THE GRAPHICAL WEB

THE GRAPHICAL WEB

- Design
- User Interfaces
- Cartoons, Animations, Ads
- Science
- Cartography and mapping
- Data Visualization
- Games
- Multimedia
- …
- The Graphical Web
- Joshua Davis

THE GRAPHICAL WEB TECHNOLOGIES

- A set of graphical technologies used on the web
  - Mostly based on web standards
    - avoiding Flash, Silverlight
  - Positioning & Layout
  - 2D Vector Graphics Primitives
  - Rendering Model
  - Graphical Effects
  - Compositing, Blending, Masking
  - 3D Graphics
- Offered (mostly) in two flavors
  - Declaratively (SVG, CSS)
  - Programmaticaly (Canvas, WebGL, GLSL)

DEMO

Paths – SVG 1.1 (Se
Scalable Vector Gra
Painting: Filling, Str
Filter Effects 1.0
Clipping, Masking
CSS Masking
Compositing and B
CSS Transforms
Text – SVG 1.1 (Secc
SVG namespace
The Quest for The
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Adobe & HTML
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GRAPHICAL/TEXT LAYOUT

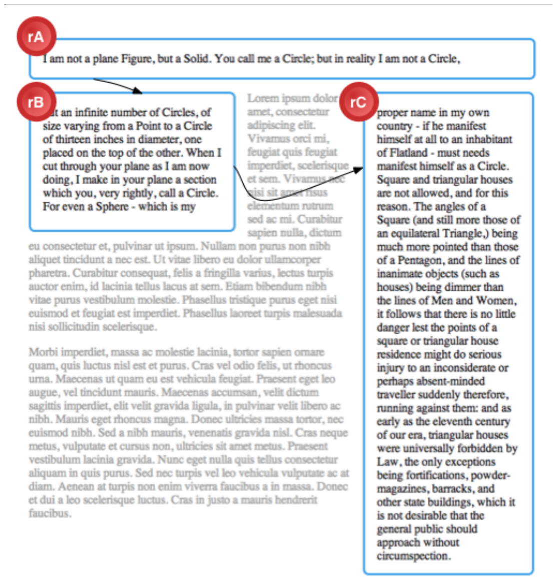
FIXED VS. REFLOWABLE

- CSS mostly deals with reflowable layouts
  - CSS Basic Layout
  - CSS Grid Layout
  - CSS Flexbox Model
  - CSS Regions
  - CSS Exclusions
  - ...
- SVG deals with fixed positioning
  - positions, angles, scales, ...

CSS REGIONS

- Enable content to flow across multiple (non-rectangular) regions
    - Useful for magazine layout

- http://dev.w3.org/csswg/css3-regions/
- http://html.adobe.com/webstandards/cssregions/



I am not a plane Figure, but a Solid. You call me a Circle; but in reality I am not a Circle,

t an infinite number of Circles, of size varying from a Point to a Circle of thirteen inches in diameter, one placed on the top of the other. When I cut through your plane as I am now doing, I make in your plane a section which you, very rightly, call a Circle. For even a Sphere - which is my

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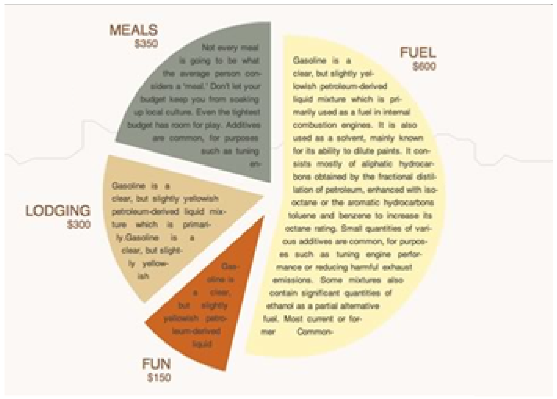
Morbi imperdiet, massa ac molestie lacinia, tortor sapien ornare quam, quis luctus nisl est et purus. Cras vel odio felis, ut rhoncus urna. Maecenas ut quam eu est vehicula feugiat. Praesent eget leo augue, vel tincidunt mauris. Maecenas accumsan, velit dictum sagittis imperdiet, elit velit gravida ligula, in pulvinar velit libero ac nibh. Mauris eget rhoncus magna. Donec ultricies massa tortor, nec euismod nibh. Sed a nibh mauris, venenatis gravida nisl. Cras neque metus, vulputate et cursus non, ultricies sit amet metus. Praesent vestibulum lacinia gravida. Nunc eget nulla quis tellus consectetur aliquam in quis purus. Sed nec turpis vel leo vehicula vulputate ac at diam. Aenean at turpis non enim viverra faucibus a in massa. Donec et dui a leo scelerisque luctus. Cras in justo a mauris hendrerit faucibus.

proper name in my own country - if he manifest himself at all to an inhabitant of Flatland - must needs manifest himself as a Circle. Square and triangular houses are not allowed, and for this reason. The angles of a Square (and still more those of an equilateral Triangle,) being much more pointed than those of a Pentagon, and the lines of inanimate objects (such as houses) being dimmer than the lines of Men and Women, it follows that there is no little danger lest the points of a square or triangular house residence might do serious injury to an inconsiderate or perhaps absent-minded traveller suddenly therefore, running against them: and as early as the eleventh century of our era, triangular houses were universally forbidden by Law, the only exceptions being fortifications, powder-magazines, barracks, and other state buildings, which it is not desirable that the general public should approach without circumspection.



Not every meal is going to be what the average person considers a 'meal.' Don't let your budget keep you from soaking up local culture. Even the tightest budget has room for play. Additives are common, for purposes such as tuning en-

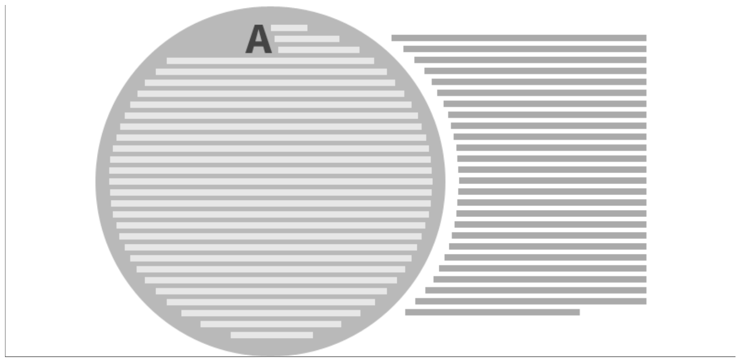
Gasoline is a clear, but slightly yellowish petroleum-derived liquid mixture which is primarily used as a fuel in internal combustion engines. It is also used as a solvent, mainly known for its ability to dilute paints. It consists mostly of aliphatic hydrocarbons obtained by the fractional distillation of petroleum, enhanced with iso-octane or the aromatic hydrocarbons toluene and benzene to increase its octane rating. Small quantities of various additives are common, for purposes such as tuning engine performance or reducing harmful exhaust emissions. Some mixtures also contain significant quantities of ethanol as a partial alternative fuel. Most current or former Common-

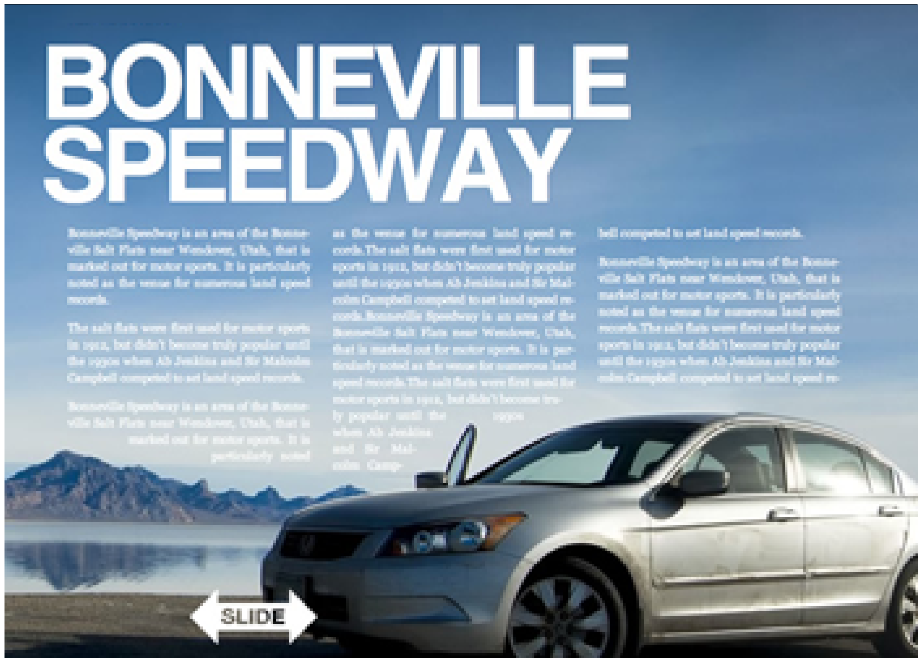
Gasoline is a clear, but slightly yellowish petroleum-derived liquid mixture which is primarily.Gasoline is a clear, but slightly yellowish

Gasoline is a clear, but slightly yellowish petroleum-derived liquid

CSS EXCLUSIONS

- To exclude certain regions from the text flow
- http://html.adobe.com/webstandards/cssexclusions/





BONNEVILLE SPEEDWAY

Bonneville Speedway is an area of the Bonneville Salt Flats near Wendover, Utah, that is marked out for motor sports. It is particularly noted as the venue for numerous land speed records.

The salt flats were first used for motor sports in 1912, but didn't become truly popular until the 1930s when Ab Jenkins and Sir Malcolm Campbell competed to set land speed records.

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FIXED POSITIONING OF GRAPHICS

- Two major types of spatial organization
  - 2D or 2.5D:
    - Objects are positioned with 2 floating-point coordinates (+ possibly a integer layer information)
    - HTML+CSS, Flash, SVG
  - 3D:
    - Objects are positioned with 3 floating-point coordinates
    - CSS, WebGL
- Each type of spatial organization defines
  - The local coordinate systems for each type of object
    - Where the (0,0,0)-point is
    - Used for positioning, rotation, scaling ...
  - The nesting of local coordinate systems
    - Transformation from one to another
    - E.g. CSS Box Model, SVG Transformations

EXAMPLE OF LOCAL COORDINATE SYSTEMS

SVG COORDINATE SYSTEMS

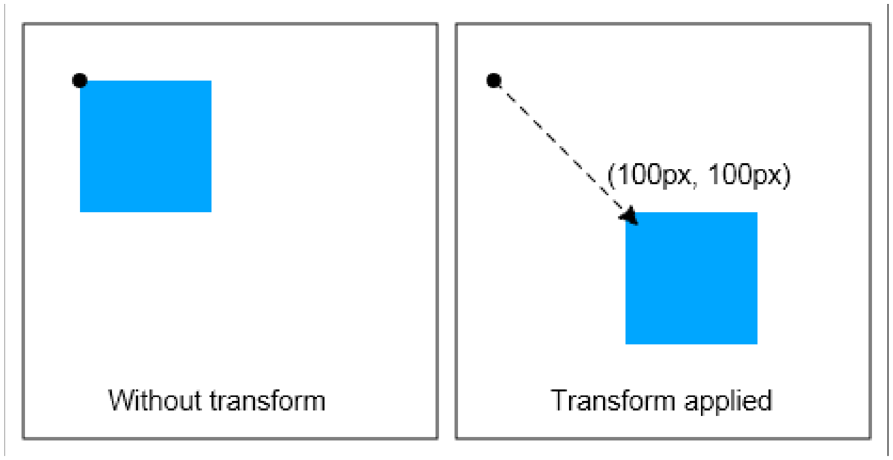
- Global Coordinate System
  - Origin: default top-left of the viewbox
  - X-axis right-wards, Y-axis downward
- Local Coordinate Systems
  - Origin: typically top-left or center of the shape
- Intermediate Coordinate Systems
  - <g> elements
- Units
  - No precision limit
  - Many possible units from CSS: cm, px, em, ...
  - User unit
    - Relation to device pixels

SVG & CSS TRANSFORMATIONS

- Initially defined in SVG 1.1
  - Now moved as a separate module, jointly developed with CSS
    - http://www.w3.org/TR/css3-transforms/
    - Also applicable to HTML elements
- Basic 2D Concepts
  - Representation of an affine transformation of 2D coordinates using a 3x3 matrix
  - Matrix is specified using the `transform` attribute:
    - Some shortcut for scale, rotate, translate, skewX, skewY
    - Possibility to use a different origin for transformation using `transform-origin`
  - Matrices can be specified at different level in the graphics tree (equivalent to matrix multiplication)
- CSS Transformations (2D/3D)
  - Apply transformation matrix to an element
    - Same principle as SVG transforms
  - Selected using CSS Selectors
  - Declare using CSS syntax

SVG & CSS TRANSFORMATION EXAMPLE

```
<svg xmlns="http://www.w3.org/2000/svg">
  <style>
    .container { transform: translate(100px, 100px); }
  </style>
  <g class="container">
    <rect width="100" height="100" fill="blue" />
  </g>
</svg>
```



EXAMPLE OF TRANSFORMATIONS OF LCS

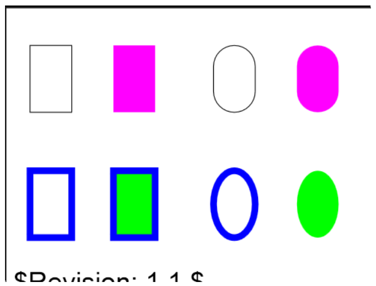
- Matrix Transformations
  - Translation
  - Rotation (with different origin)
  - Scale (with different origin)
  - Skew

CSS 3D TRANSFORMS

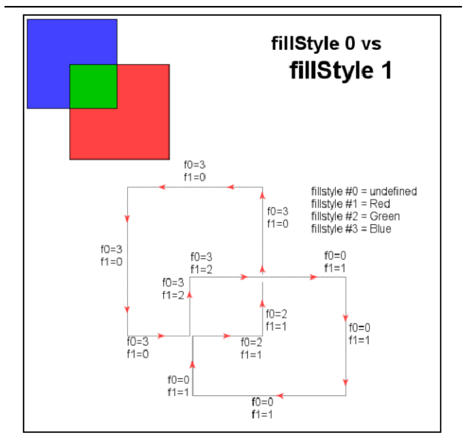
- Not a real 3D coordinate system
  - Used for 3D effects (cover flow, ...)
- Using the `perspective` and `perspective-origin` attribute

TYPES OF VECTOR GRAPHICS PRIMITIVES

- Contour-based representation
  - A shape is defined by a contour
    - Can be filled with only one "paint"
    - Can be stroked with only one "paint"



- Other representations
  - Planar-maps (Flash SWF format)
    - A shape is defined as a list of curves with 3 "paints"
      - on the right, on the left, on the curve

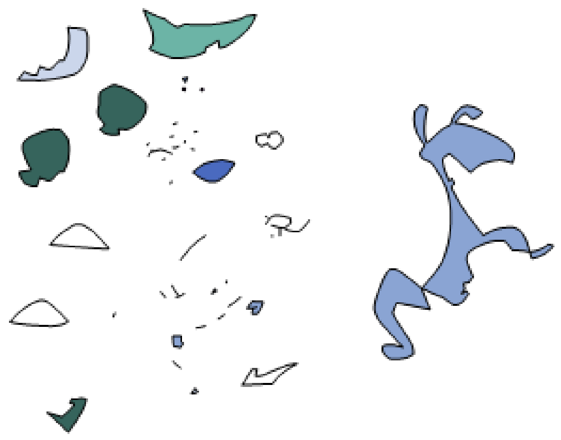


  - Advanced gradients (meshes, diffusion curves)

CONTOUR-BASED REPRESENTATION

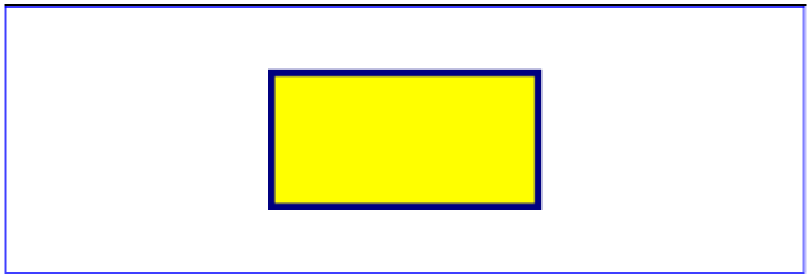
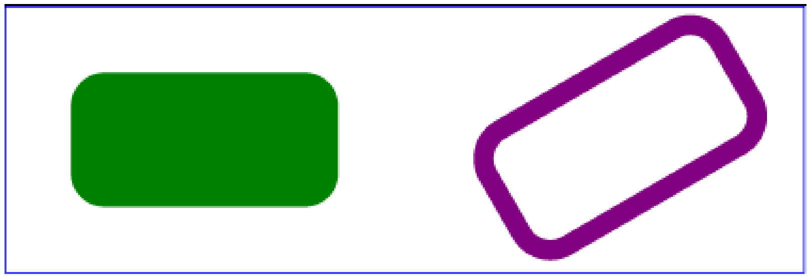
TRANSFORMATIONS AND GROUPING

Need to position each shape individually

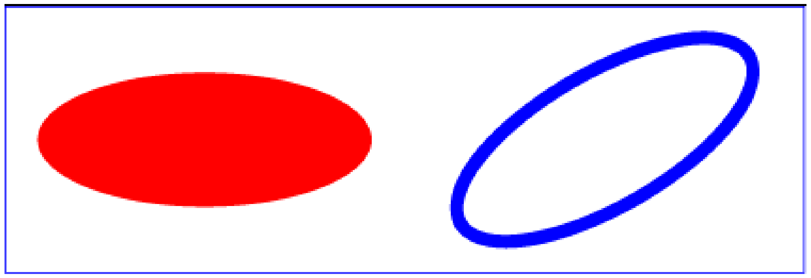
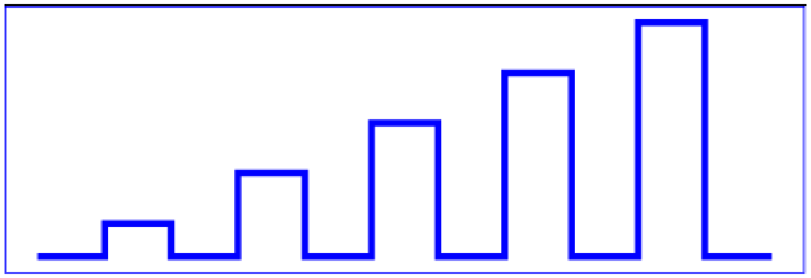


BASIC SHAPES

- Graphical Primitives
  - `<rect>`
    - Anchored on its top left corner (x, y)
    - Possible rounded corners (rx, ry)

  - `<circle>`
  - `<ellipse>`

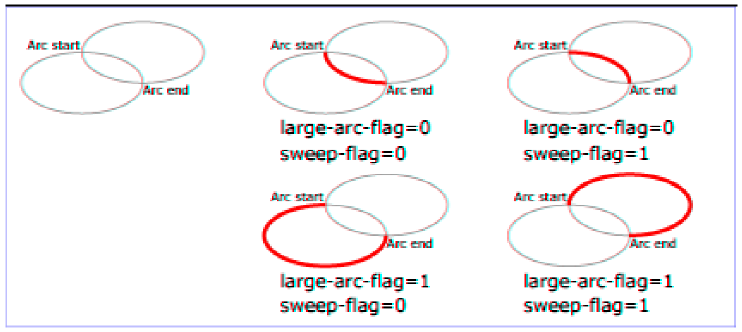
    - Anchored on its center
  - Point/Coordinate-based primitives
    - `<line>`, `<polygon>`, `<polyline>`
    - `<path>` : complex curves

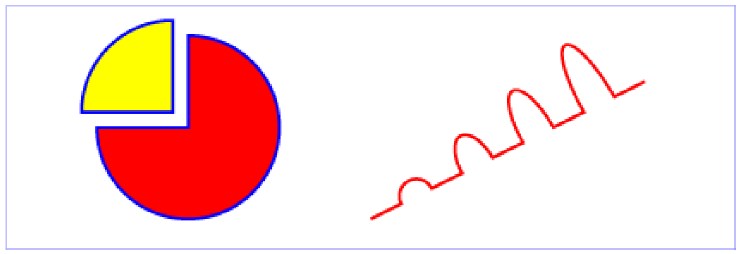
SVG CURVES

- Line segments
- Bézier Curves
  - Cubic (C)
  - Cubic Symetrical (S)
  - Quadratic (Q)
  - Quadratic Symetrical (T)
- Catmull-Rom Curves (SVG 2.0)
  - Dotty.svg
- ...

SVG ARCS

- Start-point, end-point + arc parameter
- To be extended in SVG 2.0
  - Harmonization with HTML <canvas>





SVG PATH

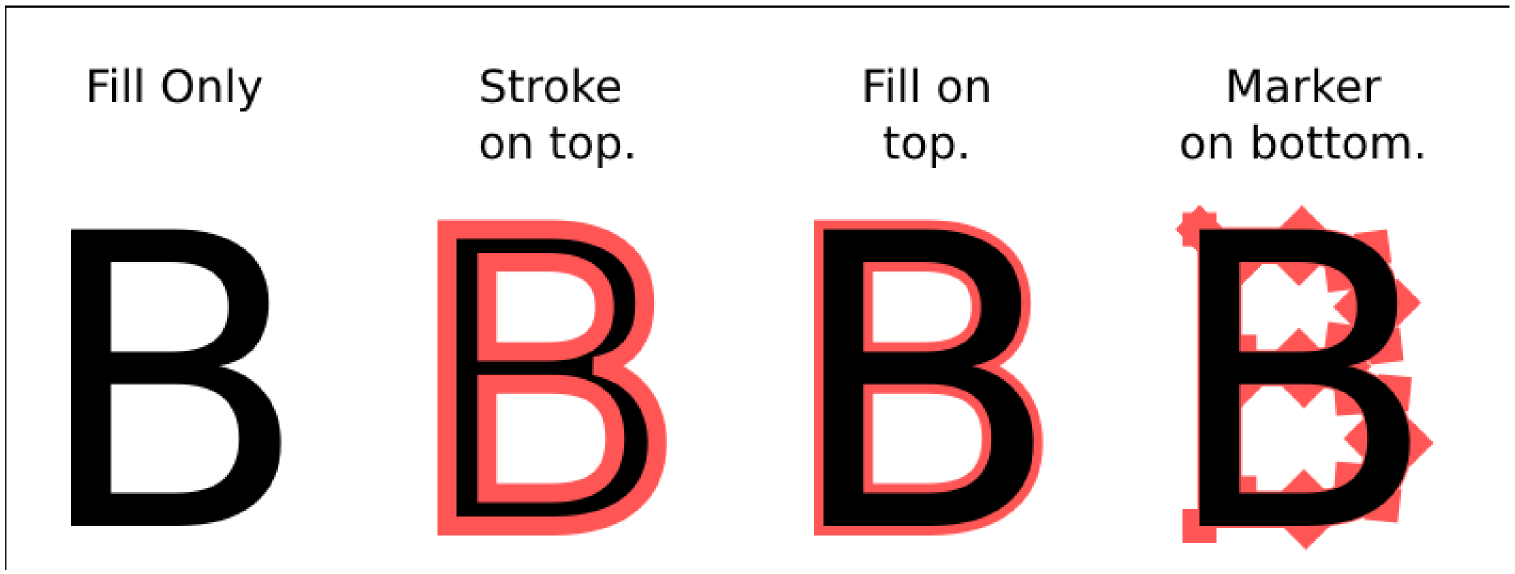
- Element used to describe complex graphics
  - `<path>`
  - Drawing commands are described using the `d` attribute
    - List of 2D points separated by drawing commands
    - Use of relative or absolute user units

TEXT IN SVG

- SVG uses specific elements for text
  - Different from HTML
    - No flowing text
    - No paragraph
  - Graphical primitives as others
    - Can be filled, stroked, …
  - With additional CSS text properties
    - `font-size`, …
- SVG Text elements
  - `<text>`
    - Renders characters on a single line
  - `<tspan>`
    - Used to change the style of some characters on a line
  - `<tref>` (deprecated)
    - Reuse existing text content across `<text>` elements
  - `<textPath>`
    - Draws a text along a path (ex: legend on a river)
  - `<textArea>` (deprecated)
    - Paragraph

SVG RENDERING MODEL

- Individual graphical element rendering
  - Drawing operations in order
    - Fill then stroke (or stroke then fill)
    - Then markers
    - Then filters
    - Then clip
    - Then mask
- Then group rendering



FILLING PROPERTIES

- `fill`
  - A uniform/solid color
    - sRGB color space or ICC color profile
      - Extensions in SVG 2 Color Module
    - Syntax:

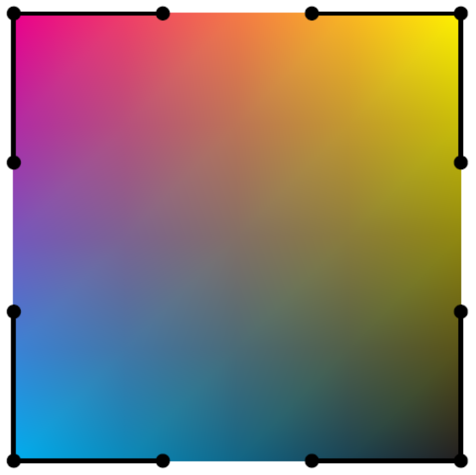
```
rgb(int[0-255], int[0-255], int[0-255]);
rgb([0-100]%, [0-100]%, [0-100]%);
black, white …
```

  - A linear or radial gradient
    - Also used in CSS
    - Extensions to Gradient Meshes in SVG 2
  - A pattern
    - Extensions to hatches in SVG 2
- `fill-opacity`
  - Transparency used for alpha-blending
- `fill-rule`
  - When a graphical primitive self-intersects

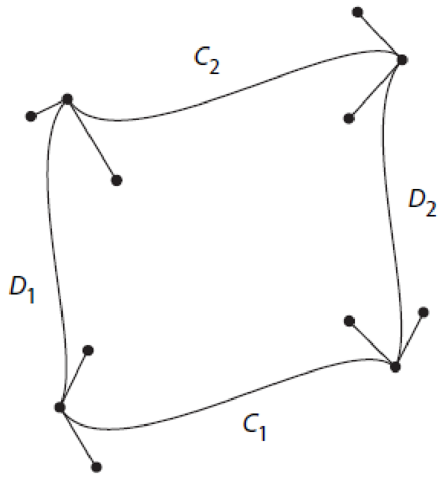
GRADIENTS AND ADVANCED GRADIENTS

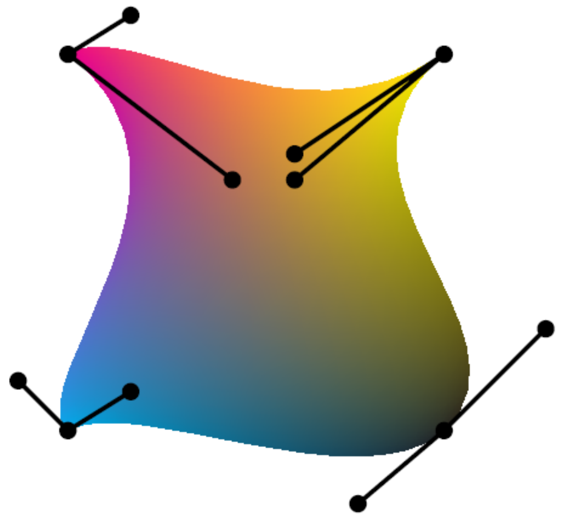
- Advanced Gradients (SVG 2.0) Goals
  - Represent photo-realistic images, artistic effects, pseudo-3D
  - In a compact, resolution-independent and efficient rendering way
  - Easy to edit, control, animate, compatible with the Web (JavaScript, XML, …)
- Gradient Meshes
  - Supported in SVG 2.0 in the form of “Coons Patch”
- Diffusion Curves
  - Still under development

COONS PATCH



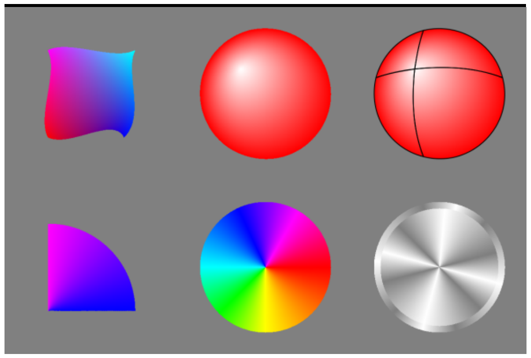
Unit square



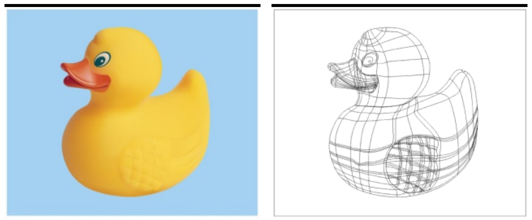


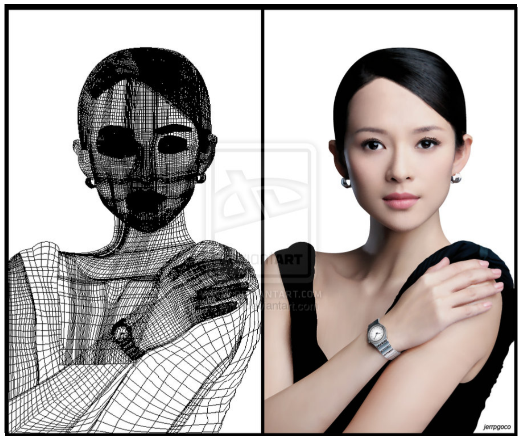
GRADIENT MESHES

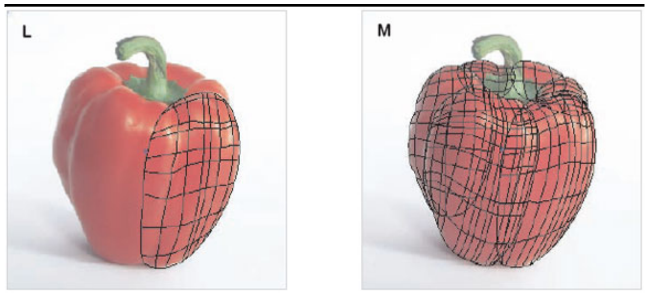
- Conical, spherical gradients



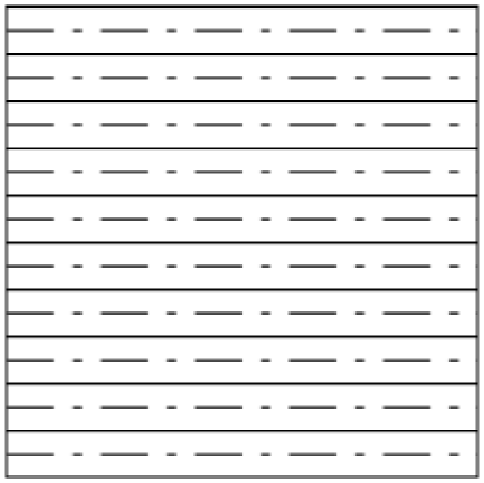
- Pseudo-3D

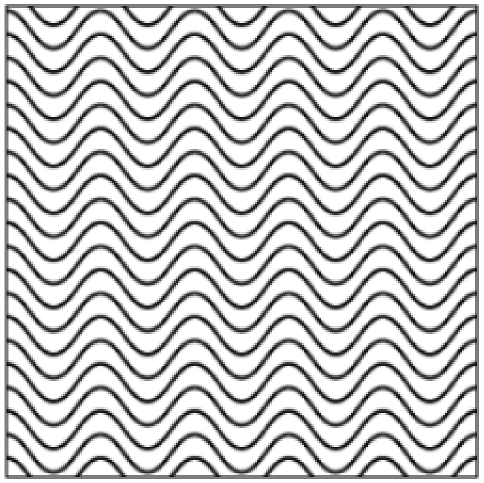






HATCHES

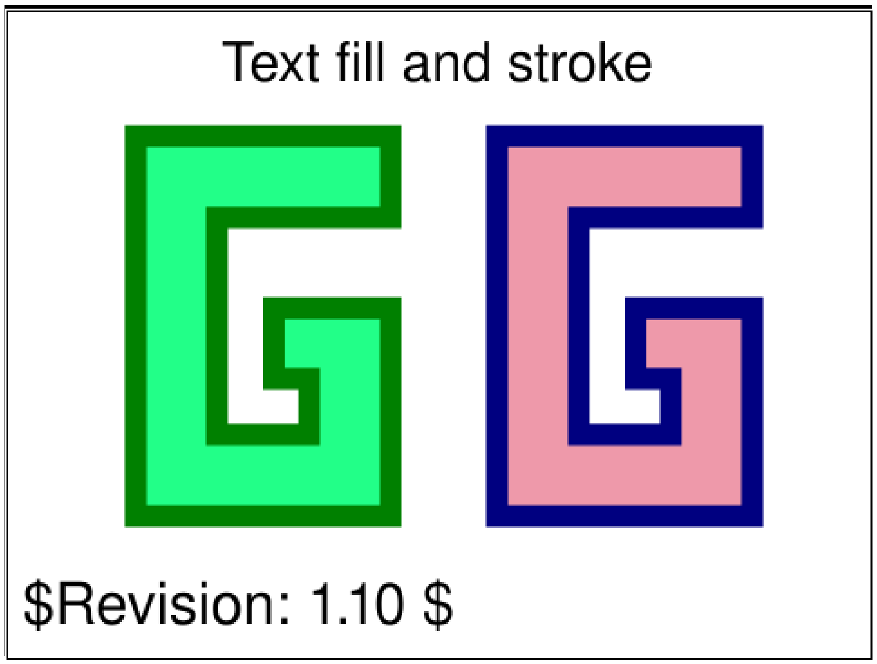


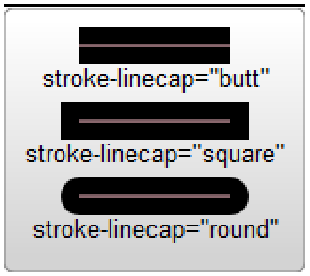


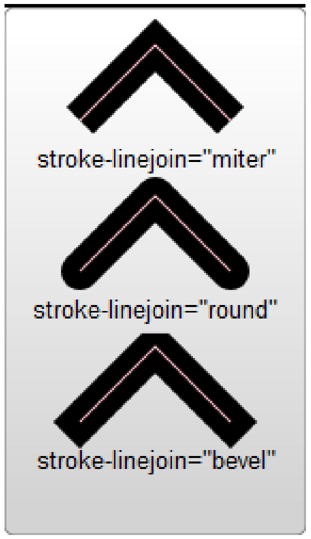
SCREENING

STROKING PROPERTIES

- `stroke`
  - Same syntax/values as `fill` including gradients, pattern, …
- `stroke-opacity`
  - Same as fill-opacity but only on the stroke
    - Can be combined
- `stroke-width`
  - Centered around the mathematical/geometrical outline
  - New attribute in SVG 2.0 to control the position of the stroke
- `stroke-dasharray`
- `stroke-dashoffset`
- `stroke-linejoin`
- `stroke-linecap`





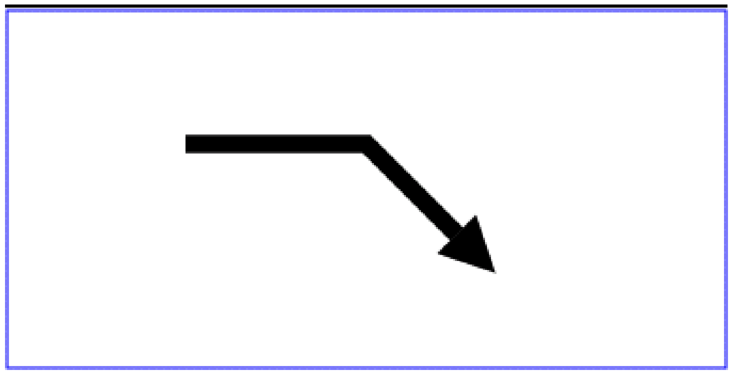


ADVANCED STROKING

- Power Strokes in Inkscape
    - Variable stroke width
    - calligraphy

SVG MARKERS

- Draws a symbol at some specific locations of a given graphical primitive
  - Initially for point-based graphical primitives (`path`, `line`, `polygon` …)
    - Extended to all primitives (`rect`, `circle`, …) in SVG 2.0
  - Initially at specific positions: start, end, middle
    - To be extended to any position (%)



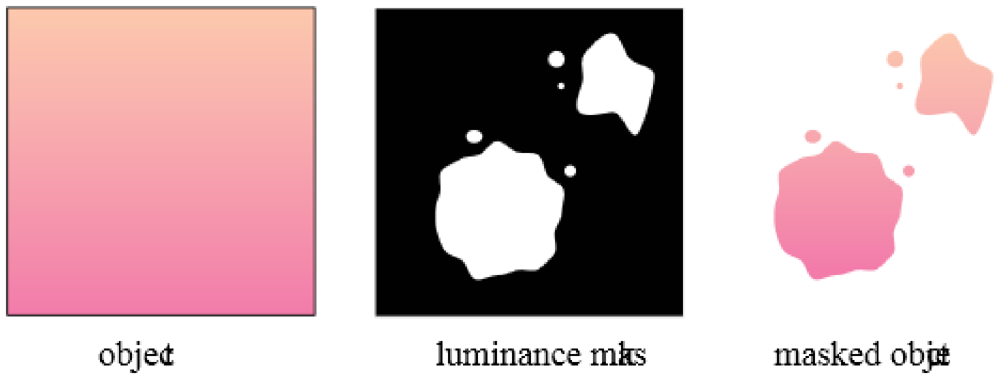
GRAPHICAL EFFECTS ON THE WEB

- Clipping
- Masking
- Filters
- Shaders

SVG & CSS CLIPPING AND MASKING

- Initially defined in SVG 1.1
  - Now moved as a separate module, jointly developed with CSS
    - http://dvcs.w3.org/hg/FXTF/raw-file/tip/masking/index.html
    - Also applicable to HTML elements
- Goals
  - Clipping: cut parts of graphics or images out
  - Masking: progressively show parts of graphics or images
- `clip-path`
- `clip-rule`
- `mask`
- `opacity`

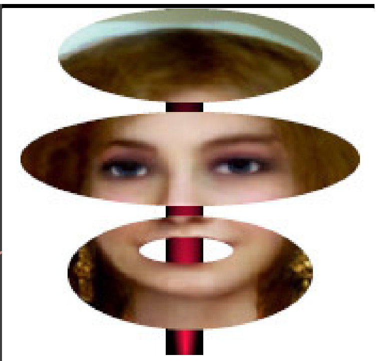
CLIPPING AND MASKING EXAMPLES



CLIPPING AND MASKING EXAMPLES (2)

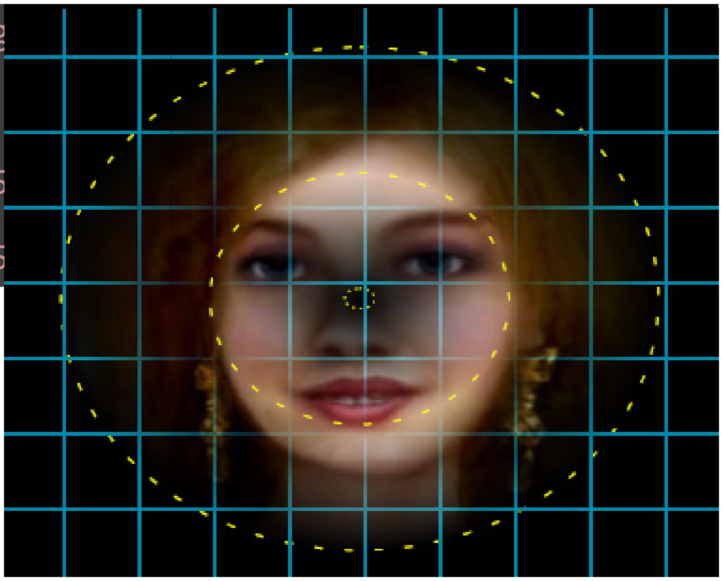
- `<clipPath>` containing three graphic elements and applied to an `<image>` (on top of a rectangle)

```
<radialGradient id="gradient1" >
  <stop offset="0.0" stop-color="black"/>
  <stop offset="0.5" stop-color="white"/>
  <stop offset="1" stop-color="black"/>
</radialGradient>
<mask id="Ma">
  <ellipse cx="50%" cy="39%" rx="20%" ry="25%" fill="ur
</mask>
<image xlink:href='p0.jpg' y="10%" x="26%" width="50%"
```



- Application of a radial gradient `<mask>` to an `<image>`

```
<rect x="322" y="0" height="200" width="20" fill="url(#g
<clipPath id="CP">
 <ellipse cx="335" cy="25" rx="70" ry="25"/>
 <ellipse cx="335" cy="80" rx="90" ry="25"/>
 <path d="M 270 140 A 65 30 0 1 1 270 141 M 308 128 A 25
</clipPath>
<image xlink:href='thesoul2.jpg' y="0" x="200" width="35
```



SVG & CSS FILTERS

- Initially defined in SVG 1.1
  - Now moved as a separate module, jointly developed with CSS
    - https://dvcs.w3.org/hg/FXTF/raw-file/tip/filters/index.html
    - Applicable to HTML elements

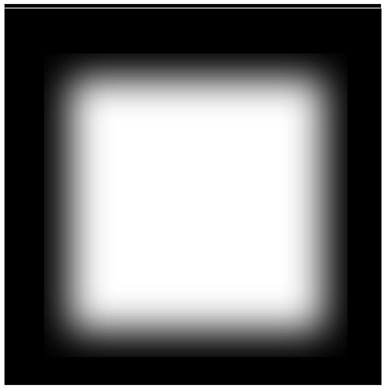
- Goal
  - Advanced manipulations of graphics at the pixel level after/during rasterizing (Photoshop-like effects)
  - Ex: Blur, Color manipulations, image manipulations …

- Elements
  - `<filter>` containing a sequence of filter primitives:
    - `feBlend, feFlood, feColorMatrix, feComponentTransfer, feComposite, feConvolveMatrix, feCustom, feDiffuseLighting, feDisplacementMap, feDropShadow, feGaussianBlur, feImage, feMerge, feMorphology, feOffset, feSpecularLighting, feTile, feTurbulence, feUnsharpMask`

- Attributes
  - `enable-background, filter, flood-color, flood-opacity, lighting-color`

FILTER EXAMPLE (1)

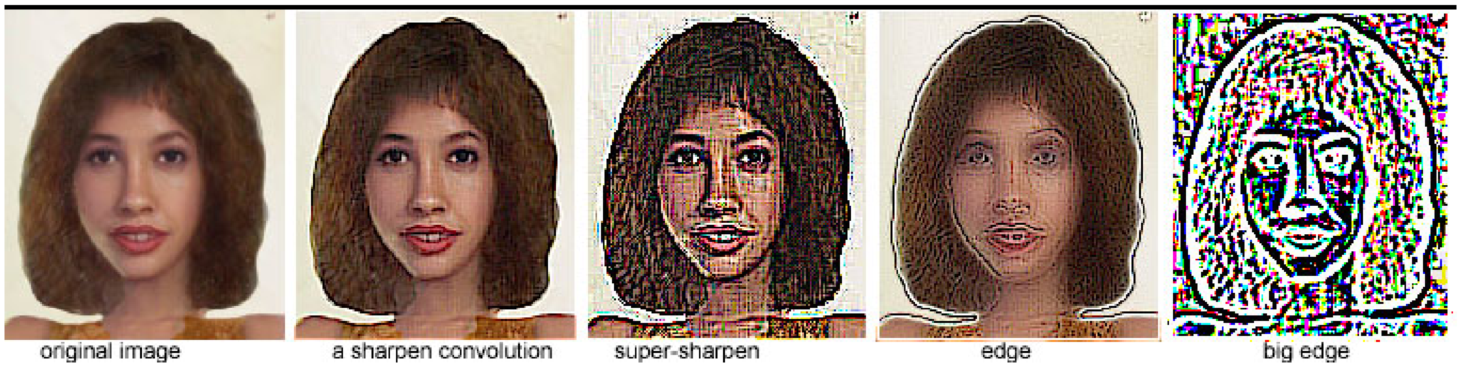
```
<filter id="A">
 <feGaussianBlurstdDeviation="10"/>
</filter>
<rect x="42%" y="10%"
     width="16%" height="25%"
     fill="white"
     filter="url(#A)" />
```



FILTER EXAMPLES

```
<filter id="edge">
        <feConvolveMatrixorder="3"
        kernelMatrix="-1 -1 -1 -1 7 -1 -1 -1 -1 " />
</filter>
<image x="465" xlink:href="p17.jpg" width="150" height="175" filter="url(#edge)" />
```

Demo: http://codepen.io/johanberonius/details/chiseled/

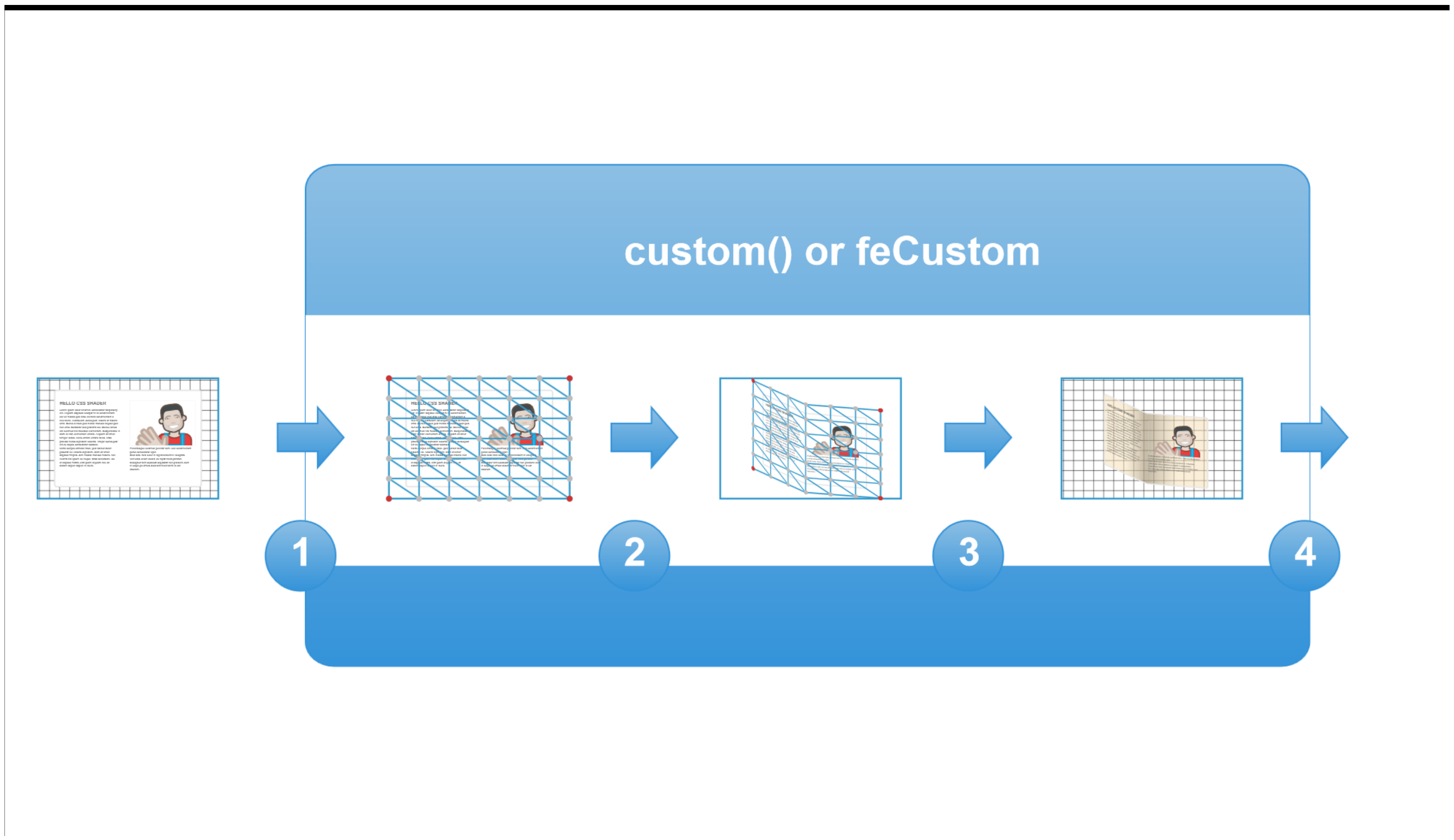


SVG & CSS SHADERS

- Extensions of Filters with a Custom Filter: feCustom
  - Transformation of input (graphics, text, images, videos) data into a texture
  - Creation of a grid on the texture
- Vertex Shaders
  - Deformation of the grid according to a « program »
- Pixel Shaders
  - Manipulation of the pixels in the texture according to a « program »
- Program written in specific shader programming language (C-like)
  - GLSL

SVG/CSS SHADERS ILLUSTRATION

- http://www.adobe.com/devnet/html5/articles/css-shaders.html



RENDERING OF GROUPS

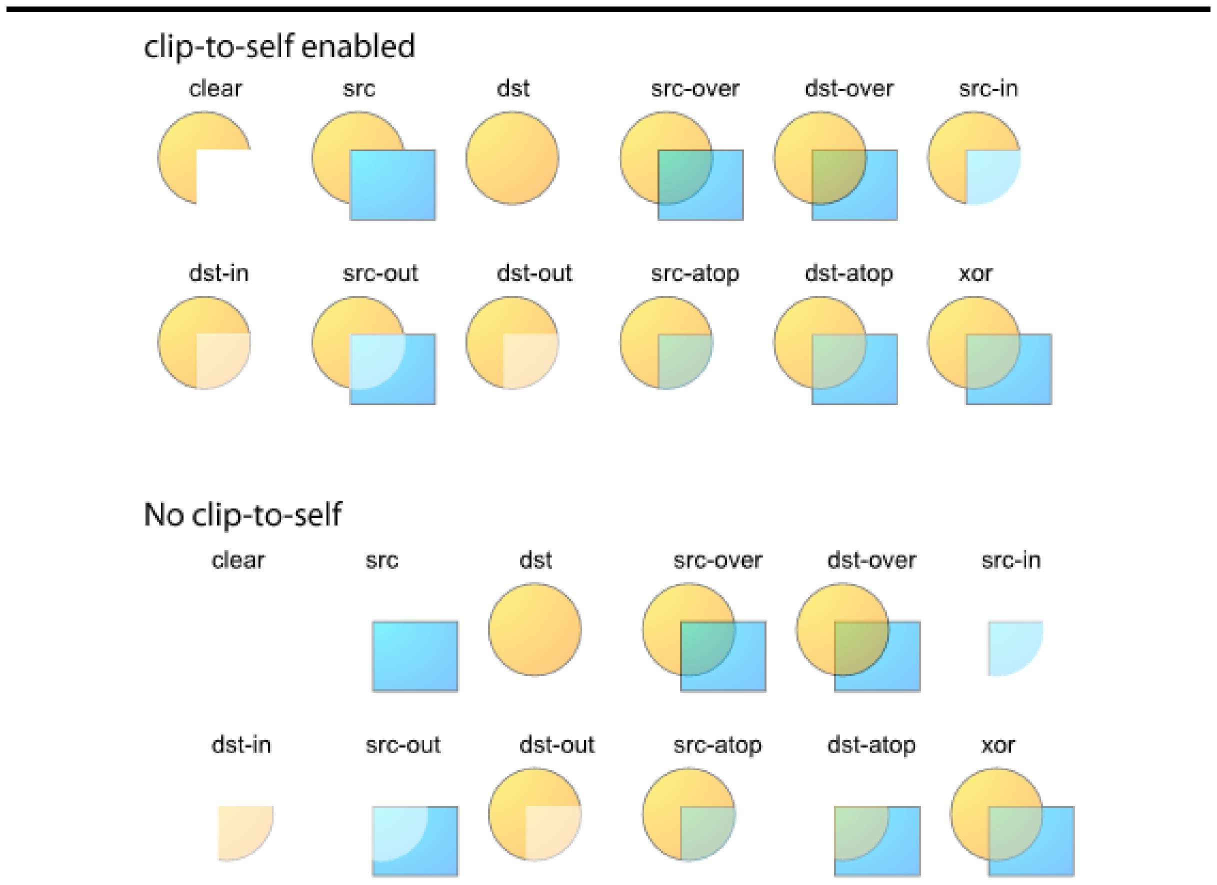
- Painter’s algorithm
  - Elements are drawn in document order using simple alpha-blending
    - Possibility to change the element order using z-index (CSS, SVG)
  - Extended with
    - SVG Vector Effects
    - CSS/SVG Compositing and Blending

SVG & CSS COMPOSITING AND BLENDING

- Initially envisaged only for SVG 2.0
  - Now jointly developed with CSS
    - https://dvcs.w3.org/hg/FXTF/rawfile/tip/compositing/index.html
    - Also applicable to HTML elements
- Goal
  - Enhance the way objects are grouped, drawn on top of each other
    - Similar to Illustrator or PDF capabilities (blending modes, knockout, isolation)
- Attributes
  - `mix-composite, mix-blending, isolation, knock-out`

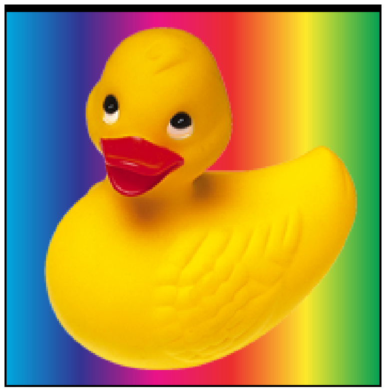
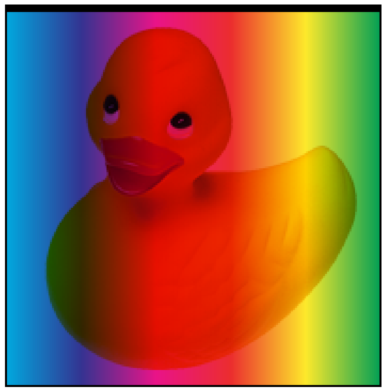
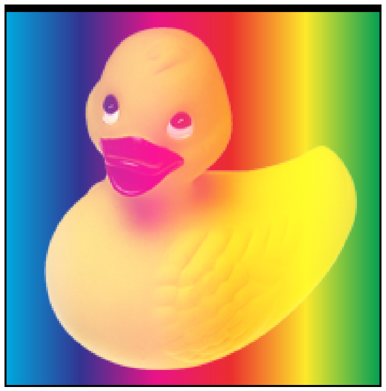
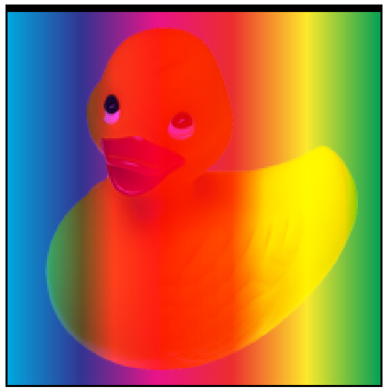
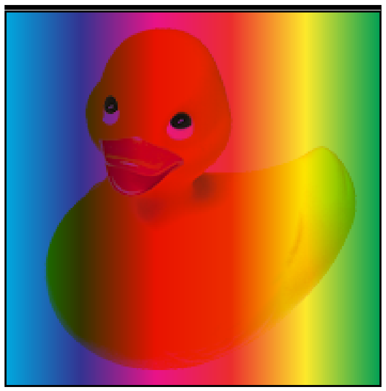
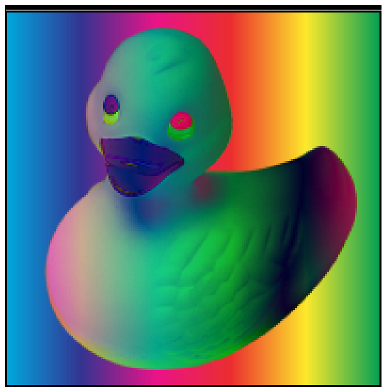
COMPOSITING

- Porter-Duff Operators



BLENDING

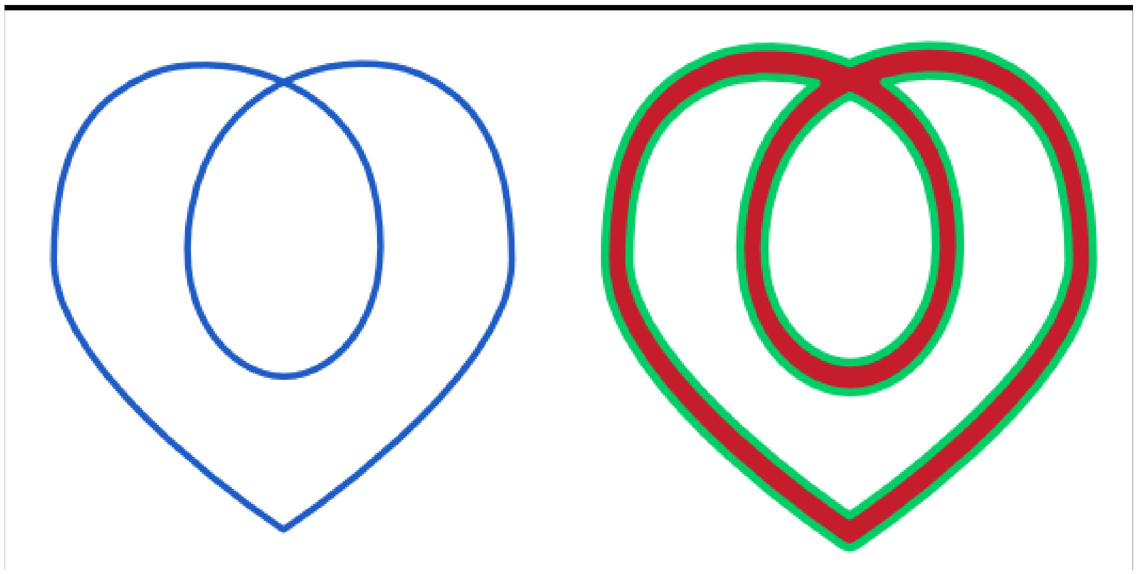
- Blending modes (PDF, Illustrator)
  - normal, multiply, screen, overlay, darken, difference

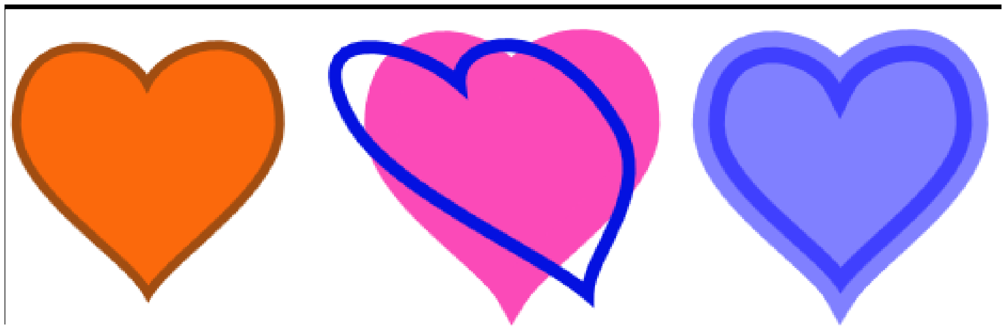







- No isolation vs. isolation

VECTOR EFFECTS

- Under consideration for SVG 2.0
  - Geometric operations on vector objects: union, exclusion, intersection …
  - http://www.w3.org/TR/2004/WD-SVG12-20041027/vectoreffects.html
  - http://dev.w3.org/SVG/modules/vectoreffects/master/SVGVectorEffectsPrimer.html





VECTOR GRAPHICS & JAVASCRIPT

- Canvas

```
functiondrawPicture(){
 var canvas= document.getElementById('example');
 var context=canvas.getContext('2d');
 context.fillStyle="rgb(0,255,0)";
 context.fillRect (25, 25, 100, 100);
 context.fillStyle="rgba(255,0,0, 0.6)";
 context.beginPath();
 context.arc(125,100,50,0,Math.PI*2,true);
 context.fill();
 context.fillStyle="rgba(0,0,255,0.6)";
 context.beginPath();
 context.moveTo(125,100);
 context.lineTo(175,50);
 context.lineTo(225,150);
 context.fill();
}
```

- Canvas vs. SVG, Canvas + SVG
  - Rendering performances
  - Rendering quality: Anti-aliasing

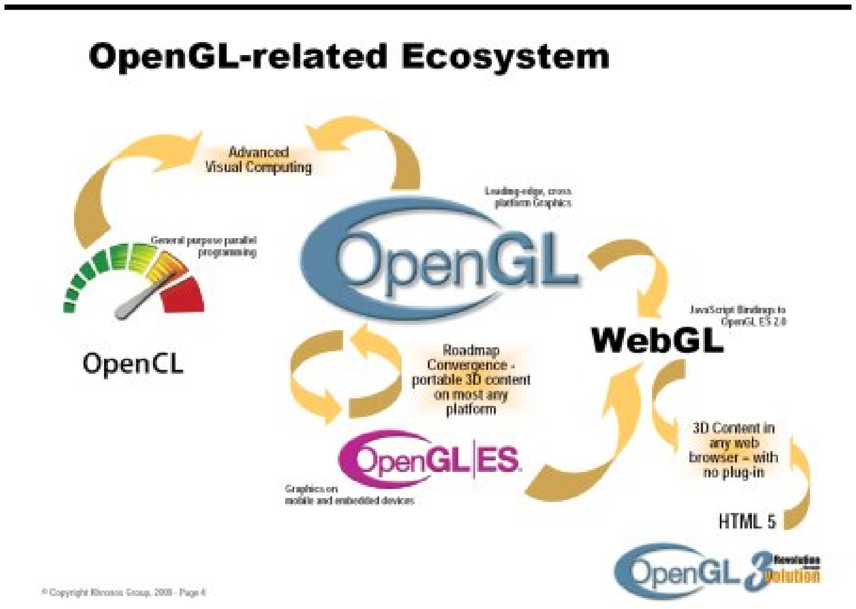
JAVASCRIPT FRAMEWORKS

- SVG-based framework
  - D3.js
  - Raphael.js
  - Processing.js
  - SVGWeb
  - Snap SVG
- Canvas-based Frameworks
  - Canvg
  - Fabric.js

GRAPHICS & GPU

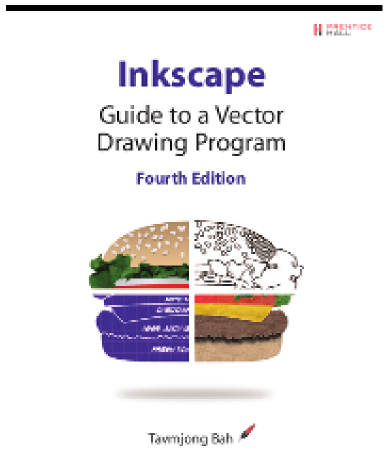
- WebGL

- Nvidia Path Rendering extensions


OpenGL-related Ecosystem
Advanced Visual Computing
General purpose parallel programming
OpenCL
Leading-edge, cross platform Graphics
OpenGL
JavaScript Bindings to OpenGL ES 2.0
WebGL
Roadmap Convergence - portable 3D content on most any platform
OpenGL ES
Graphics on mobile and embedded devices
3D Content in any web browser - with no plug-in
HTML 5
OpenGL 3 Revolution through Evolution
© Copyright Khronos Group, 2009 - Page 4

LINKS

- http://tavmjong.free.fr/INKSCAPE/MANUAL/html/
- https://developer.mozilla.org/en-US/docs/SVG
- http://carto.net/
- OpenStreetMaphttp://openstreetmap.fr/
- OpenClipArthttp://openclipart.org/
- http://svgopen.org
- http://pilatinfo.org/index.html
- http://www.w3.org/Graphics/SVG/IG/resources/svgprimer.html
- http://srufaculty.sru.edu/david.dailey/svg/
- https://hacks.mozilla.org/category/svg/
- http://www.svgbasics.com
- http://www.siteduzero.com/tutoriel-3-14858-le-svg.html


Inkscape
Guide to a Vector Drawing Program
Fourth Edition
Tavmjong Bah

ADOBE FLASH

ADOBE FLASH

- Initially proprietary technology
  - Developed by Macromedia (v1: 1996 / v10: 2008)
- Typical use cases
  - games, advertisements, cartoon animations, user interfaces
- Now partly open
  - SDK for producing files / reading files
  - Contribution of the scripting engine to OSS
  - Open Screen Project
- Major (?) technology on the Web for multimedia interactive application
  - Lack of support on iOS

THE FLASH ECOSYSTEM

- Several types of files
  - FLA: used by the authoring tool (not public)
  - SWF: published and read by the player (public)
  - FLV / F4V: container used to store audio/video data (public)

- Several Tools
  - Flash Authoring Tool
  - Flash Player
  - Flash Media Server
  - Mobile version: FlashLite (discontinued)
  - Adobe Integrated Runtime (AIR)
    - Cross-platform runtime for offline applications based on Flash (Java equivalent)
  - Flash Builder
  - Flex
    - Framework for dynamic generation of applications
  - ...

PRINCIPLES OF THE SWF FORMAT

- Delivery format
  - Efficient compression (binary format not XML)
  - Designed for streaming
- Efficient display
  - Focus on anti-aliasing, text, smooth animations
- Initially without scripting
  - Now uses ActionScript 3.0
    - =ECMAScript with specific APIs
    - Plugin-approach for playback

SWF FILE STRUCTURE

- A SWF file is
  - A header
  - A sequence of « tags »
- Flash tags
  - A tag is a header, a length and a payload
  - Definition Tags
    - Adding shapes, sounds, text, images, buttons … as « characters » to a dictionary
  - Control Tags
    - For positioning the « characters » in the « display list »
    - For triggering the display: “show frame”

FUTURE OF FLASH

- Being replaced (?) by HTML technologies
  - Converters from Flash to HTML5 (Google, Mozilla)
- Adobe's next tools: Edge Tools
  - HTML 5, CSS 3, SVG, WOFF...

An
Edge Animate
Rf
Edge Reflow
Co
Edge Code
In
Edge Inspect
Wf
Edge Web Fonts
Typekit
Bd
PhoneGap Build

MICROSOFT SILVERLIGHT

MICROSOFT SILVERLIGHT

- Multimedia Interactive Application Ecosystem
  - Plug-in for browsers (Windows, Mac)
  - Development Environment based on Microsoft .NET
  - Approach similar to Adobe Flash
- Releases
  - V1: 2007
  - V5: 2012
- Main use cases today
  - Microsoft specific tools
    - Outlook
    - Streaming

SILVERLIGHT APPLICATIONS

- Mixed declarative/imperative paradigm
  - Use XAML (Extensible Application Markup Language)
    - XML language for describing applications user interfaces
    - Very very similar to SVG
    - Can be created with the .NET Framework
  - Binding with Microsoft Windows Presentation Foundation
- Future of Silverlight
  - Will be replaced by HTML5 on Desktop ?
  - Used as a core technology on Windows Phone 8 ?