

Non-Photorealistic Rendering (NPR)

Fishing, PDI, Siggraph 1999

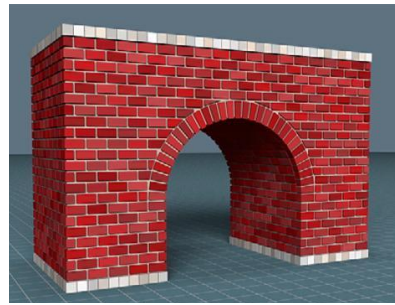
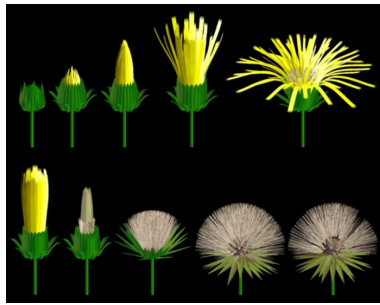
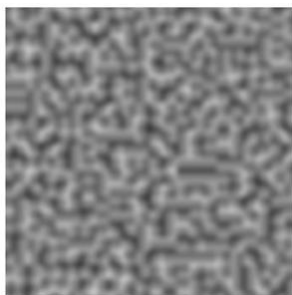
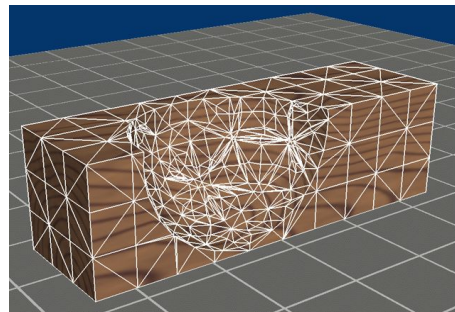
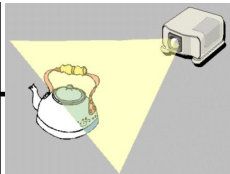
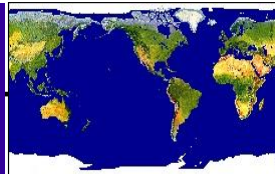


Brush, Lei Chen, Siggraph 2006



Last Time?

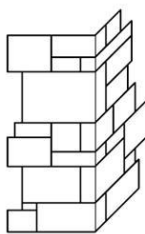
- Texture Mapping
- Solid Texture
- Procedural Textures
 - Perlin Noise
- Procedural Modeling
 - L-Systems



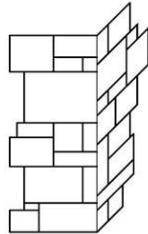
Today: Non Photorealistic Rendering

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- Papers for Next Time

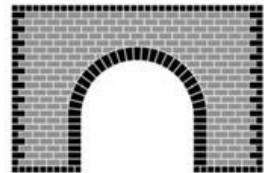
Cellular Texturing for Architecture



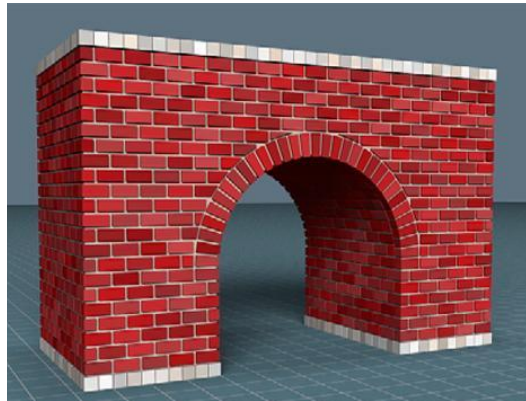
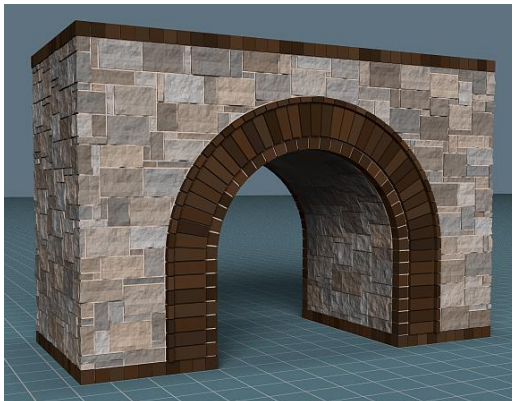
Correct



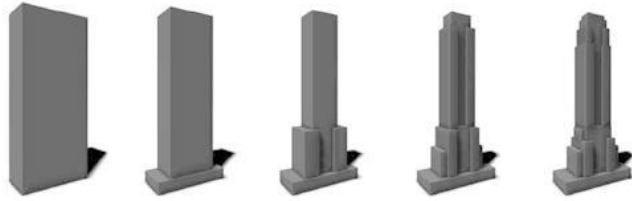
Incorrect



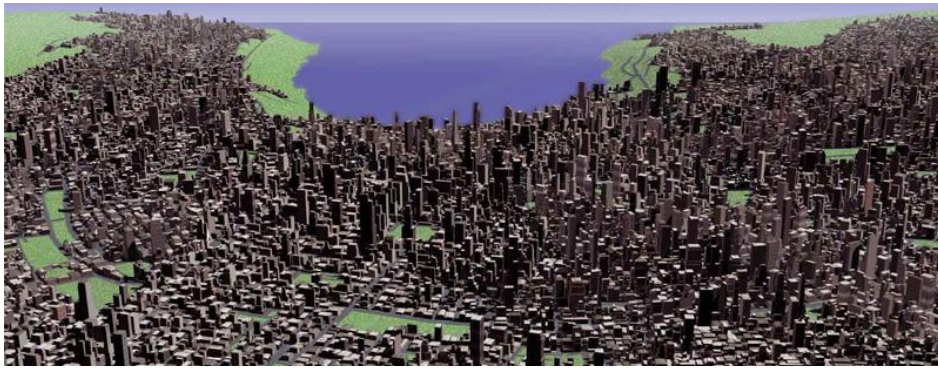
“Feature-Based Cellular Texturing for Architectural Models”, Legakis, Dorsey, & Gortler, SIGGRAPH 2001



L-Systems for Cities

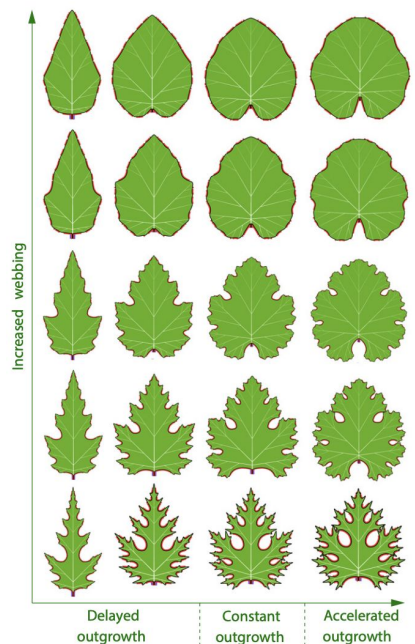
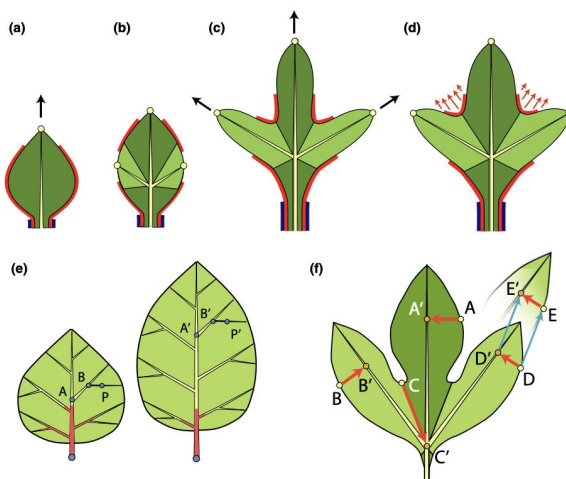


“Procedural Modeling of Cities”,
Parish & Müller, SIGGRAPH 2001



“A common developmental program can produce diverse leaf shapes”

Runions, Tsiantis and Prusinkiewicz,
New Phytologist 2017



“Modeling Trees with a Space Colonization Algorithm”,
Runions, Lane, and Prusinkiewicz, Eurographics
Workshop on Natural Phenomena (2007)



Figure 10: *A hedge made of shrubs competing for space.*

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Frank Lloyd Wright's *Fallingwater*



Frank Lloyd Wright's *Fallingwater*



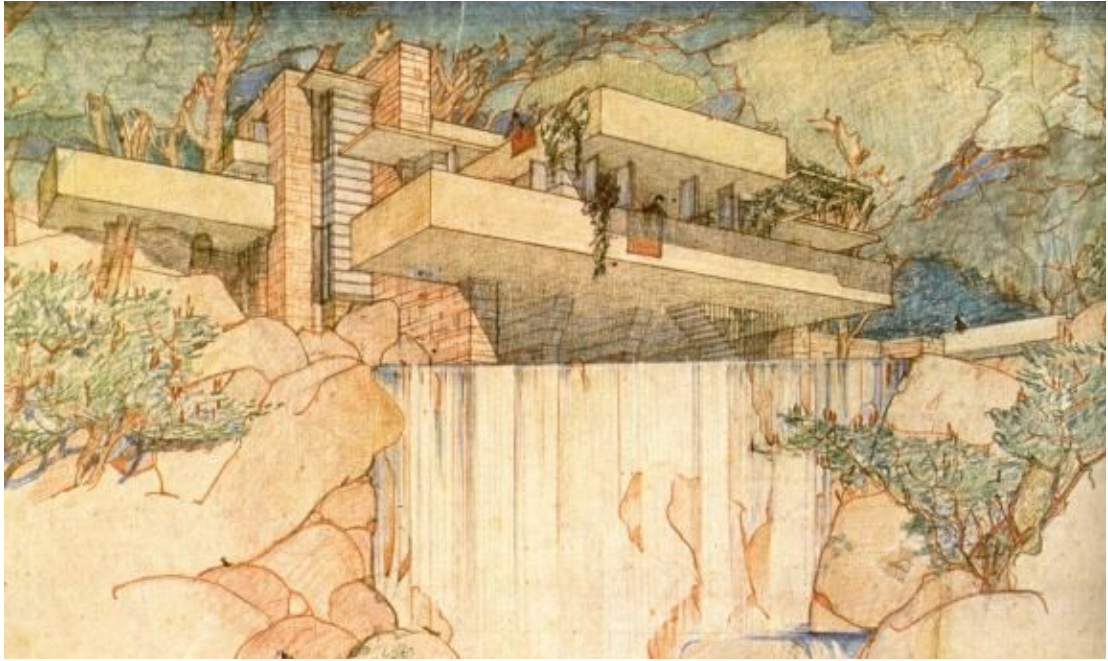
<http://www.thetimesnewroman.com/2011/07/luxe-living-fallingwater.html>

Frank Lloyd Wright's *Fallingwater*

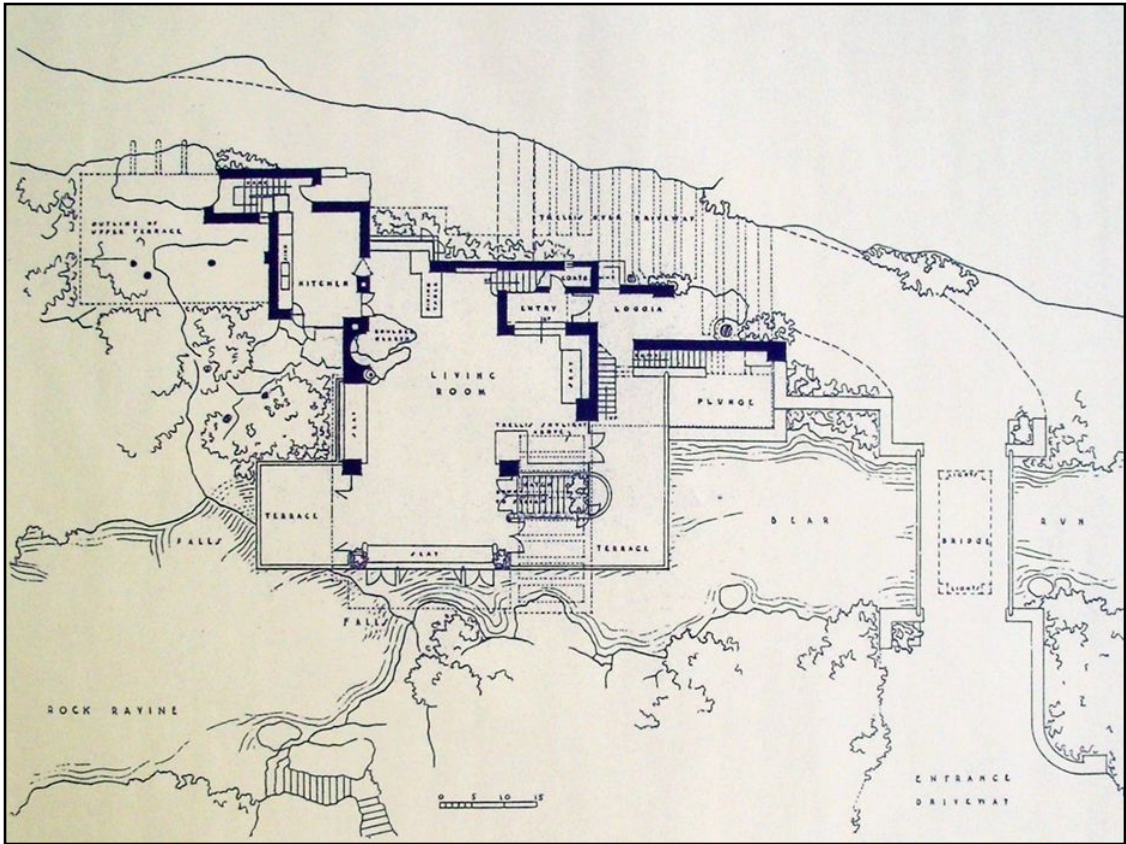


<http://www.thetimesnewroman.com/2011/07/luxe-living-fallingwater.html>

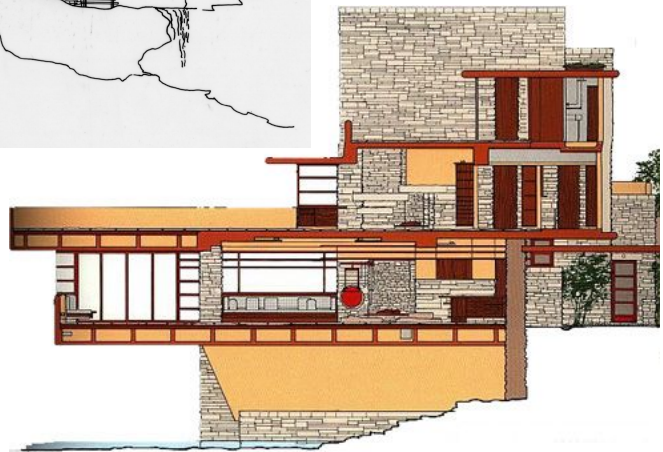
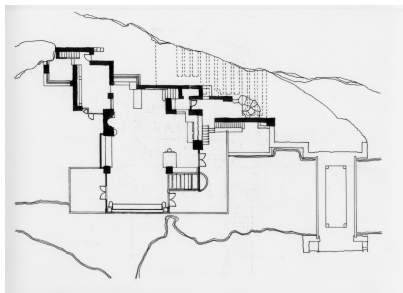
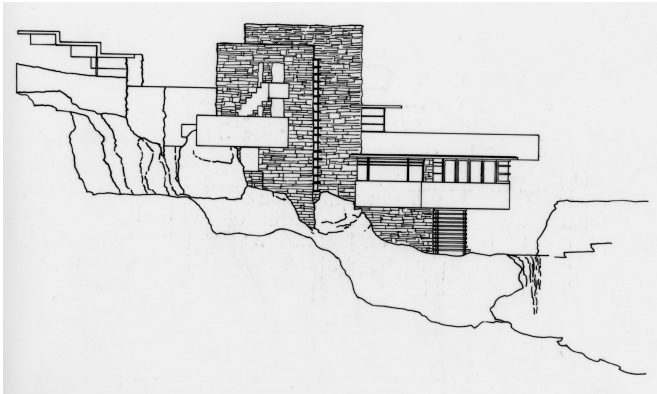
Frank Lloyd Wright's *Fallingwater*



https://si.wsj.net/public/resources/images/OD-AG561_FALLIN_G_20110506021738.jpg



Plan, Section, & Elevation Drawings





Digital Models





http://www.minecraftforum.net/topic/9148-falling-water-by-frank-lloyd-wright/page__st__20



<https://www.youtube.com/watch?v=MbCL4WJmcgg>



<https://3dwarehouse.sketchup.com/model/5b9851979897e7e3a03c22556407e748/Falling-Water>



TURBOSQUID Search Stock 3D Cart My Files Support Login/Join

Falling Water House by MillieModels \$75.00 Add to Cart

Product File Downloads

3ds Max 7 (.max)	119 KB
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Live Chat Now 24/7
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Product License
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3D Model Specifications

Product ID:	266247
Published:	Jun 6, 2005
Geometry:	Polygonal
Polygons:	17,864
Vertices:	9,653
Textures:	Yes
Materials:	Yes
Rigged:	No
Animated:	No
UV Mapped:	Unknown
Unwrapped UVs:	Unknown

Product Rating

Inrated

<http://www.turbosquid.com/3d-models/water-house-3d-x/266247>



<http://lvlworld.com/t.php/Frank+Lloyd+Wright's+-+Falling+Water>

Digital Models

From Half Life 2



Photorealistic Rendering



<https://vimeo.com/802540>



<http://luftwerk.net/projects/fallingwater/>
<https://www.youtube.com/watch?v=6RJbnA7ESKk>



<https://www.6sqft.com/a-kooky-1970s-fallingwater-lookalike-in-greenwich-is-asking-3-5m/>

Miniatures

Wiley White
Architectural Models



<http://www.architectural-models.com/galfallwat.html>

Non-Photorealistic Miniatures



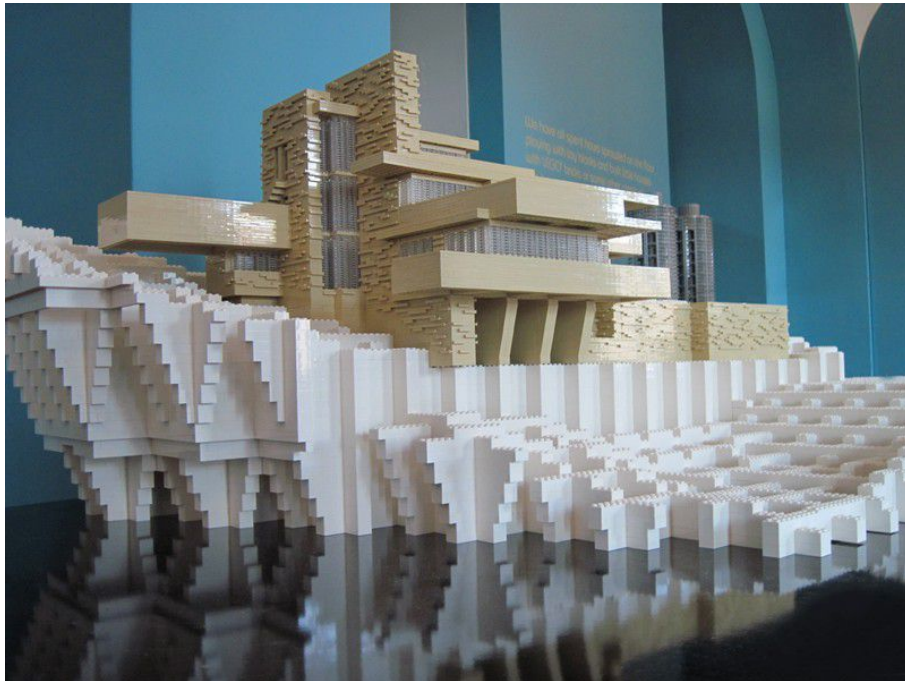
<http://shop.lego.com/ByTheme/Product.aspx?p=21005&cn=52>
<http://www.urbanbydesignonline.com/urbanbydesign/tag/fallingwater>

Non-Photorealistic Miniatures



<http://www.flickr.com/photos/matijagrguric/sets/72157623778661188/>

Non-Photorealistic Miniatures



Adam Reed Tucker <http://www.mocpages.com/moc.php/220533>

Non-Photorealistic Miniatures



<http://gardenmelodies.blogspot.com/2010/11/falling-water-gingerbread-house.html>



http://twls.libsyn.com/index.php?post_id=35584



HGA Architects & Planners - Cantilevers: Inspired by Falling Water
http://www.flickr.com/photos/j_bussmann/4549613488/



<http://www.fallingwater.org/>

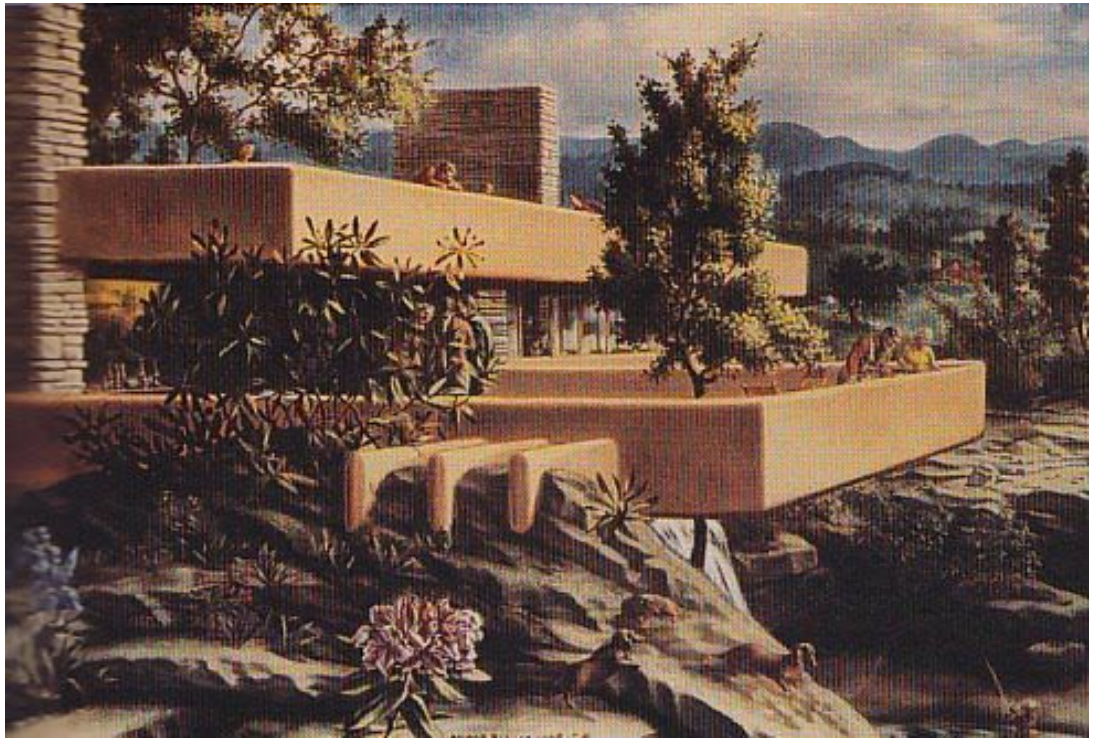
Non-Photorealistic Rendering



<http://www.studio360.org/2009/may/29/fallingwater/>



<http://www.funnyfishdesign.com/casestudies/craft-lights/?ckattempt=1>



“House At Falling Water”, Peter Blume, 1938-1968.
First painting of Fallingwater. Commissioned by the owners.

Painting / Painterly Rendering



<http://fineartamerica.com/featured/falling-water-jamie-frier.html/>

Painting / Painterly Rendering



<http://disney.go.com/create/art/2gs11k6UcUbS000010040000-g-bce863>

Painting / Painterly Rendering



<http://www.ivonneimagines.com/487/falling-water/>



<http://kempersmith.com/fallingwater.html>

Non Photorealistic Rendering



<http://www.historichollywood.biz/drawings-pennsylvania/fallingwater.htm>



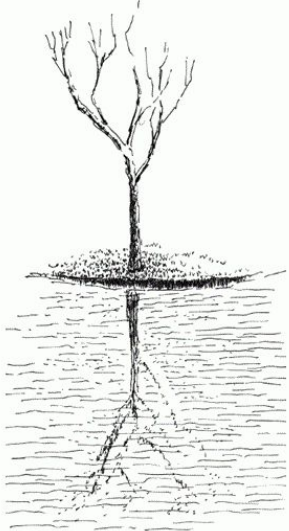
Brian Bent

http://www.dirtgalleryla.com/bb_falling.html



<http://www.anopensketchbook.com/2009/02/monticello-fallingwater.html>

How to Draw Water with Pen and Ink

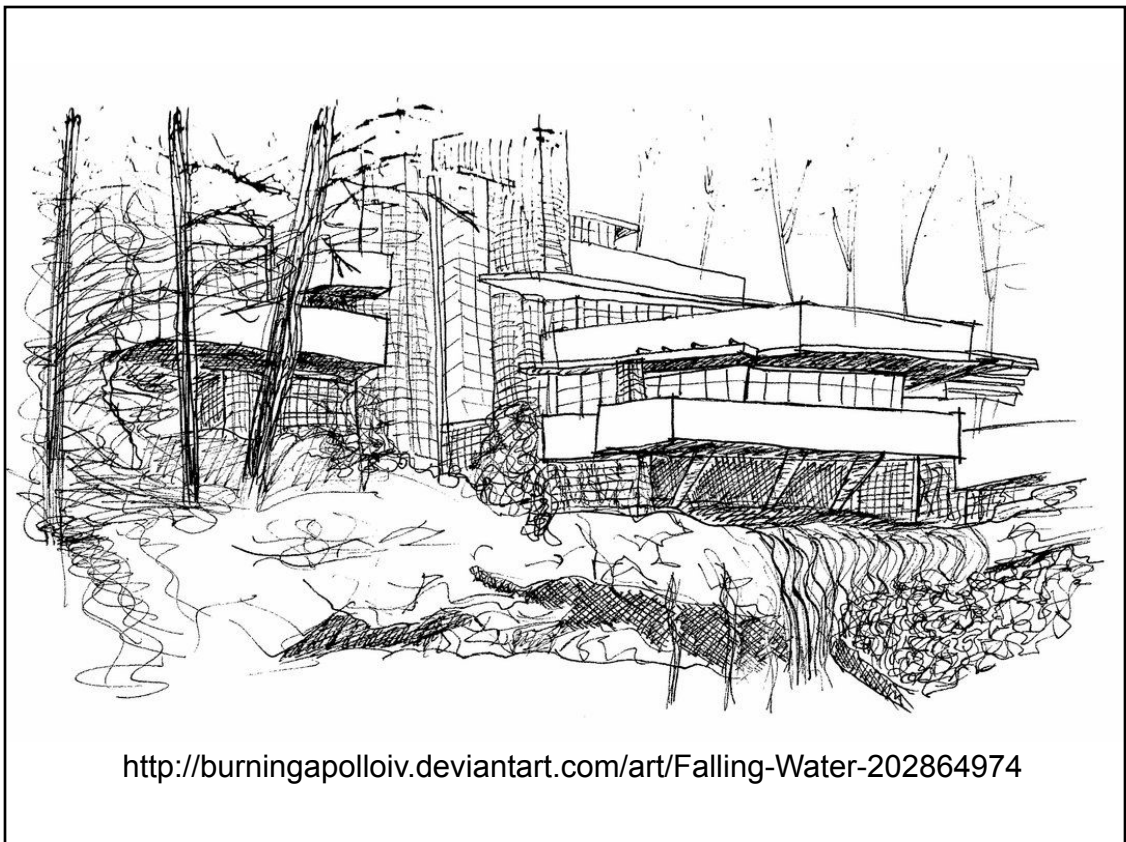
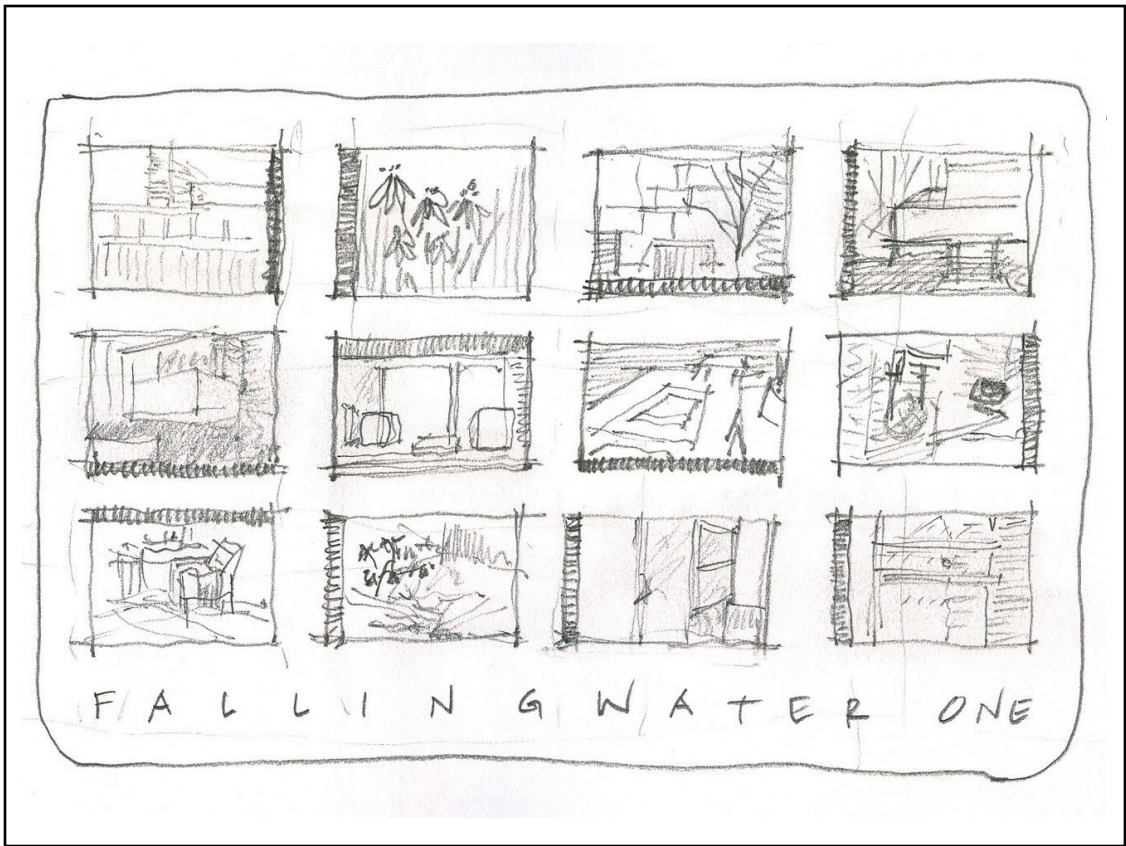


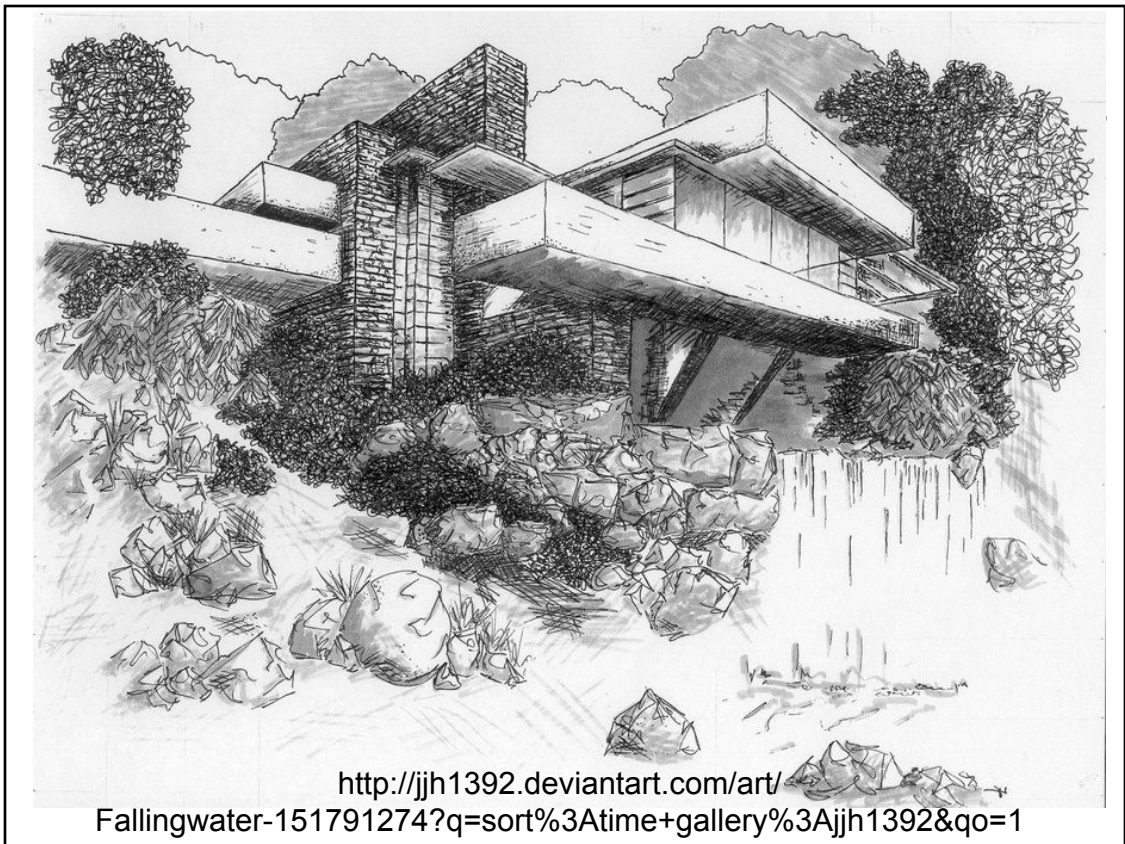
Rahul Jain <https://pendrawings.me/2016/01/04/draw-water/>

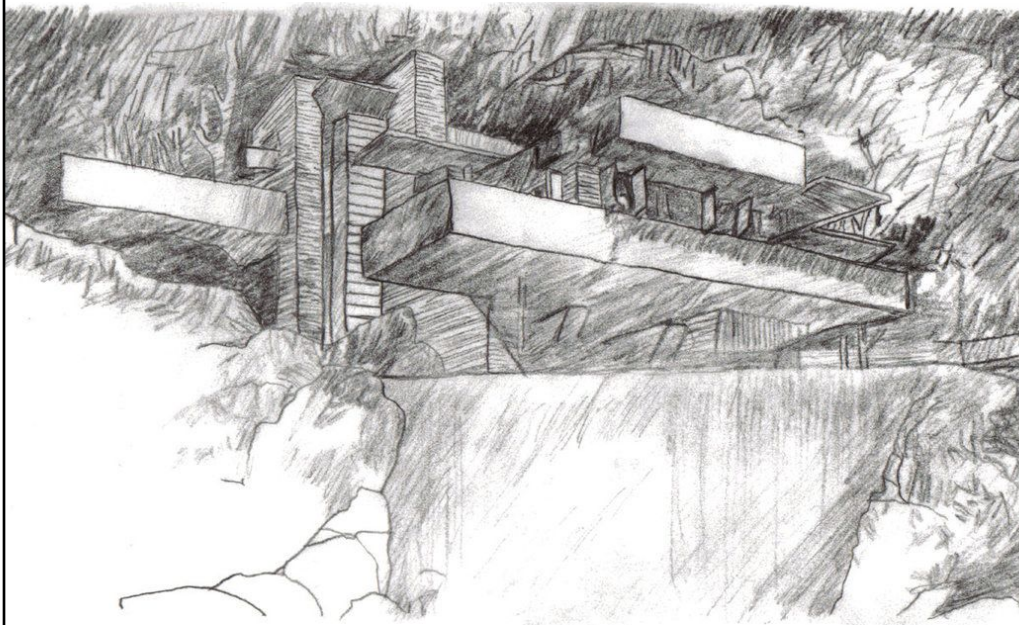


Jul 20 09

<http://www.gibson-design.com/images/Slides/fallingwater-entry-100dpi.jpg>







<http://rocket-204.deviantart.com/art/Falling-Water-Sketch-61337019>

Frank Lloyd Wright's *Fallingwater*



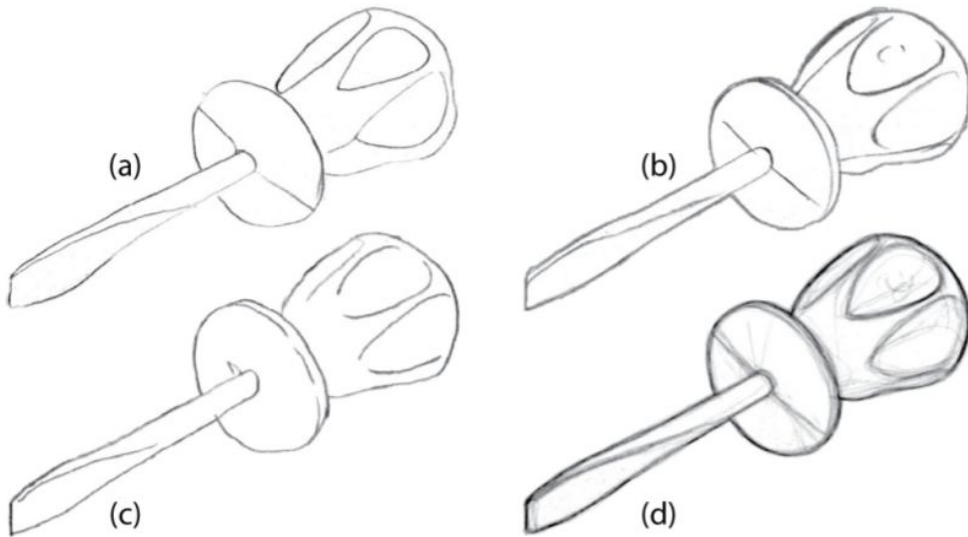
Goals for NPR?

- Exaggerate - *or* - de-emphasize lighting, texture, contrast, perspective, etc.
- Allow vagueness about material & geometry
- Varying level of detail – draw attention to particular aspects of imagery
- May use limited palette of colors, or precision/resolution
- More detail than a single traditional image can show (cross section, transparency, exploded view, multi-viewpoint rendering, etc.)

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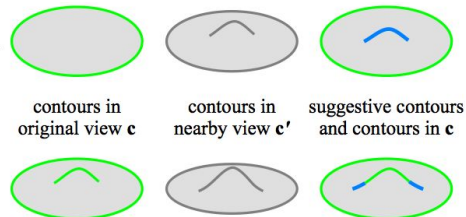
Where Do People Draw Lines?



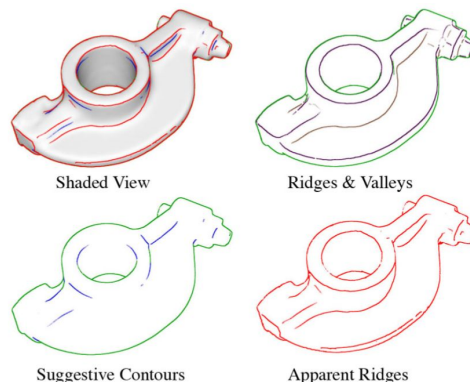
Cole, Golovinskiy, Limpaecher, Stoddart Barros, Finkelstein, Funkhouser, & Rusinkiewicz, SIGGRAPH 2008

Types of Edges in Line Drawings

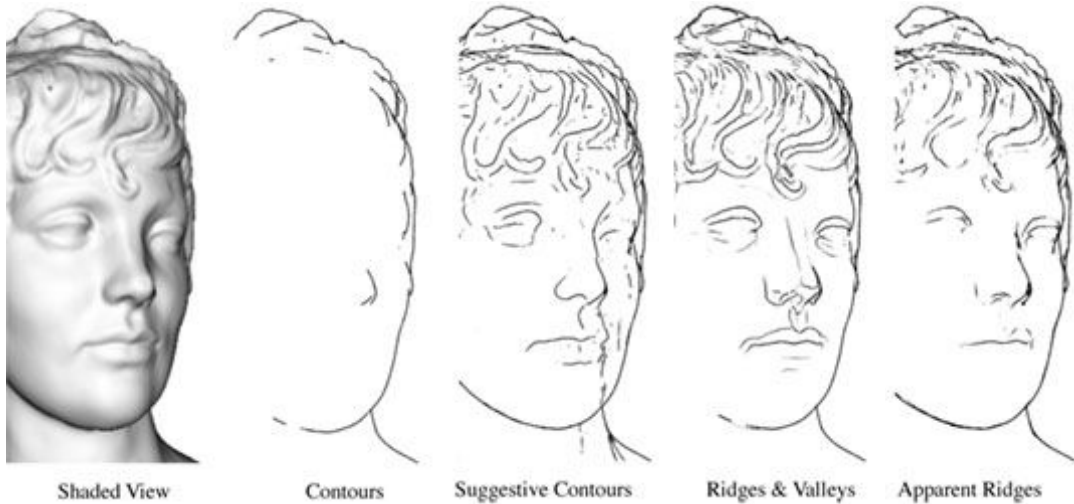
- Silhouettes/Contours: where normal is perpendicular to the view direction
- Suggestive Contour: inflection points of the surface normal
- Ridges & Valleys: extremum of curvature
- Apparent Ridges: based on *view dependent* curvature



Suggestive Contours for Conveying Shape,
DeCarlo et al., SIGGRAPH 2003



Types of Edges in Line Drawings

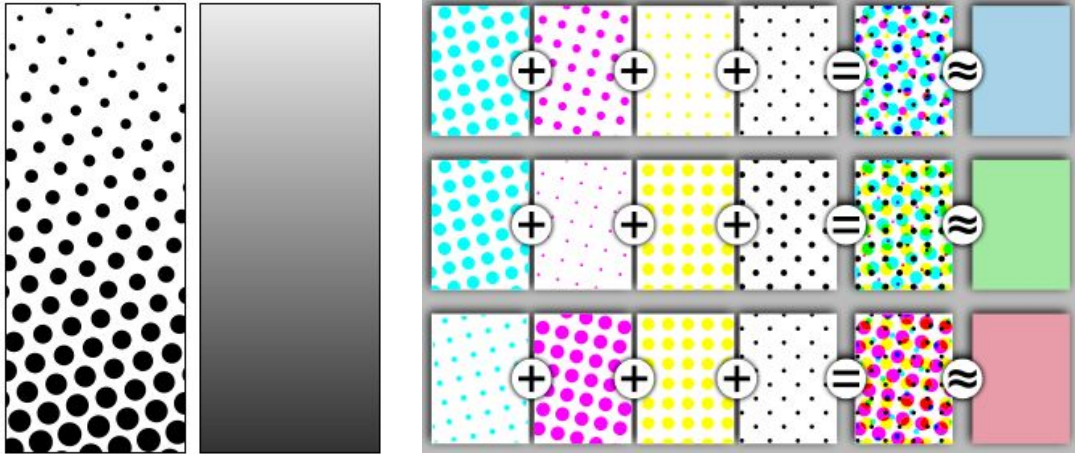


Apparent Ridges for Line Drawings
Judd, Durand & Adelson, SIGGRAPH 2007

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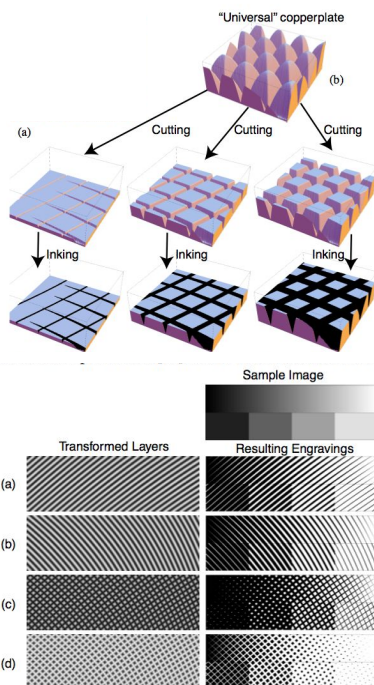
Halftoning



http://en.wikipedia.org/wiki/File:Halftoning_introduction.svg

<http://en.wikipedia.org/wiki/File:Halftoningcolor.svg>

“Digital Facial Engraving”, Ostromoukhov, SIGGRAPH 1999



Pen & Ink Illustration

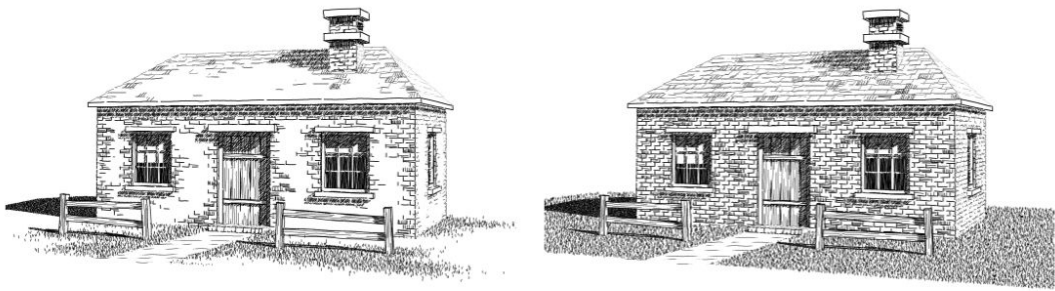
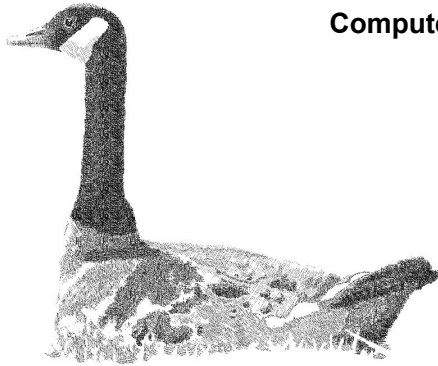


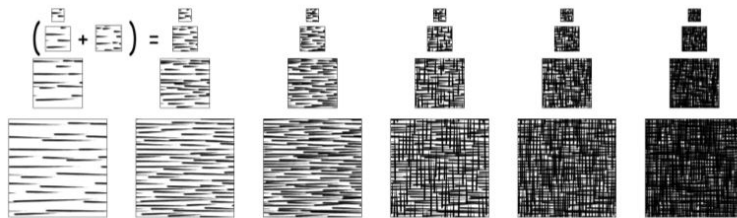
Figure 6: Indicating texture. The left house is drawn using "indication"; the right house is not.

Computer-generated pen-and-ink illustration
Winkenbach & Salesin 1996

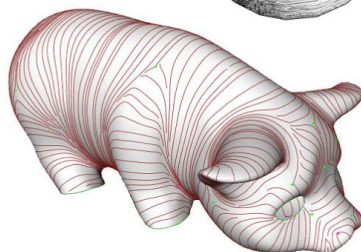
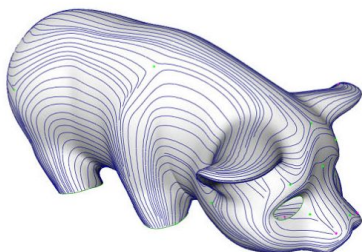
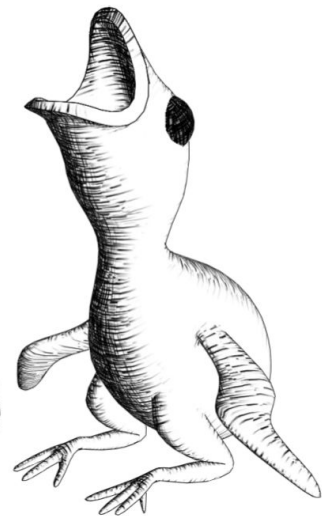
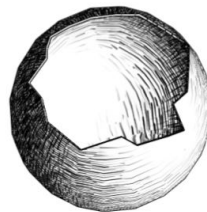


Interactive Pen-and-Ink Illustration
Salisbury et al., SIGGRAPH 1994

Real-Time Hatching



Real-Time Hatching
Praun, Hoppe, Webb &
Finkelstein SIGGRAPH 2001



smoothed minimum &
maximum curvature
[image from Alliez et al. '03]

Real-time NPR

- (Before programmable pixel shaders)
 - Create 1D texture map of shading tones
 - Local lighting (normal, view, & light directions) turned into texture coordinate
 - Texture lookup is final color
- Concerns about spatial & temporal coherence
 - popping
 - “Shower door” effect

Dynamic Solid Textures for Real-Time Coherent Stylization

Bénard, Bousseau, and Thollot, I3D 2009

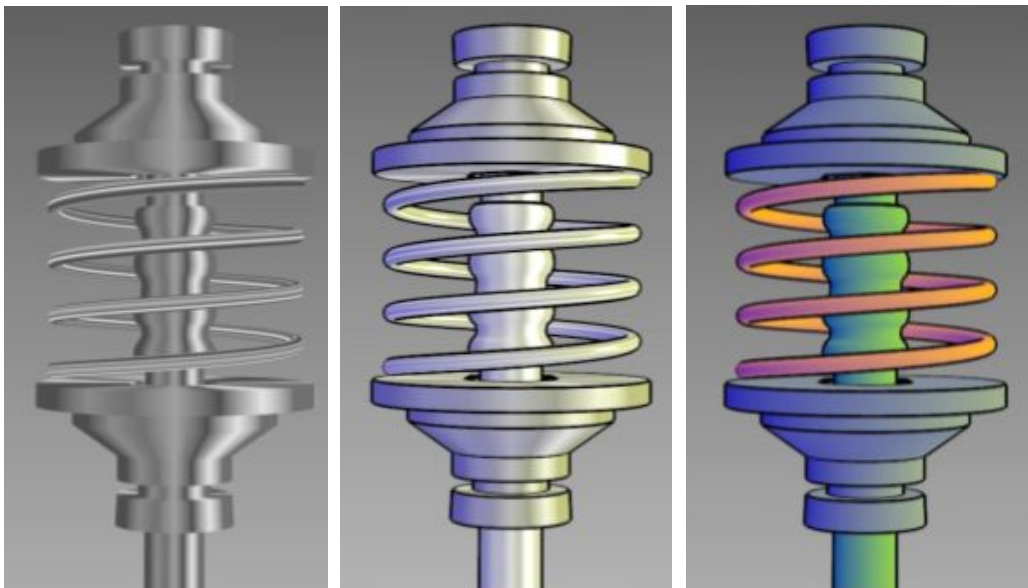


<http://artis.imag.fr/Publications/2009/BBT09/DynSolidTextures.mov>

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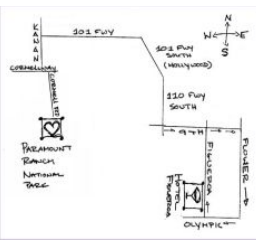
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Technical Illustration

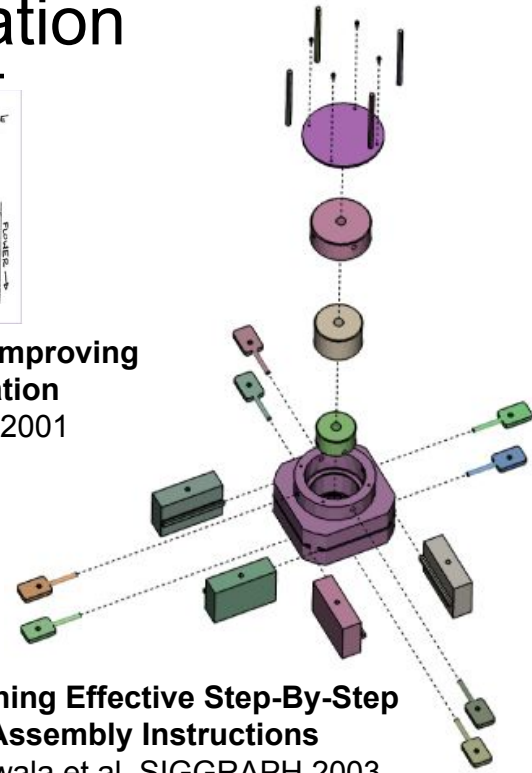
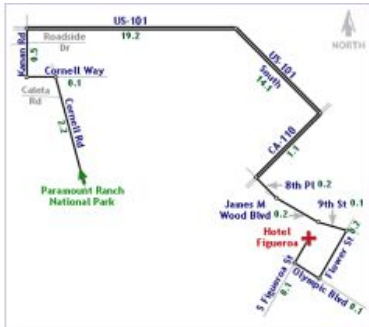


A non-photorealistic lighting model for automatic technical illustration
Gooch, Gooch, Shirley, & Cohen SIGGRAPH 1998

Technical Illustration



Rendering Effective Route Maps: Improving Usability Through Generalization
Agrawala & Stolte, SIGGRAPH 2001



Designing Effective Step-By-Step Assembly Instructions
Agrawala et al. SIGGRAPH 2003

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Painterly Rendering



Painterly rendering with curved brush strokes of multiple sizes
Hertzmann SIGGRAPH 1998

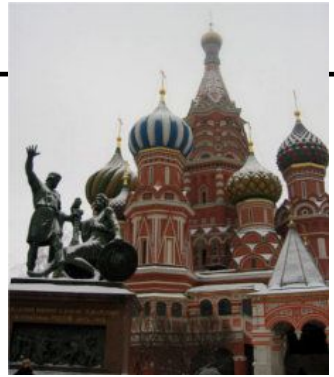
“Towards Artistic Minimal Rendering”, Rosin & Lai, NPAR 2010



Figure 1: Mona Lisa rendered in different styles. (a) line drawing, (b) image abstraction, (c)(d)(e): three styles of the proposed approach in this paper (single level, texture and pyramid).

Artistic Thresholding

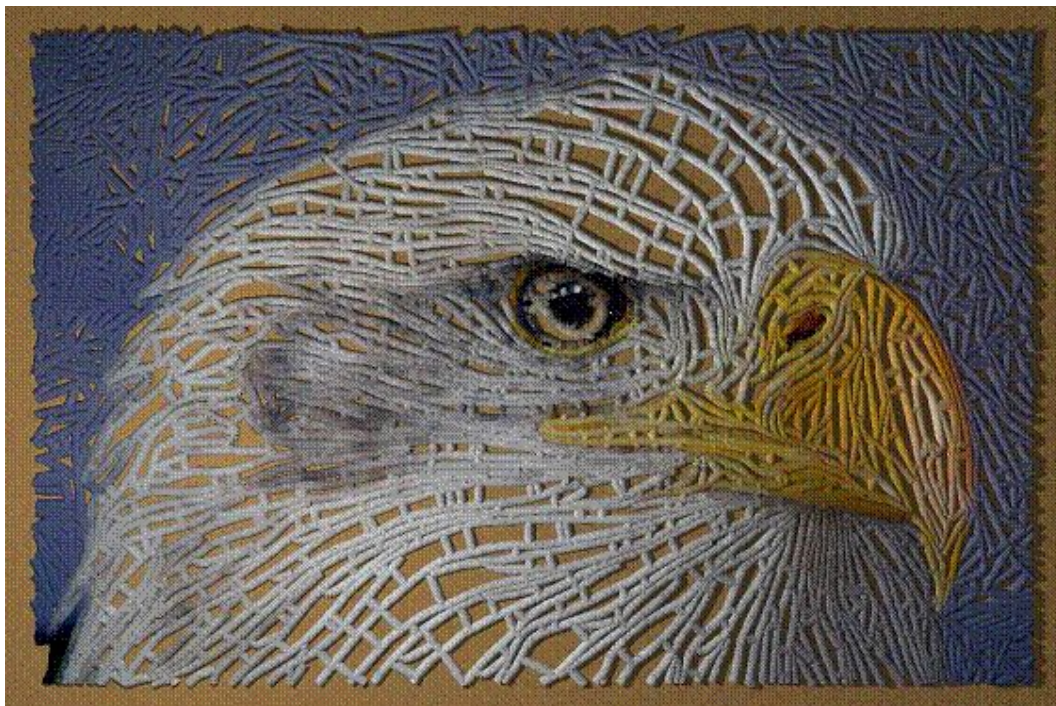
- Xu & Kaplan,
NPAR 2008



“WYSIWYG NPR: Drawing Strokes Directly on 3D Models”,
Kalnins, Markosian, Meier, Kowalski, Lee, Davidson, Webb,
Hughes, & Finkelstein, SIGGRAPH 2002



“Artistic Tessellations by Growing Curves”, Li & Mould,
Non-Photorealistic Animation and Rendering (NPAR) 2011



Example-Based Brushes for Coherent Stylized Renderings

Zheng, Milliez, Gross, and Sumner, NPAR 2017



Figure 1: These 3D paintings are rendered in screen space using our method with calligraphy and watercolor styles. The paint stroke rendering is temporally coherent as the characters and camera are animated.

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