Non-Photorealistic Rendering (NPR)

Last Time?
- Texture Mapping
- Solid Texture
- Procedural Textures
  - Perlin Noise
- Procedural Modeling
  - L-Systems

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
Procedural Modeling of Buildings

Today: Non Photorealistic Rendering

- Architectural Rendering
- Line Drawing
- Pen & Ink / Hatching
- Technical Illustration
- Artistic Styles and Painterly Rendering


Frank Lloyd Wright’s *Fallingwater*

Plan, Section, & Elevation Drawings

Digital Models

Digital Models

From Half Life 2

http://lvlworld.com/t.php/Frank+Lloyd+Wright’s+Falling+Water

Photorealistic Rendering

http://www.etereaestudios.com/docs_html/fallingwater_htm/fall_still_03.htm

http://luftwerk.net/projects/fallingwater/
https://www.youtube.com/watch?v=6RJbnA7ESKk
Non-Photorealistic Miniatures

Eating Fallingwater


HGA Architects & Planners - Cantilevers: Inspired by Falling Water

http://www.flickr.com/photos/j_bussmann/4549613488/

Non-Photorealistic Rendering

Fallingwater

http://www.fallingwater.org/


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

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
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.)

Today: Non Photorealistic Rendering

- Architectural Rendering
- Line Drawing
- Pen & Ink / Hatching
- Technical Illustration
- Artistic Styles and Painterly Rendering

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
Types of Edges in Line Drawings

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

Today: Non Photorealistic Rendering

- Architectural Rendering
- Line Drawing
- Pen & Ink / Hatching
- Technical Illustration
- Artistic Styles and Painterly Rendering

Halftoning

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

*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

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
Today: Non Photorealistic Rendering

- Architectural Rendering
- Line Drawing
- Pen & Ink / Hatching
- Technical Illustration
- Artistic Styles and Painterly Rendering

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 & Stolle, SIGGRAPH 2001

Today: Non Photorealistic Rendering

- Architectural Rendering
- Reading for Today
- Line Drawing
- Pen & Ink / Hatching
- Technical Illustration
- Artistic Styles and Painterly Rendering

Designing Effective Step-By-Step Assembly Instructions
Agrawala et al. SIGGRAPH 2003
**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 pyramidal).](image)

**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**