Visualization and Nonphotorealistic Rendering

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• Visualization
• Non-photorealistic Rendering
• Cutaway Illustration
• Contour Drawing
• Good photographs.
• Map Drawing
Visualization

- Goal: Use computer graphics to understand data.
- For virtual every data type there is a corresponding visualization.
- The importance of graphics!
Numerical Data

http://www.manifold.net/news/fly_through.jpg
Graphs

http://www.designinginteractions.com/chapters/7
Geographic Data

http://floodingdata.com/wp-content/plugins/yet-another-photo-blog/cache/g_econ.6zhzniedpgzwgsw08okco4s.7dm680981log04oslgecsckco4.th.jpeg
Flow Visualization

http://www.faculty.uiuc.edu/~leinesen/publications/ParkYufetzKeyhosLinsenHumann06.jpg
3D Volume Data

http://medvis.wvvis.at/fileadmin/hvr/images/headlarge.jpg
Figure 2.4: An example of a visualization of a single respiratory phase of a 4DCT visualization showing lung, bone, and skin.
Volume Rendering

- Visualize Large dataset for scientific / medical application.
- Generally do not start with a 3D model.

**INPUT**

CT Scan - White means higher radiodensity.

**OUTPUT**
Large Datasets

CT Scan - White means higher radiodensity.

- CT or MRI:
  - e.g. 512x512x200 ≈ 50MB
- Visible Human:
  - 512x512x1734 ≈ 433MB
Two Options

- Surface Rendering
- Volume Rendering
Surface Rendering

- Threshold volume data.

- Then run our favorite algorithm....

- Hint: rhymes with “starching dudes”
Volume Rendering

• Some data better visualized as a volume, not a surface.

• **Idea:** Use voxels and transparency.

Raytraced Isosurface  Volume Rendering
Volume Rendering Pipeline

- Data volumes come in all types: tissue density (CT), wind speed, pressure, temperature, value of implicit function.
- Data volumes are used as input to a transfer function, which produces a sample volume of colors and opacities as output.
  - Typical might be a 256x256x64 CT scan
- That volume is rendered to produce a final image.
Transfer Functions

- Transform scalar data values to RGBA values
- Apply to every voxel in volume
- Highly application dependent
- Start from data histogram
Transfer Function Example

Mantle Convection

Scientific Computing and Imaging (SCI)
University of Utah
Outline

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Basic Idea

• Which best conveys "reality?"

Photograph.

Painting.
A Rough Sea at a Jetty, 1650.
Jacob van Ruysdael.

Computer Graphics
Duncan Brinsmead

source: Jos Stam. Photography changes what we think "reality" looks like.
Reality

A Rough Sea at a Jetty, 1650. - Jacob van Ruysdael.

- This instance in time never happened!
- Perhaps a better match of “subjective reality.”
- Better illustration of “what was going on.”
- Perhaps we can do better graphics...
- By doing non-photorealistic graphics!
NPR Pipeline

- NPR Research often follows this pipeline...

1. Study Existing Rendering or Illustration Technique
2. Extract General Aesthetic Rules
3. “Algorithmicize” These Rules
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Goal
Box Cut
Box Cut

Object-aligned box cut
Window Cut

Window cut
Wedge Cut

Wedge cut
Transverse Tube Cut

Transverse tube cut
Cut Taxonomy
Results

Interactive Cutaway Illustrations of Complex 3D Models

Wilmot Li¹  Lincoln Ritter¹
Maneesh Agrawala²  Brian Curless¹  David Salesin¹,³

¹University of Washington  ²University of California, Berkeley  ³Adobe Systems

(Source: Li et al. InteractiveCutawayIllustrationsofComplex3DModels)
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Goal

\[ n(p) \cdot v(p) = 0 \]
Suggestive Contours

\[ \min n(p) \cdot v(p) \]
Examples

Suggestive Contours for Conveying Shape

Doug DeCarlo¹  Adam Finbelstein²  Szymon Rusinkiewicz²  Anthony Santella¹
More Examples

(a) Drawing likelihood  (b) User composite  (c) Suggestive contours

(d) Extracted lines  (e) Sample drawing  (f) Canny edges

Where Do People Draw Lines?

Forrester Cole, Alexey Golovnysky, Alex Limpaecher, Heather Goodhart-Brown, Adam Finkelstein, Thomas Funkhouser, and Gzyman Rusinkiewicz
Depth Edge Camera
Depth Discontinuities

Internal and external Shape boundaries, Occluding contour, Silhouettes
Shadows
Clutter
Many Colors

Highlight Shape Edges
Mark moving parts
Basic colors
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Goal
Reality
MapBlast / LineDrive

[Rendering effective route maps: ..., Agrawala and Stolte]
Figure 2: The LineDrive system. (a) Given a route as a sequence of roads, LineDrive designs a route map by processing the route through five consecutive stages. (b) The resulting LineDrive map. (c) The same map rendered without applying the generalization techniques performed by LineDrive. The constant scale factor and retention of detailed road shape make it difficult to identify many of the roads.
MapBlast / LineDrive