Non-Photorealistic Rendering (NPR)

Last Time?
- Texture Mapping
- Solid Texture
- Procedural Textures
  - Perlin Noise
- Procedural Modeling
  - L-Systems
Reading for Today:

  & “Improving Noise”, SIGGRAPH 2002

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*
Frank Lloyd Wright’s *Fallingwater*

Frank Lloyd Wright’s *Fallingwater*

Plan, Section, & Elevation Drawings
Digital Models
Digital Models

From Half Life 2

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

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

Eating Fallingwater


HGA Architects & Planners - Cantilevers: Inspired by Falling Water

http://www.flickr.com/photos/j_bussmann/4549613488/
Non-Photorealistic Rendering
Non Photorealistic Rendering

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

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/
FALLING WATER ONE

http://burningapolloiv.deviantart.com/art/Falling-Water-202864974
Frank Lloyd Wright’s *Fallingwater*
Goals for NPR?

• Exaggerate - or - de-emphasize lighting, texture, contrast, perspective, etc.
• May use limited palette of colors, or precision/resolution
• Allow vagueness about material & geometry
• Varying level of detail – draw attention to particular aspects of imagery
• 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

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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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 example](image)

*Painterly rendering with curved brush strokes of multiple sizes*

Hertzmann SIGGRAPH 1998

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

![Image of Mona Lisa](image)

*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

Reading for Friday:

Reading for Friday:

“Fragment-based image completion”, Drori, Cohen-Or, Yeshurun, SIGGRAPH 2003

Reading for Friday:

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