/textbooks/the-missing-link-an-introduction-to-web-development-and-programming">https://open.umn.edu/opentextbooks/textbooks/textbooks/the-missing-link-an-introduction-to-web-development-and-programming</a>. License: Creative Commons attribution: CC BY-NC-SA.

## TERMS TO KNOW

### Blur

A visual effect, like an out-of-focus photo, that you can control.

### Circle

An SVG element that creates a round circle.

### Composition

The final result of multiple components or elements that make up the whole.

### Coordinate System

 $A \ system \ that \ uses \ one \ or \ more \ numbers \ to \ uniquely \ determine \ the \ position \ of \ a \ point \ or \ other \ geometric \ elements.$ 

### Drop Shadow

A visual effect that adds a customizable shadow that makes the element appear to be hovering over the background.

### Ellipse

An SVG element that creates a circle that does not have equal height and width dimensions.

### Filters

Techniques of directly manipulating how an image appears on the screen by manipulating colors, brightness, and other aspects to create a specific look or visual effect.

### Gradient Colors

A technique of color that gradually transitions from one color to another.

## Line

An SVG element that creates a straight line.

### Linear Gradient Color

A visual effect that creates a linear color gradient that blends from one color to another or more.

#### Monochrome

Any graphic that only contains a single color or uses two colors to give the impression of only using a single color.

#### Path

An SVG element that creates a line that uses algebraic Bezier formulas to create smooth curves.

### Photoshopped

A quality, usually negative, of an image that makes it appear to have been edited or manipulated using Photoshop or any other graphic editing software.

#### Polygor

An SVG element that creates a shape consisting of multiple straight lines in a closed configuration.

#### Polyline

An SVG element that creates a complex line consisting of multiple straight lines connected end to end, but not closed overall.

### Radial Gradient Color

A visual effect that creates a radial or circular pattern gradient.

### Rasterized

A graphic, vector or otherwise, that is converted into a fixed height and width and saved using raster graphic techniques.

### Rectangle

An SVG element that draws a rectangle. Also used to draw a square.

### Rendered in Real-Time

The process of calculating and producing an image from vector data, or other, wherein the computer reproduces an image using its vector data, each time it is loaded.

#### Stroke

An element of graphics, particularly vector graphics, that applies a visual line or border around an object's edge and contains a color and thickness in pixels.

#### Text

An SVG element that creates a block of text.

### Vector Graphics

Digital images created from a series of geometrically defined points, lines, and shapes.