SVG In Motion

— Freelance front-end dev.
— Wrote the Codrops CSS Reference.
— Co-authored Smashing Book 5
— SVG advocate

What’s with all the vowel letters?

— Swaïdaan

— Swaydein

— Sw-"eye"-daan

What we will cover (not in this particular order):

1. How to Embed SVG
2. The SVG `viewBox`
3. Animating the `viewBox`
4. SVG Animation Techniques: CSS, SMIL, JavaScript
5. SVG Sprite Animation Techniques
6. SVG Line Drawing Effects

6 Embedding Techniques

```
<img src="mySVG.svg" alt="..."/>
```

1) Image can be cached (Requires HTTP request. But: HTTP/2!).

2) No CSS interactions.

3) No scripting.

4) CSS animations work only if defined inside <svg>

```
<picture>
  <source type="image/svg+xml" srcset="path/to/image.svg">
  <img src="path/to/fallback.png" alt="Image description">
</picture>
```

Same as <img>

Fallback is included inside <picture>

```
background-image: url(path/to/mySVG.svg);
```

Same as `<img>`, but the SVG *can be* cached as part of the style sheet if it is inlined using data URIs.

```
<object type="image/svg+xml" data="mySVG.svg">
  <!-- fallback here; beware of multiple requests -->
</object>
```

1) Image cached.

2) Scripting.

3) Default fallback mechanism.

4) CSS animations and interactions work only if defined inside <svg>

```
<iframe src="mySVG.svg">
  <!-- fallback here -->
</iframe>
```

Same as <object>

```
<svg xmlns="http://www.w3.org/2000/svg" …>
  <!-- svg content -->
</svg>
```

1) Image is not cached.

2) No extra HTTP requests.

3) Scripting.

4) CSS animations and interactions.

Need to provide Fallback? Read this guide: https://css-tricks.com/a-complete-guide-to-svg-fallbacks/

Which embedding technique should you choose?!

- Is the SVG animated?
- Is it interactive?
- What kind of animation? (Does it require JS?)
- What browser support do I need (for the animation)?
- What kind of content and fallback do you need? (e.g. infographics)

Quick Animation Recap

Embedding Technique	Animations	Interactions?
<img>	CSS (, SMIL)	No
url();	CSS (, SMIL)	No
<picture>	CSS (, SMIL)	No
<iframe>	CSS, JavaScript (, SMIL)	Yes
<object>	CSS, JavaScript (, SMIL)	Yes
<svg>	CSS, JavaScript (, SMIL)	Yes

Embedding Technique	CSS Animations Location	JS Animations Location
<img>	Inside <svg>	-
url();	Inside <svg>	-
<picture>	Inside <svg>	-
<iframe>	Inside <svg>	Anywhere
<object>	Inside <svg>	Anywhere
<svg>	Anywhere	Anywhere

Accessing an embedded SVG document (<object>):

```
window.onload=function() {
    // Get the Object by ID
    var a = document.getElementById("svgObject");

    // Get the SVG document inside the Object tag
    var svgDoc = a.contentDocument;

    // Get one of the SVG items by ID;
    var svgItem = svgDoc.getElementById("svgItem");

    // Set the colour to something else
    svgItem.setAttribute("fill", "lime");
};
```

***script accessing the SVG from main page must be CORS compatible**

To Optimize or Not To Optimize

Useful SVGO[ptimization] Tools

Published January 26, 2015 |
Estimated Reading Time: 7 min

One of the steps you need to do when working with SVG is optimizing the SVG code after exporting it from the editor and before embedding in on your web page. For that, several standalone optimization tools exits. The two tools I usually mention in my articles and talks are Peter Collingridge's online editor, and SVGO. In this article, I'm going to introduce you to a new SVGO Tool that provides us with everything Peter's tool does, and a bit more.

This is not to say that peter's tool is no longer useful—it certainly is. But if you use SVGO,

Optimization tools usually change the SVG document structure, and can break any animations you've set up.

CSS, SMIL or JavaScript?

— SMIL has been deprecated.
— Use CSS only for simple animations.
— Use JavaScript for complex animations.

Re SMIL: You can use a polyfill if you need to make it work. Follow this guide for details on how to use it.

Animation	Technique/Tool
Transforms (scale, rotate, translate, skew)	CSS, JavaScript Recommended: JavaScript
Path Morphing	JavaScript
Line Drawing	CSS, Javascript Recommended: JavaScript
Color and other simple animations and transitions	CSS, JavaScript Recommended: CSS whenever possible

Animating SVG with CSS: The Good, the Bad and the Ugly

1) The list of SVG attributes that can be animated with CSS is limited (in SVG 1.1).

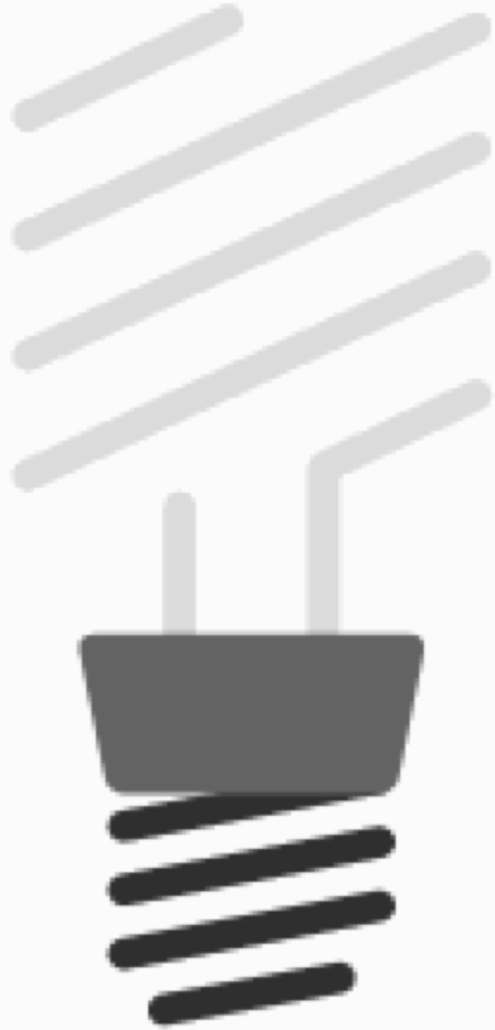
2) In SVG2, the list is extended.

3) Most properties are animated on SVG elements just like they are animated on HTML elements.

Shared with CSS	SVG-Only
font, font-family, font-size, font-size-adjust, font-stretch, font-style, font-variant, font-weight, direction, letter-spacing, text-decoration, unincode-bidi, word-spacing, visibility, text-rendering, writing-mode, clip-path, mask-opacity, filter, pointer-events, image-rendering, clip, color, cursor, display, overflow	clip-rule, flood-color, flood-opacity, stop-opacity, kerning, tech-anchor, color-profile, color-rendering, fill, fill-opacity, fill-rule, marker, marker-end, marker-mid, marker-start, stroke, stroke-width, stop-color, lighting-color, enable-background, dominant-baseline, color-interpolation-filters, color-interpolation, glyph-orientation-horizontal, glyph-orientation-vertical, shape-rendering, baseline-shift, alignment-baseline, stroke-miterlimit, stroke-linejoin, stroke-linecap, stroke-dashoffset, stroke-dasharray, stroke-opacity

Using these properties, you can apply animations and transitions to SVG elements just like you would with HTMl elements, using the main CSS selectors:

```
rect {

}
#myPath {

}
.circle {

}
```



PROOF OF CONCEPT

Light up your icons

You love CSS. So does Iconic. Each icon is designed with stying in mind. Individual elements of each and every icon can be given a completely custom look. So, by all means, go crazy.

Hover to show alternate styling

```
Elements | Network | Sources | Timeline | Profiles | Resources | Audits | Console | Grunt
<div class="container">
  ::before
  <div class="row">
    ::before
    <div class="col-md-6 col-md-offset-3">
      <h4>Light up your icons</h4>
      <p>…</p>
      <p class="text-center" style=" margin-bottom: 80px; ">
        <svg xmlns="http://www.w3.org/2000/svg" xmlns:xlink="htt
          <circle class="icon-container" cx="357" cy="357" r="33
          <g class="iconic-lightbulb-screws">…</g>
          <g class="iconic-lightbulb-light">
            <defs>…</defs>
            <g clip-path="url(#iconic-lightbulb-light-clip)">…</
            <line x1="478" y1="129" x2="254" y2="233"></line>
            <line x1="354" y1="125" x2="254" y2="173"></line>
            <line x1="478" y1="189" x2="254" y2="293"></line>
            <line x1="478" y1="249" x2="254" y2="353"></line>
          </g>
          <path class="iconic-lightbulb-base" d="M292.431,505c0.
        </svg>
html  body  section  article  div  div  div  p.text-center  svg.svg-inject.iconic.iconic-ligh
Styles | Event Listeners | DOM Breakpoints | Properties
:active   :hover
:focus    :visited
element.style {
}
.iconic-lightbulb:hover .iconic-lightbulb-light * {        index.html:58
  stroke: rgb(255, 204, 0);
  stroke-width: 32;
}
.iconic-lightbulb .iconic-lightbulb-light * {              index.html:50
  stroke-width: 16;
  stroke: rgb(221, 221, 221);
  fill: none;
  stroke-linecap: round;
```

Fullscreen Overlay Styles & Effects

HUGE INC | CORNER | SLIDE DOWN | SCALE | DOOR | CONTENT PUSH

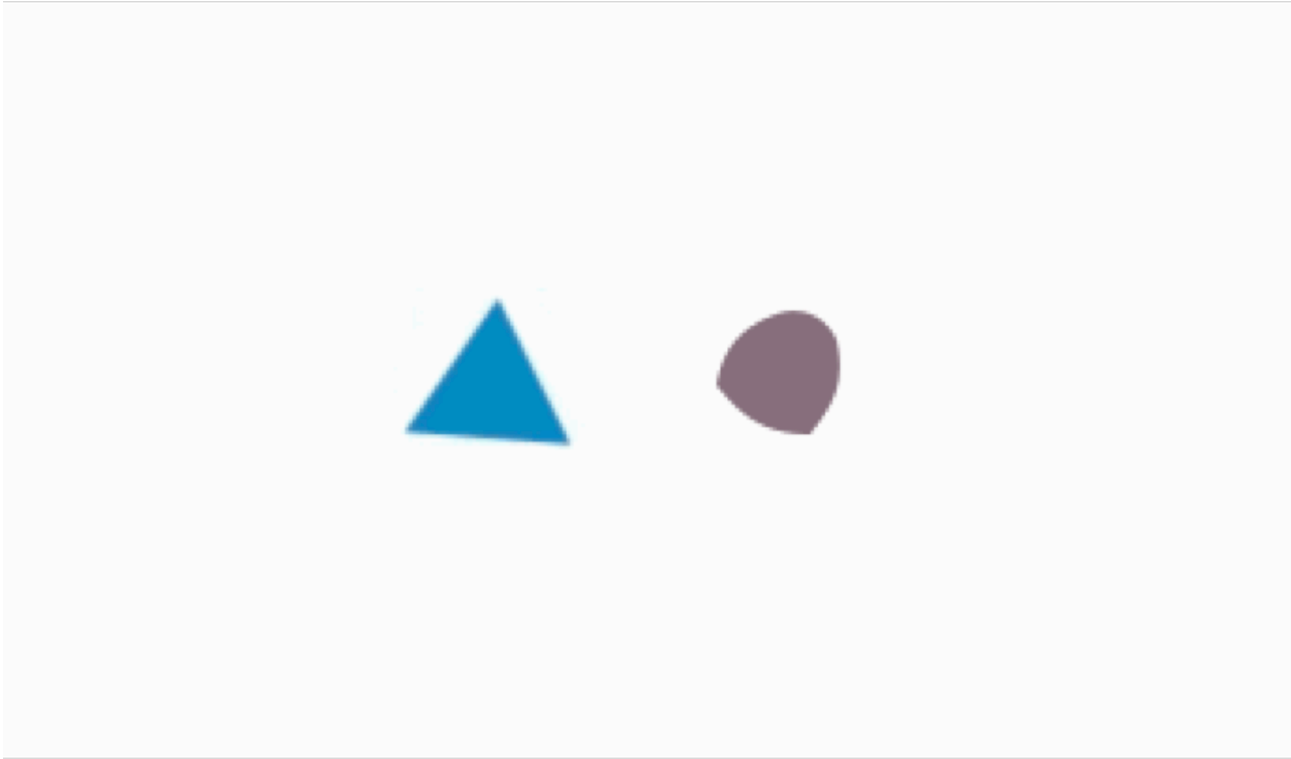
CONTENT SCALE | CORNER SHAPE | LITTLE BOXES | SIMPLE GENIE | GENIE

Genie effect with SVG animation.

OPEN OVERLAY

```
path {
  transition: d .6s ease-in-out;
}

path.open {
  d: "M20.308,...";
}
```

```
<path>
    <animate
        attributeName="d"
        dur="1440ms"
        repeatCount="indefinite"
        keyTimes=".."
        calcMode="spline"
        keySplines=".."
        values="M 0,0
                C 50,0 50,0 100,0
                100,50 100,50 100,100
                50,100 50,100 0,100
                0,50 0,50 0,0
                Z;

                M 0,0
                C 50,0 50,0 100,0
                100,50 100,50 100,100
                50,100 50,100 0,100
                0,50 0,50 0,0
                Z;

                ..."/>
```



https://css-tricks.com/guide-svg-animations-smil/

CSS Transformations on SVG elements:

	transform-origin (default value)
HTML Elements (div, ::before, etc.)	**50% 50%** *(the center of the element itself, calculated relative to its box model)*
SVG Elements (circle, rect, etc.)	**0 0** *(top left corner of the SVG canvas, not of the element itself)*

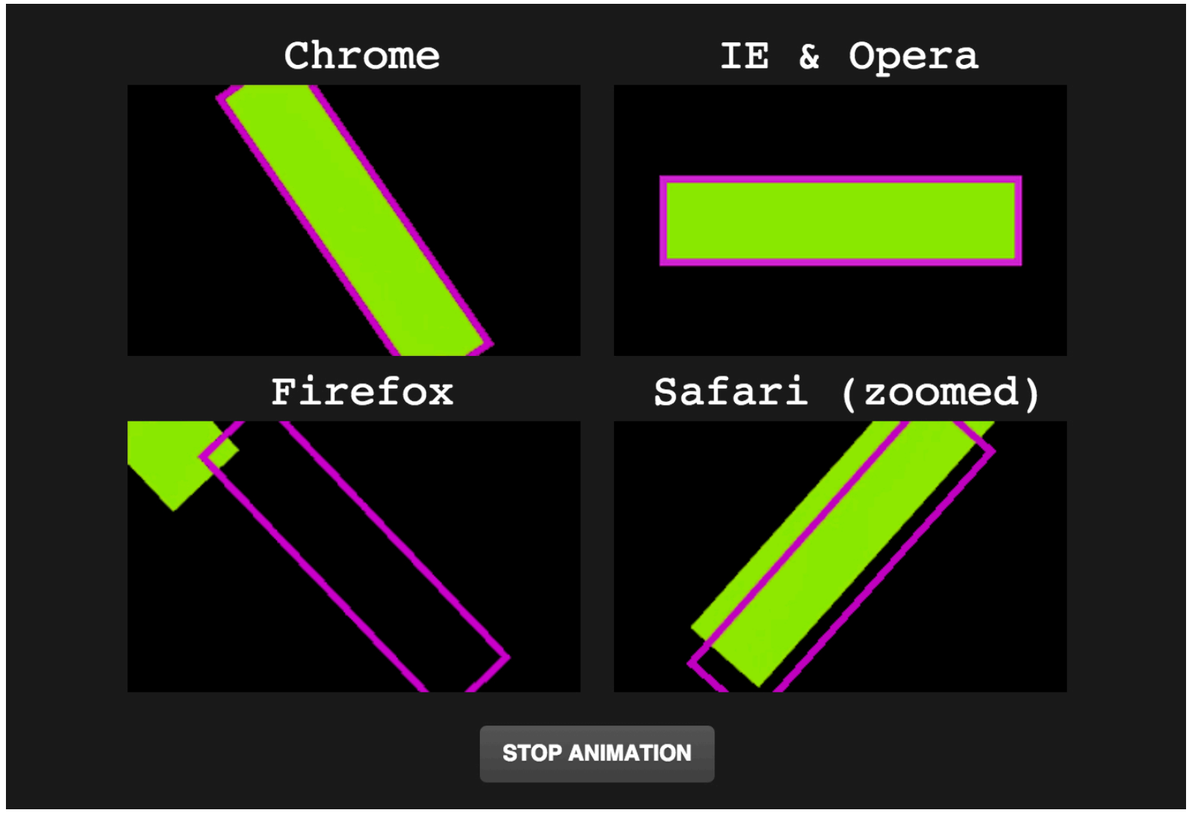
```
<!DOCTYPE html>
<div style="width: 100px; height: 100px; background-color: orange"> </div>
<svg style="width: 150px; height: 150px; background-color: #eee">
        <rect width="100" height="100" x="25" y="25" fill="orange" />
</svg>
```

```
div { transform: rotate(45deg); }
```

```
rect { transform: rotate(45deg); }
```

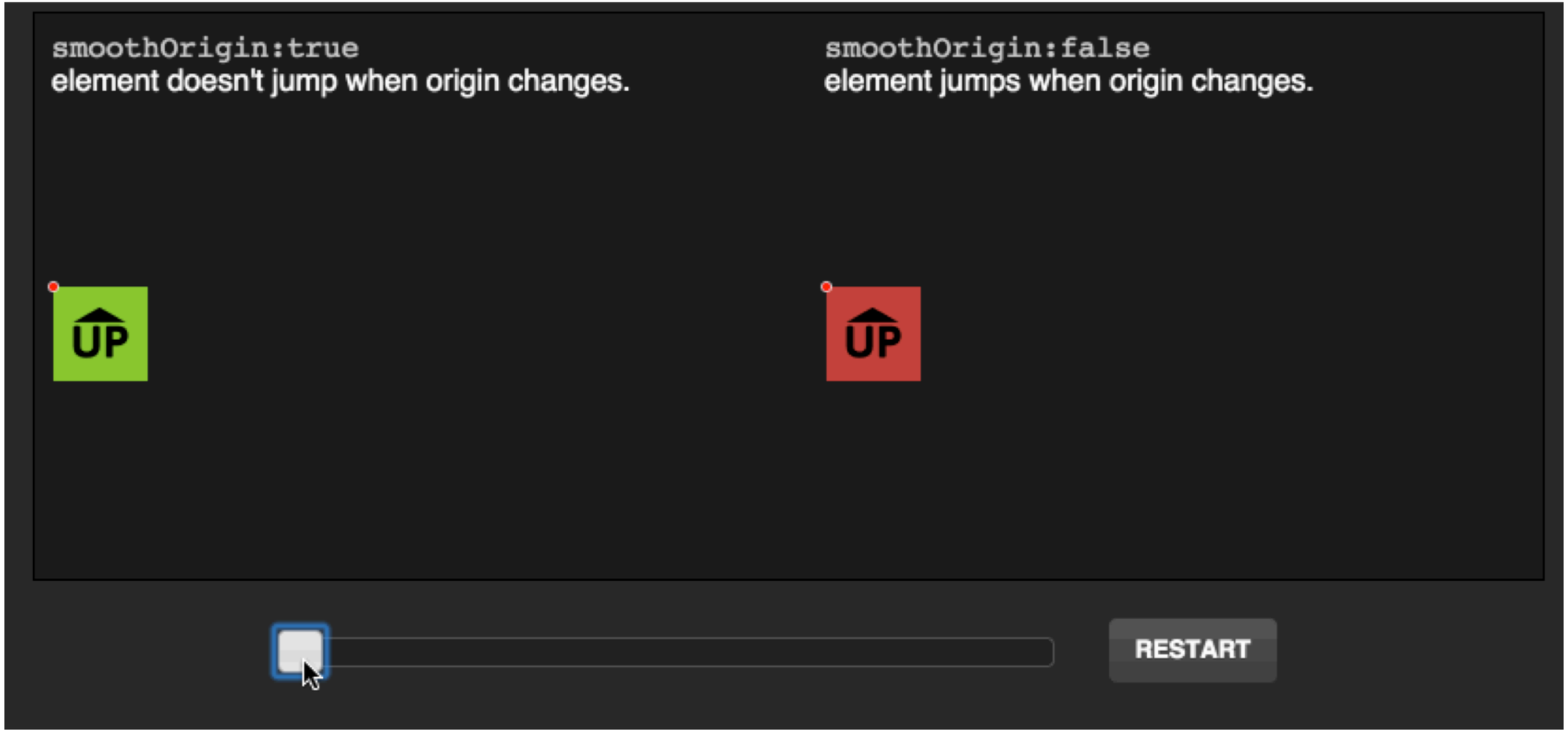
Change the `tranform-origin` value:

1. Using percentage values: The value is set relative to the element's bounding box, which includes the stroke used to draw its border.
2. Using absolute values: The origin is set **relative to the entire SVG canvas**.



http://greensock.com/svg-tips

*Firefox bug has been fixed in FF44.



http://greensock.com/svg-tips

CSS transforms don’t work in IE/Edge. 🙄

CSS 3D Transforms on SVG Elements?

Don’t count on them yet.

You can use standard sprite animation to achieve 3D animation effects.

What about performance?

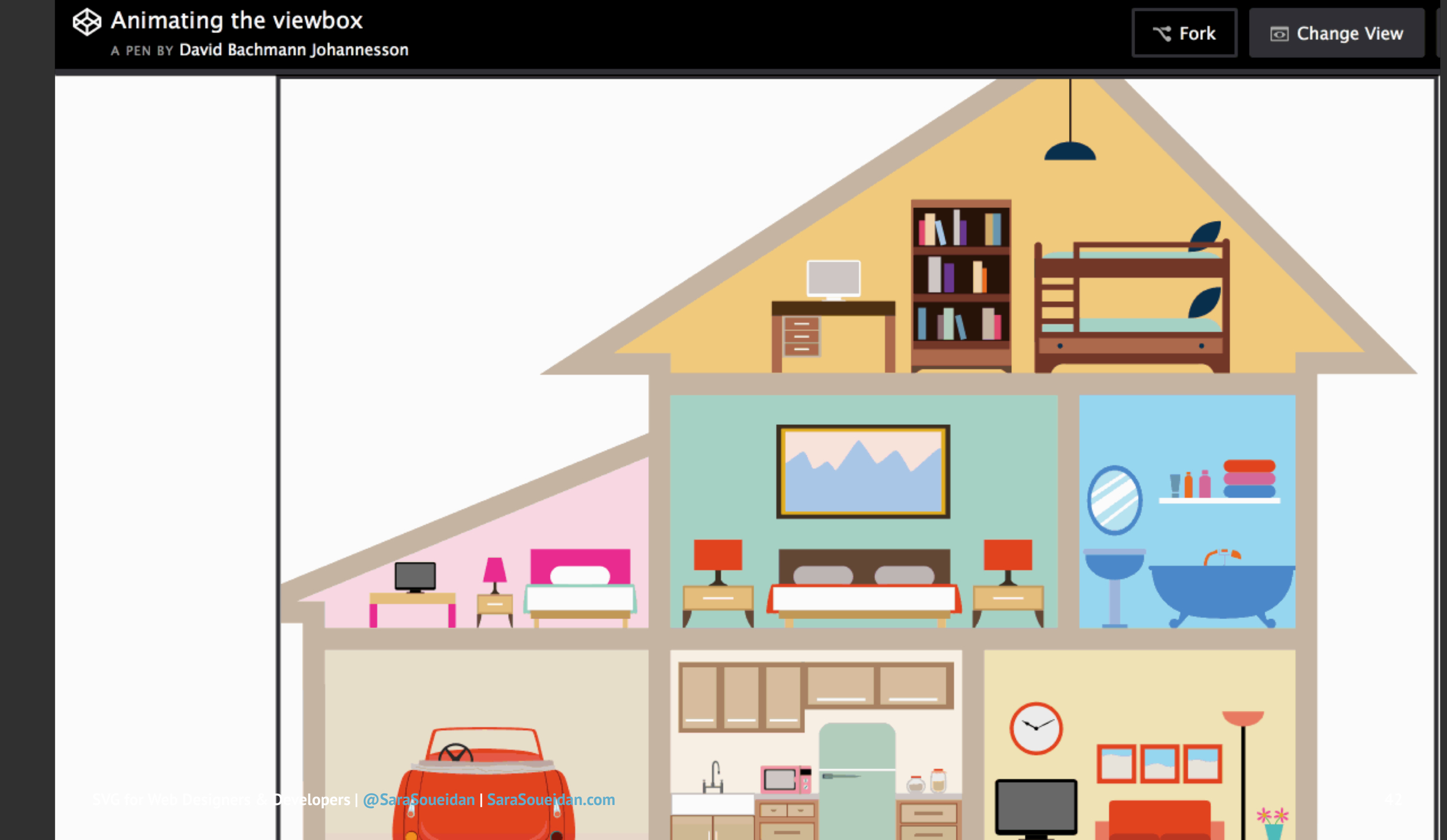
Some useful (possibly outdated) benchmarks: https://css-tricks.com/weighing-svg-animation-techniques-benchmarks/

The SVG `viewBox`

The `viewBox` is made up of four numerical values: the first two determine the coordinates of the origin of the system, and the other two determine the system's finite dimensions.

```
viewBox = <min-x> <min-y> <width> <height>
```

These values are animatable.


Animating the viewbox
A PEN BY David Bachmann Johannesson
Fork
Change View

By changing the value of the `viewBox`, you change the area of the canvas that is visible inside the SVG viewport. This enables you to zoom in to specific areas or objects.

But how do you determine the value for the `viewBox` to use, to zoom into a particular area of choice?

SVG Bounding Boxes 💡

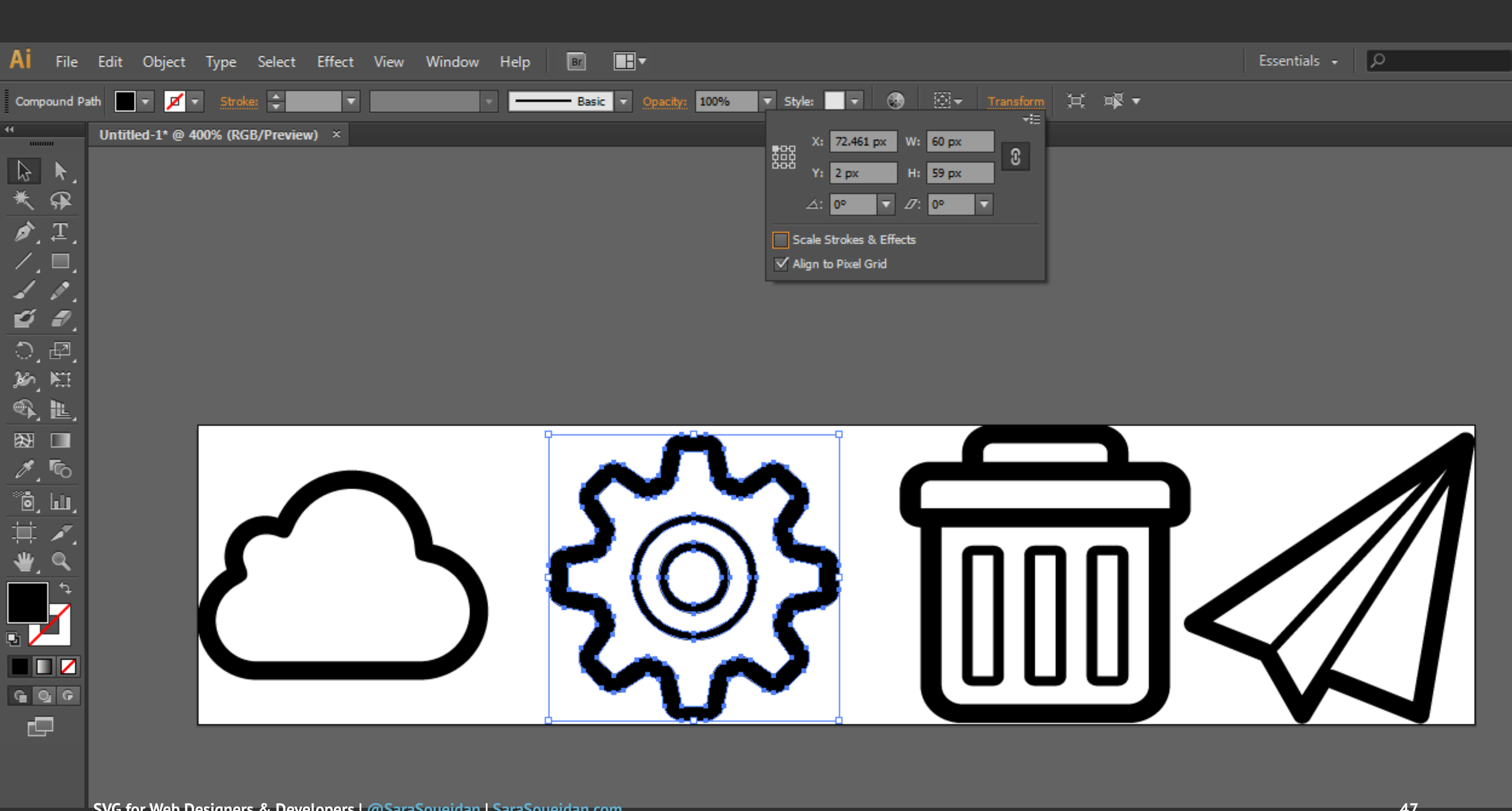
The bounding box (or "bbox") of an element is the tightest fitting rectangle aligned with the axes of that element's user coordinate system that entirely encloses it and its descendants.

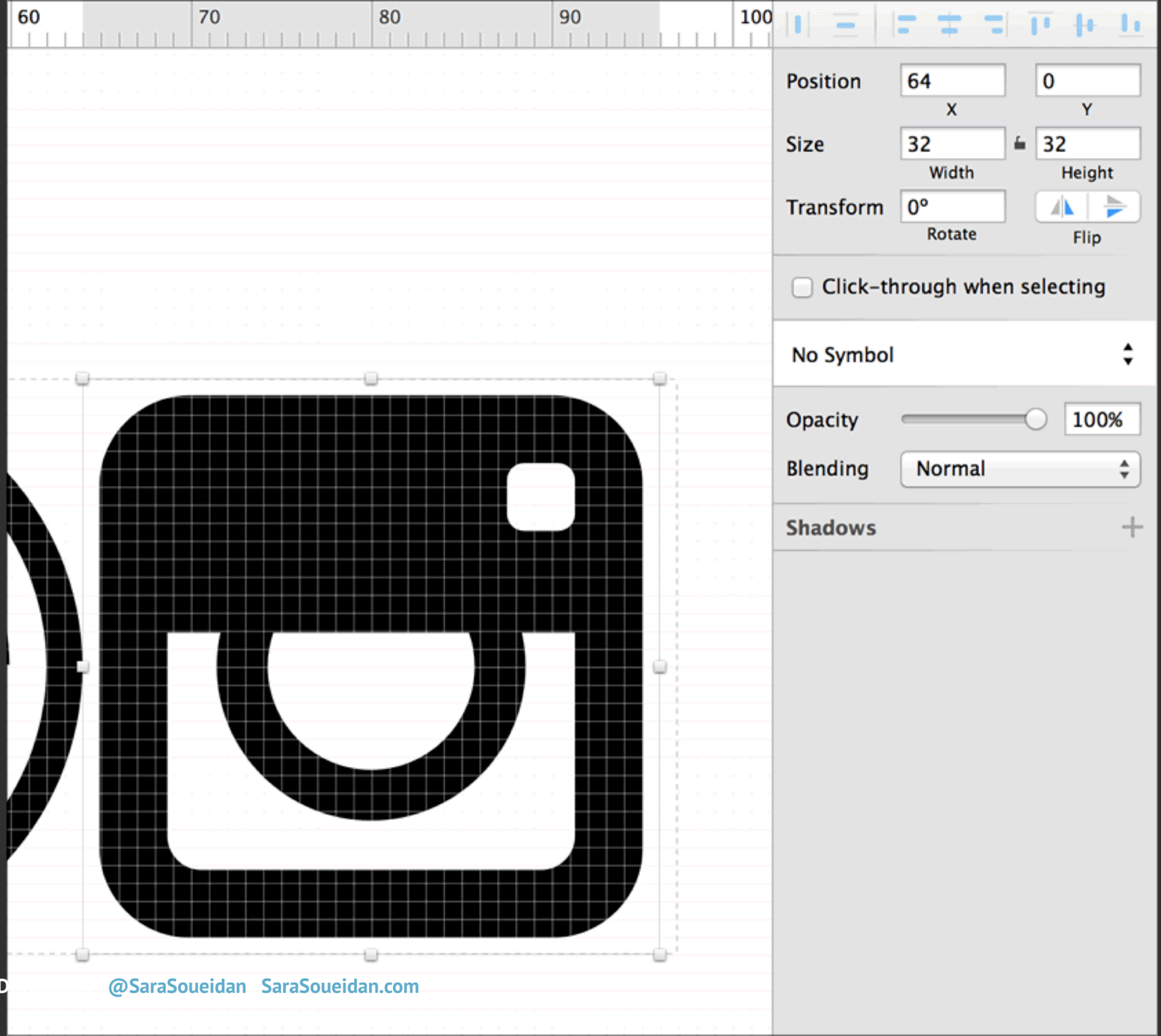
An SVG BBox has the ame properties as those defining the SVG `viewBox`: x, y, width and height…

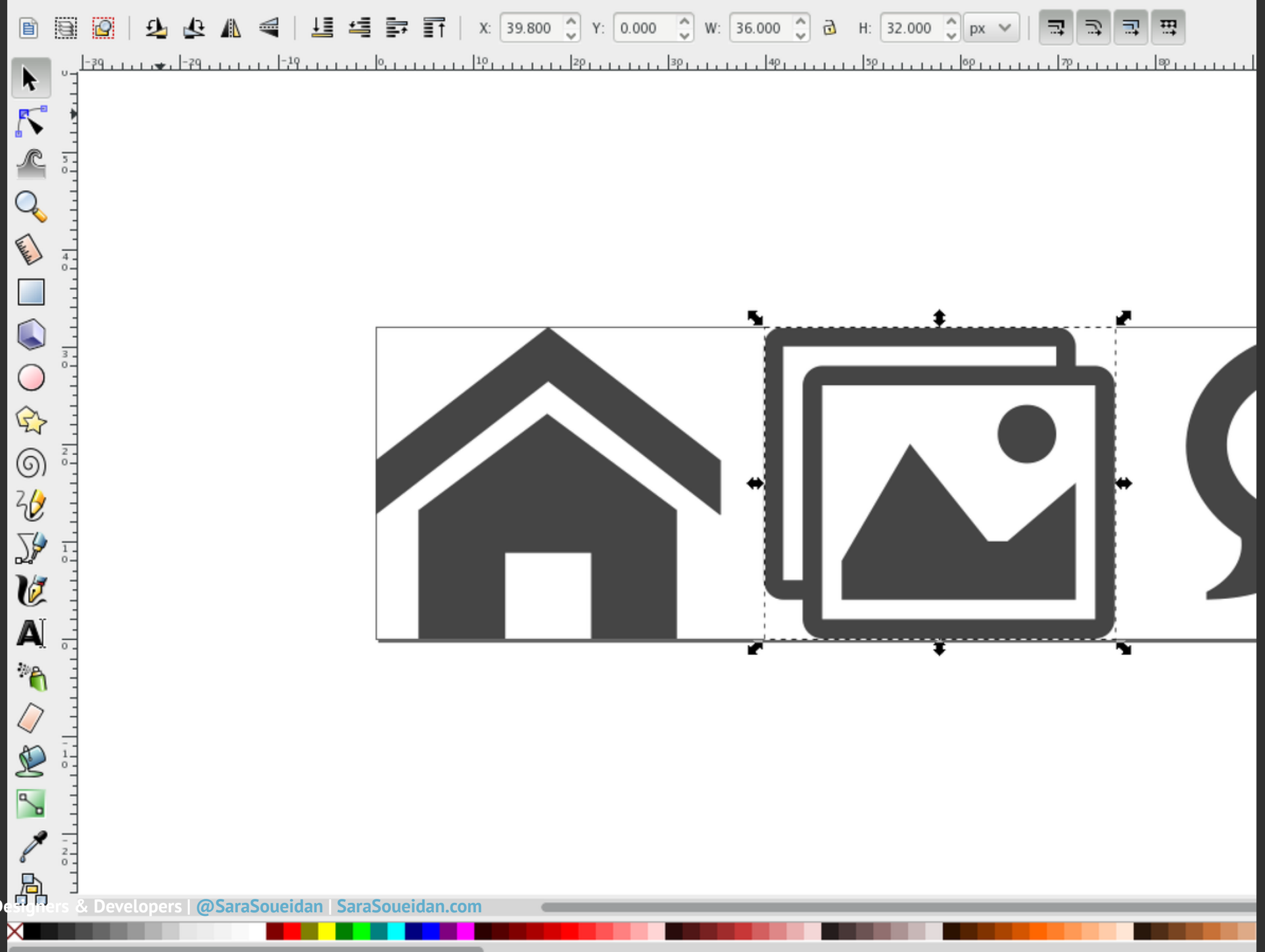
You can retreieve these properties using the `getBBox()` method:

```
var svgElement = document.getElementById('el');
bbox = svgElement.getBBox();

console.log( bbox.x ) ;
console.log( bbox.y ) ;
console.log( bbox.width ) ;
console.log( bbox.height ) ;
```

OR, you can do it visually in your graphics editor of choice:

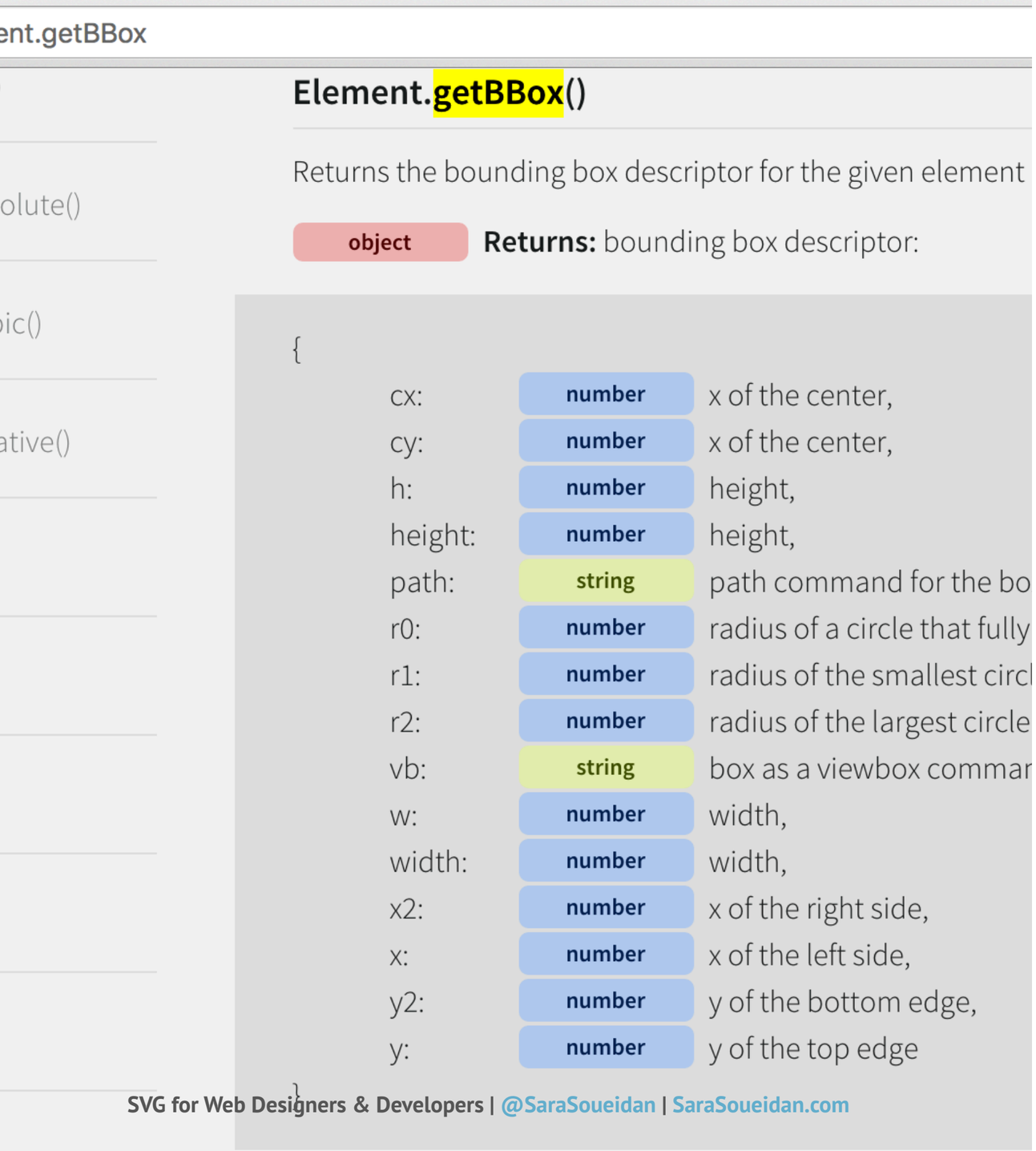

File Edit Object Type Select Effect View Window Help
Essentials
Compound Path
Stroke:
Basic
Opacity:
100%
Style:
Transform
Untitled-1* @ 400% (RGB/Preview)
X: 72.461 px
W: 60 px
Y: 2 px
H: 59 px
0°
0°
Scale Strokes & Effects
Align to Pixel Grid


60
70
80
90
100
Position
64
X
0
Y
Size
32
Width
32
Height
Transform
0°
Rotate
Flip
Click-through when selecting
No Symbol
Opacity
100%
Blending
Normal
Shadows


X: 39.800
Y: 0.000
W: 36.000
H: 32.000
px

You can use the properties of an element's bounding box as values for the `viewBox`. This will make the element zoom in to the viewport. Example: zooming into spcific areas/countries on a map…

```
var svg = document.getElementById('map'),
    s = Snap(svg);

var leb = document.getElementById('LB');
    var bbox = Snap(leb).getBBox();

var clicked = false;
function zoomIn(ev) {
    if(clicked == false) {
        clicked = true;
        s.animate({viewBox: bbox.vb}, 1000);
    }
    else {
        clicked = false;
        s.animate({viewBox: "0 0 1100 700"}, 2000);
    }
}

leb.addEventListener('click', zoomIn, false);
```



Snap.svg is “the jQuery of SVG”.

The `getBBox()` method returns a *string*, making the bounding box values available as a `viewBox` command!

You can also use GreenSock—particularly useful for when yo have nested or sequenced animations:

```
tl
  .to(svg, 2, {delay: 1, attr: {viewBox: "450 350 252 178"}})
  .to(svg, 4, {attr: {viewBox: "60 350 252 178"}})
  .to(svg, 2, {attr: {viewBox: "60 210 252 178"}}, "-=0.25")
  .to(svg, 4, {attr: {viewBox: "444 210 252 178"}})
  .to(svg, 2, {attr: {viewBox: "0 0 757.8 534.8"}})
```

Source: http://codepen.io/dbj/pen/RWmQNJ?editors=1010

Ideally, we'd be able to do this in CSS:

```
svg {
  viewBox: 0 0 200 200;
  transition: viewBox .4s ease-in-out;
}

svg:hover {
  viewBox: 0 0 100 100;
}

@keyframes zoom {
  from { viewBox: ....; }
  to { viewBox: ...; }
}
```

SVG Sprite Animation Techniques

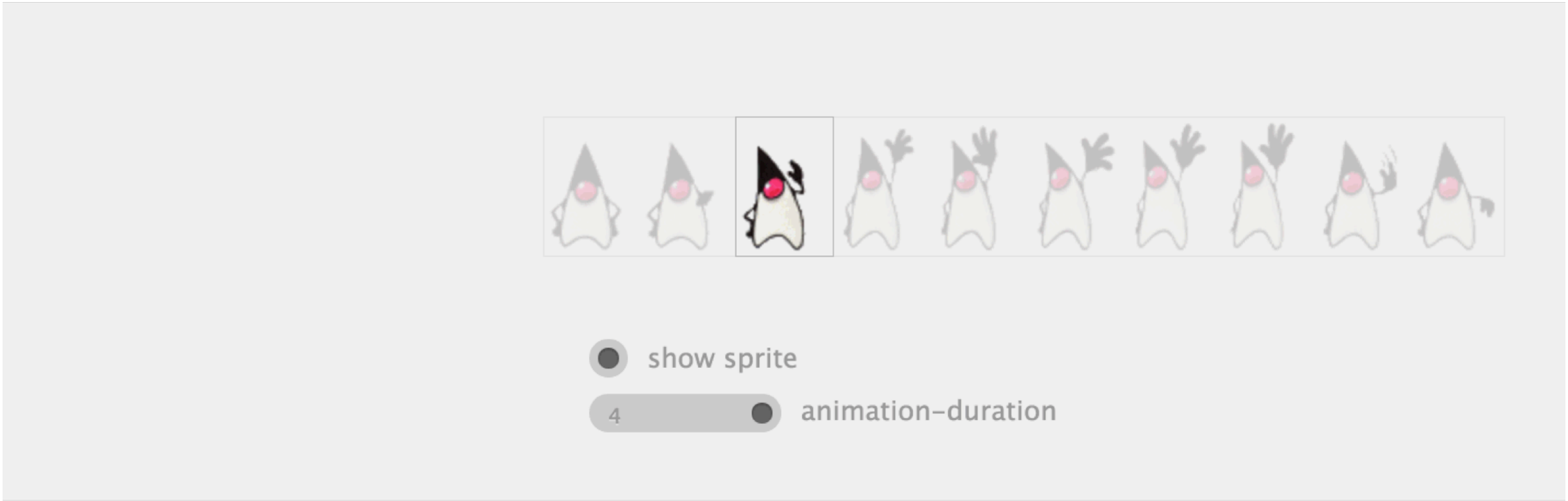
Technique #1: SVG-as-Background Sprite Animation

This technique treats an SVG image just like a PNG sprite image.

— The SVG image would have all the "frames" drawn inside of it.
— The SVG is used as a background image on an element.
— The position of the SVG in the background positioning area is animated using `steps()`, thus showing only one frame at a time, over a specified period of time.

```
#element-with-animated-background {
    /* ... */
    background-image: url(path/to/image.svg)
    width: width-of-each-frame;
    height: height-of-the-image;
    animation: frame-animation 1s steps(number-of-frames) infinite;
}

@keyframes frame-animation {
    0% { background-position: 0px 0; }
    100% { background-position: -(width-of-the-image) 0; }
}
```

Where 500px is the width of the image used as a background



http://simurai.com/blog/2012/12/03/step-animation/

Technique #2: (Independent) SVG Sprite Animation

How is this different from Technique #1?

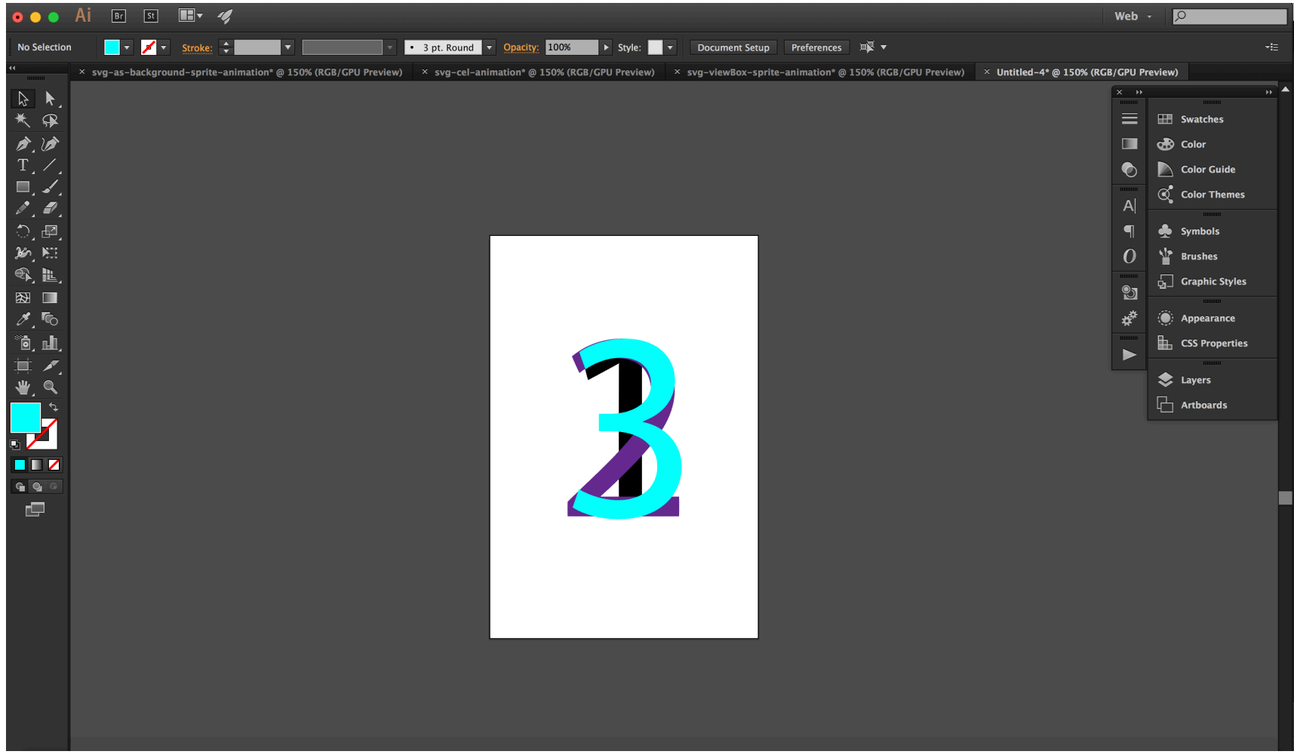
— The SVG is used as a foreground image, not an element's background image, so the frame animation happens *inside* the SVG.

— The frames inside the SVG are positioned on top of each other.

— Each frame is **animated into view** by changing its `opacity`.

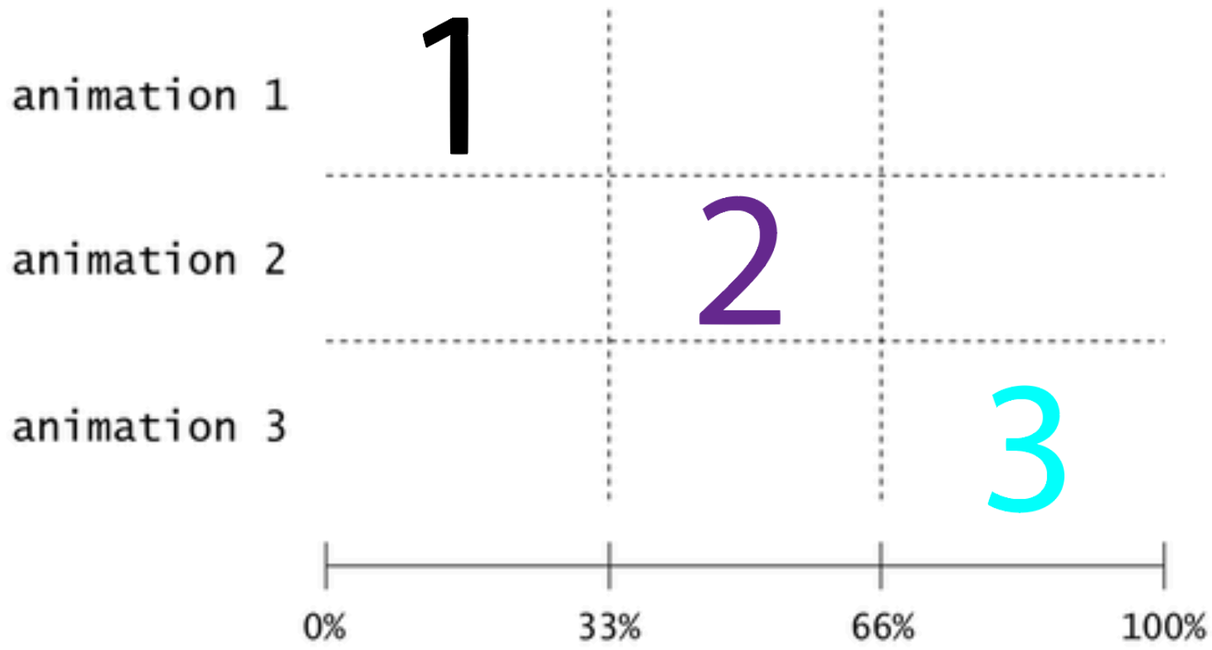
— Frame animation uses `steps()` to animate each frame in *independently* but *concurrently*.

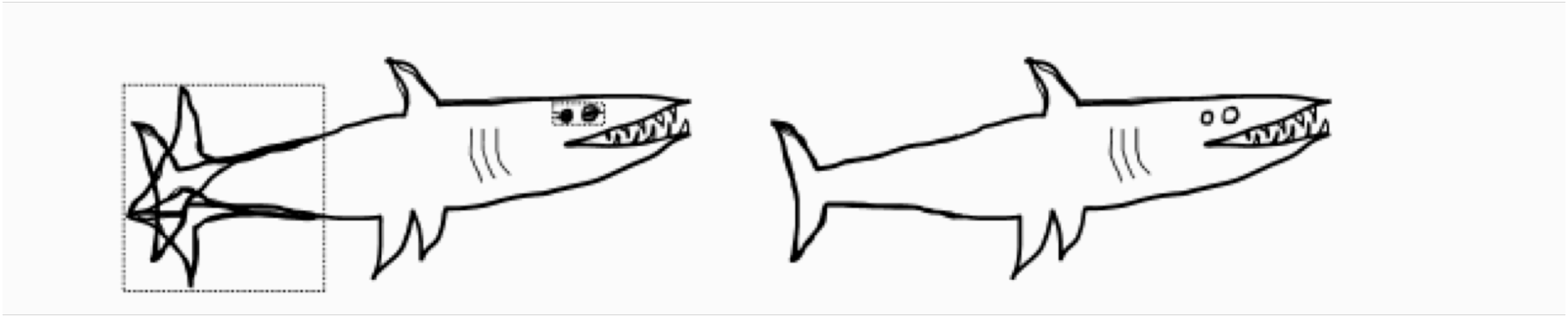
For example, suppose we have three frames in our animation, wrapped in a `<g class="frames"></g>`



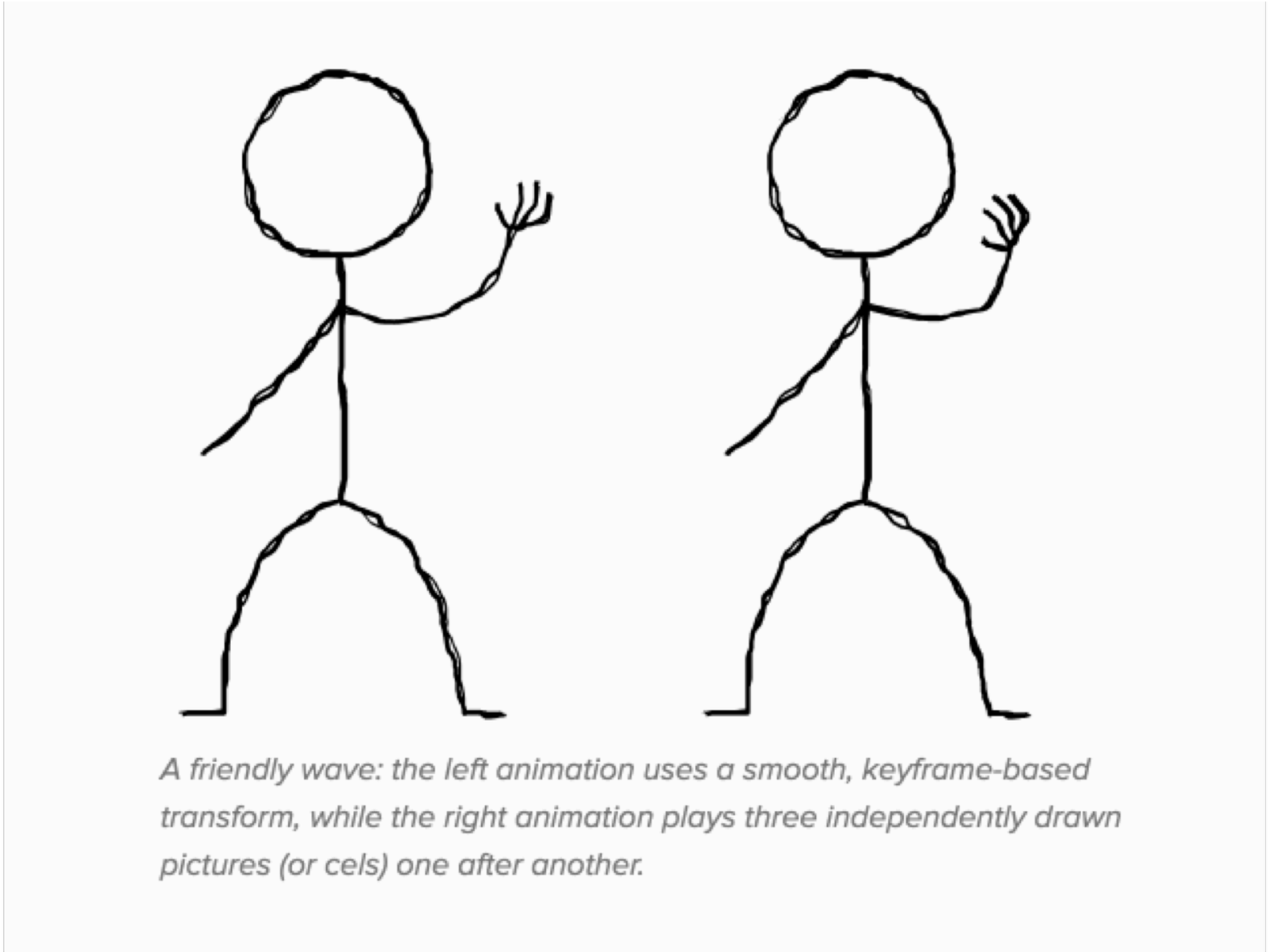
```css
@keyframes frame-1-animation {
  0% {
    opacity: 1;
  }
  33.33333% {
    opacity: 0;
  }
}

.frames > :nth-child(1) {
  animation-name: frame-1-animation;
}

@keyframes frame-2-animation {
  33.33333% {
    opacity: 1;
  }
  66.66667% {
    opacity: 0;
  }
}

.frames > :nth-child(2) {
  animation-name: frame-2-animation;
}

@keyframes frame-3-animation {
  66.66667% {
    opacity: 1;
  }
  100% {
    opacity: 0;
  }
}

.frames > :nth-child(3) {
  animation-name: frame-3-animation;
}
```

In the animation timeline: each animation starts before the previous one finishes. The sum of all animation is the duration of the entire animation, so the duration **of visibility of each frame** is = total animation duration / 3.





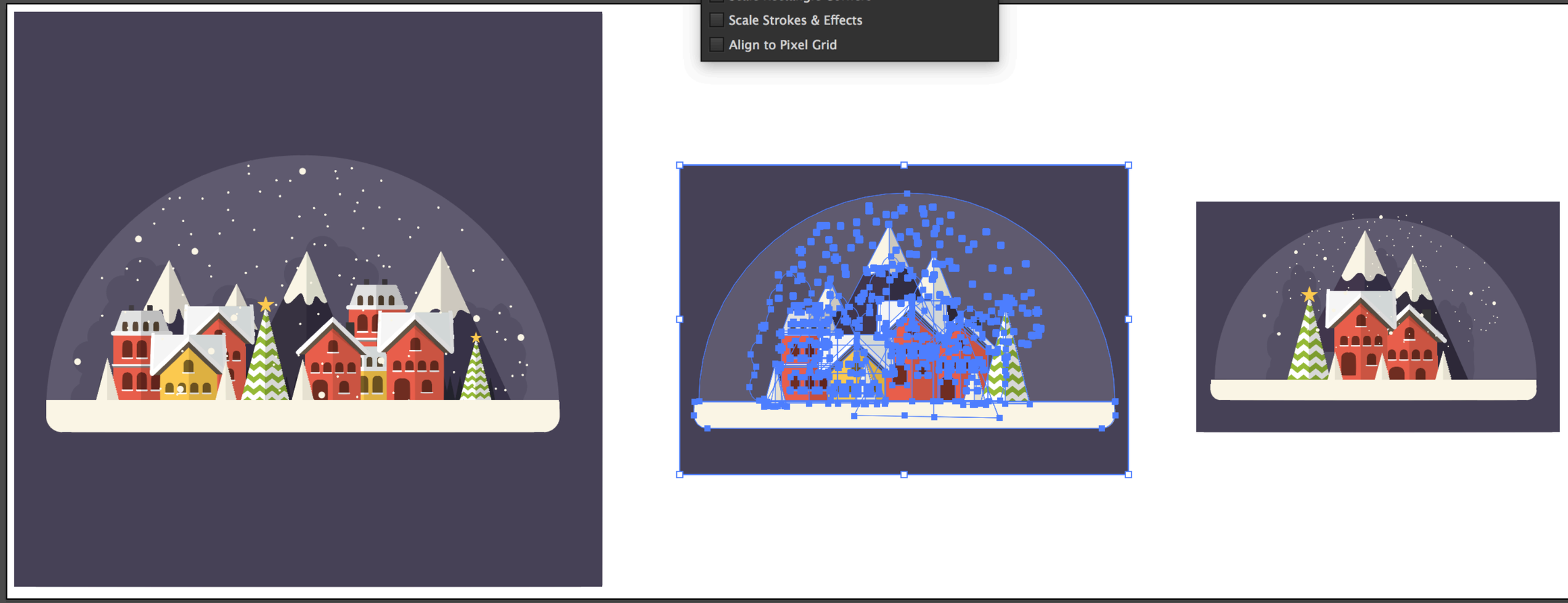
http://www.smashingmagazine.com/2015/09/creating-cel-animations-with-svg/



A friendly wave: the left animation uses a smooth, keyframe-based transform, while the right animation plays three independently drawn pictures (or cels) one after another.

Technique #3: Responsive SVG Sprite Animation using `viewBox`

- The SVG is independent.
- Instead of multiple frames, the SVG contains multiple "scenes".
- Each scene is brought into view / shown inside the viewport depending on the size of the viewport.
- OR: The SVG is cropped so that only one scene is visible inside the viewport.
- `viewBox` is used to crop the SVG to each scene.


Ai
Web
Group
Stroke:
Basic
Opacity:
100%
Style:
Transform
svg-as-background-sprite-animation* @ 15...
svg-cel-animation* @ 150% (RGB/GPU Previ...
Untitled-5* @ 100% (RGB/GPU Preview)
28155-NWX9PD.ai* @ 114% (RGB/Overprint ...
X: 546.143 px
W: 363.857 px
Y: 130.665 px
H: 251.335 px
0°
0°
Scale Rectangle Corners
Scale Strokes & Effects
Align to Pixel Grid

```
var svg = document.getElementById("svg");

// media query event handler
if (matchMedia) {
        var mq = window.matchMedia("(min-width: 500px)");
        mq.addListener(WidthChange);
        WidthChange(mq);
}
// media query change
function WidthChange(mq) {
        if (mq.matches) {
    svg.setAttribute("viewBox", "...");
        }
        else {
    svg.setAttribute("viewBox", "...");
        }
};
```

Read more about this technique: http://www.smashingmagazine.com/2015/03/different-ways-to-use-svg-sprites-in-animation/

Animating SVG with JavaScript

Popular SVG JavaScript animation libraries:

1. GreenSock Animation Platform (GSAP)
2. Snap.svg (“*The jQuery of SVG*”)
3. Velocity.js
4. D3.js

GSAP's strengths:

— The ability to stack tweens
— Creating precise timelines
— Control tween delays
— Specify moments in time to start animations
— Start animations relative to each other using relative labels
— Nest timelines
— Create time lapses and Slow-Mo scenes
— Morphing shapes without point number restrictions: any shape can be morphed into any shape
— Line drawing, text animation, and much more

GSAP animation capabilities include:

— Motion Along A Path

— Advanced Text Animation

— Draggable

— Shape Morphing

— Line Drawing

— Relative Color Tweening (See this pen)

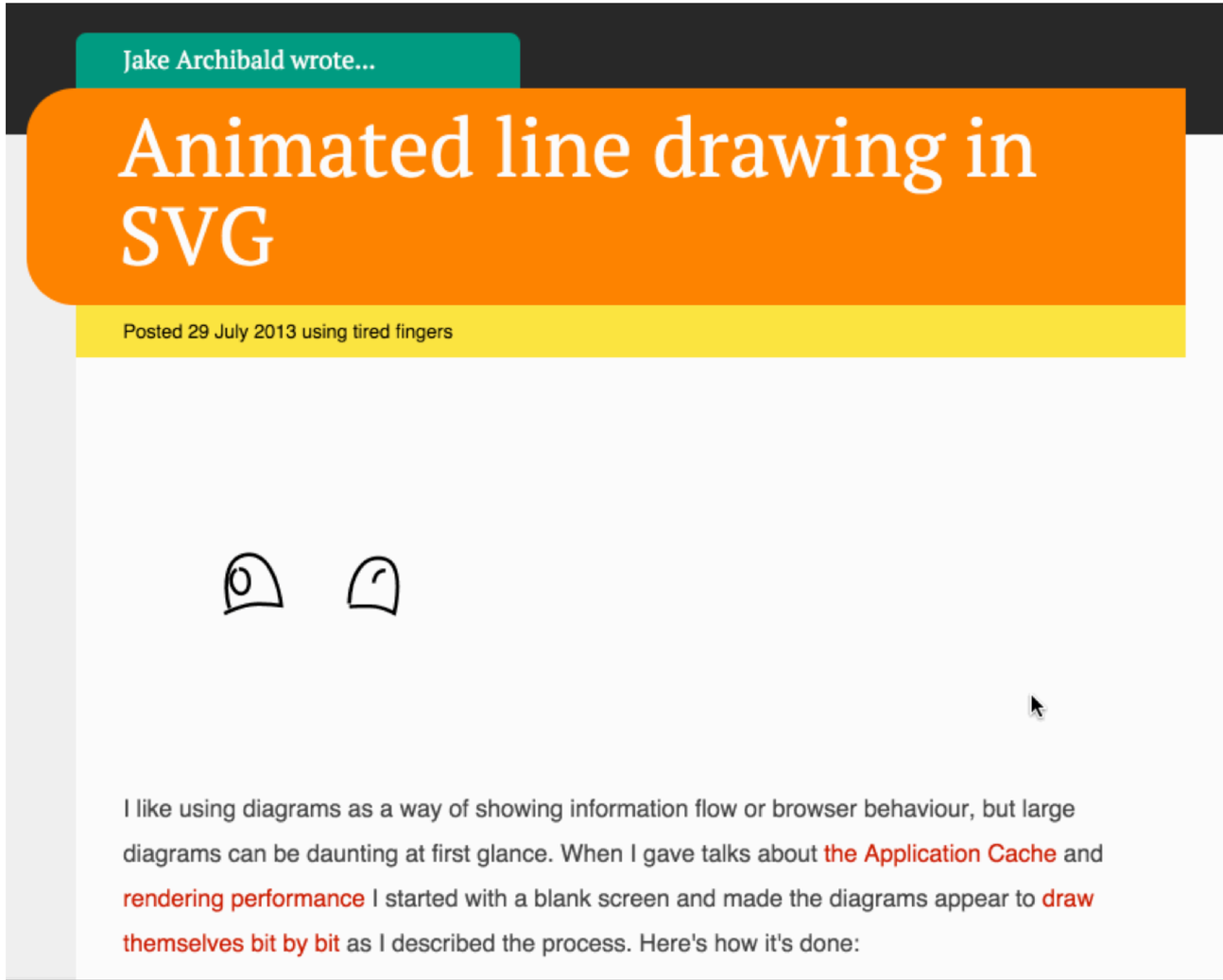
Example: Line Drawing Effect

Line Drawing with SVG:

The line drawing effect is essentially an animated *stroke offset*.

The stroke is a perfect even line, with perfect line edges and the equal amount of distance between the edges along the entire path/ stroke length.

Article



Thank You

Credits:

1. CSS SVG transform origin bugs / behavior GIFS from GreenSock
2. Snow globe illustration designed by Freepik
3. Grumpicon screenshot from http://grumpicon.com