Non-Photorealistic Rendering (NPR)

_Fishing_, PDI, Siggraph 1999
Last Time?

- Texture Mapping
- Solid Texture
- Procedural Textures
  - Perlin Noise
- Procedural Modeling
  - L-Systems
Today: Non Photorealistic Rendering

- Papers for Today
- Worksheet
- Architectural Rendering
- Line Drawing
- Pen & Ink / Hatching
- Technical Illustration
- Artistic Styles and Painterly Rendering
- Papers for Next Time

Cellular Texturing for Architecture

“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*

Frank Lloyd Wright’s *Fallingwater*
Plan, Section, & Elevation Drawings
Digital Models
Falling Water House by MilliieModels

Product File Downloads
- 3ds Max 7 (.max)
  - 119 KB

Live Chat Now 24/7
- Quality Guarantee
- File format conversions

Product License
- Standard Royalty Free
- View License · FAQ

3D Model Specifications
- Product ID: 266247
- Published: Jun 6, 2003
- Geometry: Polygonal
- Polygons: 17,864
- Vertices: 9,653
- Textures: Yes
- Materials: Yes
- Rigged: No
- Animated: No
- UV Mapped: Unknown
- Unwrapped UVs: Unknown

Product Rating
- Free

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


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.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

Painting / Painterly Rendering

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

Painting / Painterly Rendering

http://www.ivonneimagines.com/487/falling-water/
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/](https://pendrawings.me/2016/01/04/draw-water/)

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


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


“Digital Facial Engraving”,
Ostromoukhov, SIGGRAPH 1999
Pen & Ink Illustration

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

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

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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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)-(e): three styles of the proposed approach in this paper (single level, texture and pyramid).
Artistic Thresholding

- Xu & Kaplan, NPAR 2008

“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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