nashville women programmers presents

You Down with SVG?

a primer for developers


Who *is* this guy?
MAIN TRAIL
I'm Ben Marks….

As a developer,
WHY SHOULD I CARE?

Communication leads to community, that is,
to understanding, intimacy, and mutual valuing.

- Rollo May

What are SVGs?

- **S**calable **V**ector **G**raphics – a w3c standard
  - *“...a modularized language for describing two-dimensional vector and mixed vector/raster graphics in XML.”*
- That standard is not fully implemented anywhere.
- Vector images get:
  - A ***path*** (where to draw)
  - A ***stroke*** (how to draw)
  - Often they can also get a ***fill***

- Raster images are encoded pixel by pixel – ***location*** and ***color***

The Bad Things

- No Bitmaps*
- Slow animations*
- Complicated format*
- Canvas-like activities

The Good Things

- Small size
- Scalable
- Responsive
- Reusable
- Animatable
- Constructable
- DOM Interface

BAD THINGS

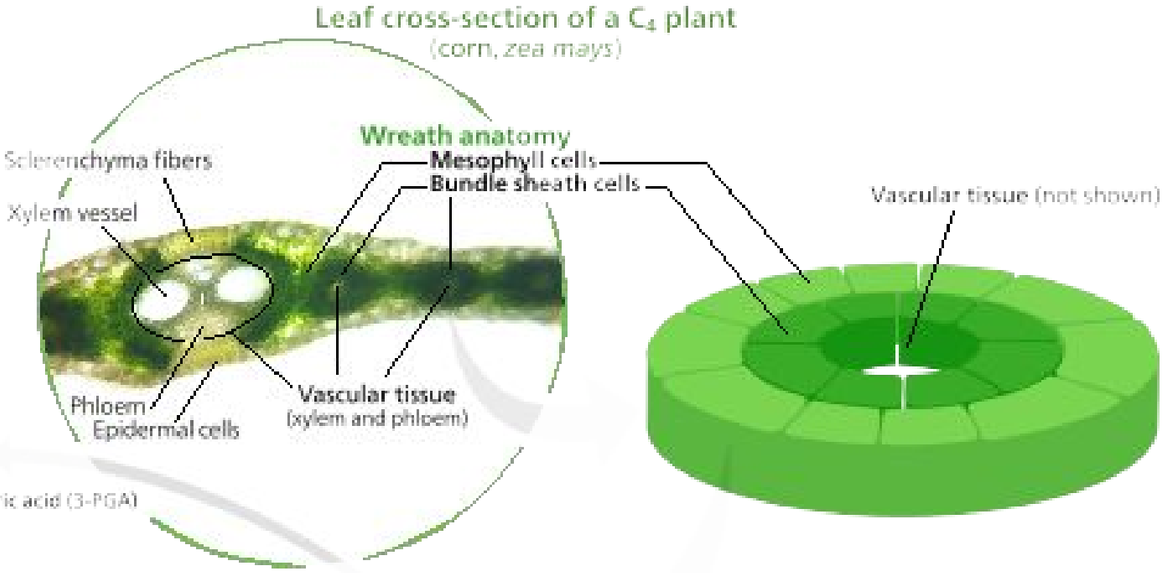
SVGs can't do “Bitmappy things”*

* Well, *actually* they **can**.

Raster images can be embedded into SVGs, and often times are optimized when doing so. Wanna see?
More later when we discuss the <image> element.

Graphic artists can do wonders with SVG beyond line drawing.
I can Prove it!

C_4 photosynthesis



10 Back in a mesophyll chloroplast, the complete light reactions generate ATP and NADPH. The ATP phosphorylates the pyruvate, regenerating phosphoenolpyruvate. The ATP and NADPH also convert the 3-phosphoglyceric acid to **glyceraldehyde-3-phosphate** (G3P).

11 The glyceraldehyde-3-phosphate gets sent *back* to the bundle sheath, where it can pair up to make **glucose**.

Pyruvate

3-Phosphoglyceric acid (3-PGA)

mesophyll chloroplast

NADP+ light reactions ATP NADPH

1 In the cytoplasm of a **mesophyll cell**, **carbon dioxide** combines with water to form carbonic acid.

Phosphoenolpyruvate (PEP)
only carbons and phosphate groups are shown

H_2O

CO_2

HCO_3^-

Glyceraldehyde-3-phosphate (G3P)

Discharged phosphate group

P_i

2 An enzyme called ***phosphoenolpyruvate carboxylase*** (not shown) adds the carbonic acid to a three-carbon molecule called **phosphoenolpyruvate**.

3 Combined, they form a four-carbon molecule called *oxaloacetate*, which enters a **mesophyll chloroplast**.

Oxaloacetate (OAA)

NADPH

mesophyll chloroplast

the light reactions

NADP+

Malate

4 *Malate dehydrogenase* (not shown) reduces the oxaloacetate into **malate**, using NADPH produced from the complete **light reactions**.

Dimorphic chloroplasts
Bundle sheath chloroplast
Mesophyll chloroplast

Plasmodesmata

Vascular parenchyma cell

Phloem
(sieve-tube and companion cell complexes)

Vascular tissue

Waxy suberin layer

Bundle sheath cell

Mesophyll cell

5 Malate is exported from the mesophyll cell through **plasmodesmata**, arriving in a **bundle sheath cell**. The malate enters a bundle sheath chloroplast.

6 *NADP-dependent malic enzyme* (not shown) breaks down malate into pyruvate and carbon dioxide while reducing $NADP^+$ into NADPH.

Malate

Pyruvate

CO_2

NADPH

ATP

bundle sheath chloroplast

the calvin cycle

NADP+

7 Light energy is harnessed by the chloroplast to carry out **cyclic photophosphorylation** to generate ATP.

Glyceraldehyde-3-phosphate (G3P)

8 The enzyme **rubisco** incorporates the carbon dioxide into multi-carbon molecules. The ATP is used to turn them into **3-Phosphoglyceric acid**, or 3-PGA, plus some sugar in the form of **glyceraldehyde-3-phosphate** (G3P) if there's enough NADPH available. *Don't confuse 3-PGA or G3P with phosphoenolpyruvate!*

3-Phosphoglyceric acid (3-PGA)

9 The 3-phosphoglyceric acid and the pyruvate are exported from the chloroplast and sent back to the mesophyll cell.

Yes, this *is* an SVG with NO embedded rasters.

Slow Animations

Animations in SVG perform quite well...
...on *one element at a time!*

An Example of What I'm Talking About...

Complicated Animations from the MDN

“It Has a Complicated Structure!”

So does your app (ZING!)

Seriously though... the strawberry example from earlier:

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<svg id="svg2" xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns="http://www.w3.org/2000/svg" height="1600pt"
 width="1526pt" version="1.1" xmlns:cc="http://creativecommons.org/ns#" xmlns:dc="http://purl.org/dc/elements/1.1/" viewBox="0
 0 1525.7446 1600">
<g id="g37000" transform="scale(.3518)">
<path id="path4-3" fill="#70ac7c" d="m2959 0h0.93c8.16 2.57 22.25-2.1 24.83 9.22-9.54 3.08-23.29 0.93-28.63 11.36-7.05
 12.93-17.85 22.95-26.07 34.97-3.08 7.2-8.04 14.28-15.38 17.54 1.22 12.93-11.18 20.51-15.73 31.2-24.55 43.48-40.94 88.36-60.55
 133.3-1.47-12.74 9.86-24.17 8.88-38.2 7-2.08-0.83-13.38 7.47-9.02 1.76-5 6.01-10.36 2.79-15.63 4.73-0.42 4.85-5.76 5.45-9.41
 3.84-11.8 9.24-23.05 16.38-33.4-8.55 2.72-3.26-2.26 0.88-5.12-4.28-7.12 10.67-8.22 5.35-16.55 8.56 2.38 4.37-20.14
 16.62-17.98-2.79-8.27 1.87-11.42 7.72-15.43-8.5-4.4 1.61-3.94 3.9-8.81 1.23-4.89 4.01-9.99 9.45-6.16-3.06-7.02 3.01-15.44
 10.1-16.93-3.73-4.07-1.91-6.38 2.16-8.78-8.53-6.67 11.9-4.08 0.35-10.33-8.68 0.63-4.34-8.11-9.64-10.25 11.47-4.26 20.89-12.37
 32.74-15.63z"/>
<path id="path6-9" fill="#96be6f" d="m2890 27.3c13.73-0.01 24.31-10.57 37.08-11.67 5.3 2.14 0.96 10.88 9.64 10.25-4.53
 4.85-12.32-1.43-15.41 4.9-3.9 5.03-11.09 5.25-15.91 8.95 9.65 3.65-4.14 8.61-8.16 3.73-0.74 1.3 5.22 9.61 0.35
 11.37-0.17-4.22-4.2-9.62-3.71-0.51-1.52 7.9-4.2-0.33-4.01-4.58-3.9 4.46-5.06 10.19-4.51 15.95-1.93-1.75-8.13-3.69-6.09 0.36
 7.95 8.1-14.63 0.37-10.31 7.61 5.54-3.51 8.31 7.25 2.36 4.63-2.19-9.02-13.05 7.06-3.12 3.19 5.6 7.2-21.05 3.09-7.37 8.29 2.23
 6.58-9.66-1.92-7.9 4.81 9.09-0.94 0.99 10.84-4.12 2.25 6.97 9.13-15.46 9.23-4.25 13.75-0.23 2.69-5.38 6-5.95
 10.42-3.75-5.44-7.22-0.61-10.53 2.73 1.05 6.27-7.99 12-0.78 17.16-10.12-0.53-9.06 14.91-20.5 10.28-3.97 2.65 3.51 2.71 5.69
 3.72-15.63 5.73-14.33 25.69-28.85 31.34-5.87 2.82-0.52 15.41-9.17 13.28 0.73 3.54 3.31 8.69-2.51 6.93-0.91 5.88-1.14
 12.94-6.48 16.67 2.13 1.09 6.02 6.1 1.25 5.54-6.73-1.02 0.5 8.78-2.92 11.6-4.4 3.42-2.3 13.29-9.5 9.22-0.14 5.45-0.82
 10.56-7.31 10.97-5 3.87 6.3-0.3 4.14 4.71-7.37-0.86-6.86 7.65-5.63 12.59-5.15-4.65-7.19 13.91-1.34 13.06 4.04-5.01 8.3-10.11
 14.44-12.64-1.27 6.42-9.51 8.56-9.22 15.98-8.21 10.24-7.73 22.16-7.44 34.87-0.03 1.85 0.09 3.7 0.26 5.56l0.08 0.93c-0.01 4.46
 0.68 8.9 1.27 13.33-1.57 2.99-2.19 6.29-1.58 9.63l-0.27 0.76c-1.5 1.87-2.61 4.67-5.35 4.73 5.12-19.75-6.25-40.13
 0.54-59.61-5.27-5.38 3.73-11.94 0.05-18.11 4.29-4.72 5.62-17.35-3.42-16.6 9.06-13 0.13-29.17 0.11-43.13 3.36-5.84 3.28 10.15
 6.73 5.33 3.46-11.36 4.59-22.26 4.04-33.93 2.23-10.67 1.19 2.22 5.06 0.78 0.77-11.23 5.34-22.53
 3.28-33.71-0.84-0.61-1.66-1.17-2.48-1.7 2.06-10.65 14.75-15.24 16.78-26.64 7.06-1.32 1.96-10.69 8.92-9.44 3.8
 0.2-6.54-9.78-1.04-6.75 5.46 4.24 2.37-7.17 8.29-5.16 2.3-9.66 15.04-11.73 13.97-22.49 5.21-0.54 6.52-4.81 1.42-6.06
 12.71-1.87 15.35-17.95 26.99-22.58 5.87-8.87 17.67-10.74 20.48-22.07-5.12-7.39-13.93 5.67-14.83-1.98 3.62-4.14 9.15-4.96
 14.36-4.04 4.7-12.47 24.66-6.03 28.83-18.17 6.75-2.56 3.37 15.45-3.57 13.98 0.06 12.45 14.49-0.81 19.13-4.57z"/>
```

Canvas-like Activities

- Canvas and SVG are two different things
- Canvas is for complicated drawing and animation

- SVG is primarily a static 2D containment
  - The specifications seem to cover a whole lot more…
  - …except most devices are 2d surfaces

GOOD THINGS

Small File Size

- SVG is just a text file containing XML
  - directions
  - paint methods
  - groupings
- No pixel-by-pixel specification in binary
- Human readable

SVG to PNG to JPG

This is a test of the SVG-to-PNG-to-JPG conversion factor.

SVG Size: 1 - 4kb
PNG Size: 62kb
JPG Size: 48kb

Scalable

There are no absolute dimensions in SVGs

They can be scaled nigh-infinitely

Let’s check it out!

Responsive

As you might have noticed in the example:

Using a relative dimension for the parent element has a side effect of responsiveness.

The scalar nature allows the image to lose none of the detail.

Let’s see again

Reusable

Another side effect of scalability is reuse.

Why have multiple copies of graphics when you can scale the ones you have?

Think branding on headers or footers

Let’s see that too!

Constructable

Since these are just collections of XML, they can be constructed wholesale via Javascript, or whichever language you prefer.

In fact, this is what most SVG libraries help you do.
D3.js is the queen of them all!

Let’s do it!

DOM Interface

SVG is XML, and therefore has a DOM Interface

This makes it easy to manipulate individual nodes, or groups of nodes via Javascript or CSS

Elements!

Mozilla Developer Network makes reasonable divisions

- `descriptive` elements
- `structural` elements
- `shape` elements
- `graphics` and `HTML` elements
- `gradient` elements
- `animation` elements
- `filter primitive` elements

Descriptors

Generally accessibility-related. Not directly rendered, but can be indirectly rendered, such as a tool-tip!

- `<desc>` - Descriptions
- `<metadata>` - Information about data. Should be elements from other XML namespaces.
- `<title>` - The title, generally the first child of its parent.

Structural Elements

- `<svg>` - the main container for the image
- `<g>` - a grouping element
- `<symbol>` - used to define a reusable shape
- `<defs>` - used to define a reusable element (like a gradient)
- `<use>` - implements `<symbol>`s or `<defs>`

Shape Elements

- `<circle>` - A circle
- `<ellipse>` - A squished circle
- `<line>` - the points between two defined points
- `<polygon>` - a closed shape, not necessarily regular
- `<polyline>` - an open shape, made of little lines. That means they do not scale well, unless you like seeing the little lines.
- `<rect>` - a regular four-sided rectilinear shape
- `<path>` - This is the magical element. An open or closed shape composed of lines, or curves. these scale very well.

Graphics and HTML Elements

All of these elements are ways to embed elements not normally found in SVG, for instance audio or video.

- `<image>` - This is how we get JPGs and PNGs into and SVG
- `<audio>` - Sound in an SVG? Yep!
- `<video>` - And moovin’ pitchers!
- `<canvas>` - And yes, this is a way to make your canvas responsive, or add filters to the canvas.
- `<iframe>` - embed anything!

Gradients

These are all special fills. The `<mesh>` element is used as a container for the `<meshgradient>` element. Keep in mind that gradient definitions can contain multiple `<stops>`s.

- `<linearGradient>` - Just your standard gradient, one color to another
- `<meshgradient>` - This is a new gradient, proposed in SVG 2.0
- `<radialGradient>` - Standard radil gradient
- `<stop>` - This defines a color or saturation point in the gradient.

Animation Elements

This is the surprising part of the standard. With these, you can define animations, without JS and without CSS.

- `<animate>` - Generic animate element
- `<animateMotion>` - Animates motion along a path
- `<animateTransform>` - Animates transform, scale, skew, and rotate
- `<discard>` - Allows a programmer to remove unused elements, saving resources!
- `<mpath>` - This is the element to specify a motion path to other animate elements
- `<set>` - Sets a given attribute to a given value for a set amount of time.

Filter Primitives

These are all super cool. They are visual filters to apply to SVGs or parts of SVGs, like a blur or tiling. Please play with these.

- `<feBlend>`
- `<feColorMatrix>`
- `<feComponentTransfer>`
- `<feComposite>`
- `<feConvolveMatrix>`
- `<feDiffuseLighting>`
- `<feDisplacementMap>`
- `<feDropShadow>`
- `<feFlood>`
- `<feFuncA>`
- `<feFuncB>`
- `<feFuncR>`
- `<feGaussianBlur>`
- `<feImage>`
- `<feMerge>`
- `<feMergeNode>`
- `<feMorphology>`
- `<feOffset>`
- `<feSpecularLighting>`
- `<feTile>`
- `<feTurbulence>`
- `<feFuncG>`

Oh yeah... CSS

All of these components are elements with attributes

They can be manipulated and formatted with CSS!

Change colors

More complex animations

Manipulate the viewbox

Did I mention the viewbox?

This is an attribute of the original `<svg>` tag
It defines the “window” through which we view an SVG.

The SVG can be **`x`** units by **`y`** units

The viewbox can be defined as **`w`** by **`z`** units

Allows you to crop and zoom in on different parts of the image.

Check out the map!

SVGs are used extensively in GIS

Each county is made of its own path…
Each state is made of its own path…
The Country is made up of one path…

By manipulating the viewbox and component visibility it looks like different components.

Alpha Masks

SVGs also have an alpha channel -- they can have variable transparency.

You can use this property, along with the `<mask>` element, to make complicated shapes in web design. Recall that `<path>`s can take almost any shape!

Pointer Events

Wowee-zowee. There are internally defined events?!

Yes. Yes there are. they are *Pointer events*.

I have an example from Wikipedia:

The `begin` Attribute

This is where the animation… begins, and is key to making it happen.

Further Reading

MDN - specifically the SVG section:
https://developer.mozilla.org/en-US/docs/Web/SVG
Sarah Drasner's Excellent talk *SVG can do THAT!?*
http://slides.com/sdrasner/svg-can-do-that#/
Here's a link to the map she made:
https://codepen.io/sdras/full/dXoLEJ/