Announcements

Final Project: multiple due dates

- Project proposal due Wed Nov 17, 11pm
- Progress report 1 due Mon Nov 22, 11pm
- Progress report 2 due Wed Dec 1, 11pm
- Final report due Wed Dec 8, 11pm
Conveying Shape

Topics

Photographs vs. drawings
Types of lines
Lines of curvature
Silhouettes and contours
Graphical drawing conventions
Texture and tone
Effects of drawing style
A photographic depiction captures the exact appearance of the object as we actually see it. Subtle, complex details of coloration and texture are fully represented, with great accuracy.

Photograph of the right hip bone (lateral aspect).
Johannes W. Rohen and Chihiro Yokochi.

A drawing offers the possibility to clarify structural or conceptual information that may be difficult to perceive in even a very good photo.

Color drawing of the same subject.

Photo vs. Drawing in Archaeology

Hand-drawn illustrations are routinely used to emphasize important features that are difficult to capture in a photograph, while minimizing secondary detail.

Drawings are also useful to portray information that cannot be captured or represented photographically, such as hidden surfaces.
Types of Lines

Lines Signify Features

Geometric features
- Creases
- Boundaries
- Self-intersections
- Silhouettes
- Isoparametric lines
- Parabolic lines
- Principal directions of curvature

Classic Geometric Line Types

- Isoparametric
- Discontinuities
- Boundaries
- Silhouettes
Lines in Images

Photoshop “Find Edges …”

Causes of Image Discontinuities

Material features
- Texture features
- Material boundaries

Lighting features
- Attached and unattached shadows
- Highlights and highlight boundaries
- Isoluminance contours
- Luminance extrema

Lines Signify Features
How to Create Drawings?

Picasso, Portrait of Igor Stravinsky, 1920. Graphite and charcoal, Musée Picasso, Paris, France

Two Big Issues

Which lines to draw?

How to draw the lines?

Lines of Curvature
Normal Curvature

Curvature applet: [http://www.ies.co.jp/math/java/calc/curve/curve.html](http://www.ies.co.jp/math/java/calc/curve/curve.html)

Space Curve

Curvature of Surfaces

Hilbert and Cohn-Vossen (1952)
Geometry and the Imagination
Curvature of Surfaces

Hilbert and Cohn-Vossen [1952]
Geometry and the Imagination

Principal Curvatures

Hilbert and Cohn-Vossen [1952]
Geometry and the Imagination

Artistic Inspiration

Russell Drake's “single line system of shading”

- the flow of the shape is conveyed through the directions of the carefully drawn strokes

Principal Directions

Klein bottle
From Hertzmann and Zorin

Guassian Curvature

\[ K_1 = \text{curvature in first principal direction} \]
\[ K_2 = \text{curvature in second principal direction} \]

Gaussian curvature: \( K = K_1 K_2 \)
Mean curvature: \( H = (K_1 + K_2) / 2 \)

\( K > 0 \): elliptic, convex or concave
\( K < 0 \): hyperbolic, saddle-shaped
\( K = 0 \): parabolic, cylindrical or planar
Gaussian Curvature

Parabolic Lines

Silhouettes and Contours
Occluding Contour

Definitions

**Rim** – the closed space curve on the shape that makes up the silhouette; the space curve is smooth and has no discontinuities except when the surface is discontinuous; the rim is not a plane curve!

**Contour** – the projection of the rim; the projection may have singularities

**Silhouette** – the visible part of the contour

DeCarlo, Finkelstein, Rusinkiewicz, Santella. Suggestive contours for conveying shape, SIGGRAPH 2003
Suggestive Contours

DeCarlo, Finkelstein, Rusinkiewicz, Santella. Suggestive contours for conveying shape, SIGGRAPH 2003

Suggestive Contours - DEMO

Graphical Drawing Conventions
Drawing Parameters

- Haloed lines
- Taper near t-junction
- Control of line weight
- Highlighting
- Eye-lashing
- Sketchiness
Illustration Rules (Dooley & Cohen)

Importance
- Low
- Medium
- High

Types
- Boundaries
- Creases
- Silhouettes
- Isoparametric

Line Weight

Single weight | Two weights | Distance weighting

From Martin (reproduced in Gooch and Gooch)

Fig. 12-1 Line contrast shading.
Highlighting

Texture and Tone
Stroke Collections

Prioritized Stroke Textures
[Salisbury et al. '94]
[Winkenbach et al. '94]

Art Maps
[Klein et al. 2000]

Pen and Ink Illustration
[Winkenbach and Salesin 94]

Pen and Ink Illustration [Winkenbach and Salesin 94]

Collection of stroke images
Will blend → design with high coherence
Stroke nesting property

Pen and Ink Illustration [Winkenbach and Salesin 94]

Pen and Ink Illustration [Winkenbach and Salesin 94]
Effects of Drawing Style

Assessing the effect of non-photorealistic rendered images in CAD, Schumann, Strohotte, Raab, Laser, CHI '96

Comparison: CAD

Comparison: Shaded
Comparison: Sketch

Draft vs. Presentation

Affect vs. Cognition

Figure 15.26: The use of sketches, CAD plots, and shaded images for the presentation of a first draft versus the presentation in a final presentation (Schumann et al. 1996)

Figure 15.27: Mean values of the assessment of the effect of the media (CAD users) (Schumann et al. 1996). The symbol * denotes the items in which sketches differ significantly (p<0.05) from CAD plots and the shaded images, while * denotes the items in which CAD plots differ significantly (p<0.05) from sketches and shaded images.
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<th>Summary</th>
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<td>Illustrations often better than photographs</td>
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<td>- Enhance important features</td>
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<td>- Deemphasize unimportant detail</td>
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<td>Grand challenge</td>
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<td>- Produce a good line drawing</td>
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<td>- What lines, not just how to draw lines</td>
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