Passing Through the Trough of Disillusionment of Illustrative Visualization

Ivan Viola
Hype Cycle

- Peak of Inflated Expectations
- Plateau of Productivity
- Slope of Enlightenment
- Trough of Disillusionment
- Technology Trigger

Visibility vs. Time
Illustrative Visualization

Definition: computer supported interactive and expressive visualization of complex data through abstractions from traditional illustrations

[Toverud]

[Bruckner et al. 2010]
Low-Level Visual Abstractions

- Concerned with **how** different objects are presented
- Stylized depiction
  - Silhouettes and contours, pen and ink, stippling, hatching, ...
High-Level Visual Abstractions

- Deal with **what** should be visible and recognizable
- Focus+Context
  - Depth of field, lens distortions, deformations
- Smart visibility
  - Cutaways, breakaways, ghosting, exploded views, peel-aways...
One approach to improving the perceptual effectiveness of computer graphics is to adapt tools and techniques for conveying visual information used by artists and illustrators.

A second approach builds directly on knowledge of human vision system by using perceptual effectiveness as an optimization criterion in the design of the computer graphics systems.

These two approaches are not completely distinct....
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VISIBILITY

TIME
Line Drawing

[Saito and Takahashi 1990]
Contour Composition in Image Space

Combination Depth + Normal map

(a) (b) (c) (d) (e) [Hertzmann et al. 1999]
Hype Cycle for Illustrative Visualization

- Technology Trigger
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- Plateau of Productivity

[Saito and Takahashi 1990]
[Hertzmann et al. 1999]
Contour Extraction in Object Space

\[ n_i \]

\[ x_i \]

[Ebert and Rheingans 2000]
[Csebfalvi et al. 2001]
Line Drawing

[Kindlmann et al. 2003]
Ridge and Valley Lines

[Ohtake et al. 2004]
Lit Sphere Style Transfer

[Sloan et al. 2001]
Use a sphere map indexed by the eye-space normal to determine the color of a point.

[Sloan et al. 2001]
Style Transfer Functions

[Bruckner and Groeller 2007]
Hype Cycle for Illustrative Visualization

Cut-Away Views

[Viola et al. 2004]
Exploded Views

the degree-of-explosion controls the amount of displacement

Degree-of-Explosion

Explosion Factor

Viewing Factor

Spacing Factor
Visual Guidance in Data

- Input: known and classified volumetric data
- High level request: show me feature X
- Output: visually pleasing focusing at X

[Viola et al. 2006]
Guidance Elements

object selection by user

importance distribution

characteristic viewpoints

viewpoint transformation

cut-away and level of ghosting

focus discrimination
Visual Guidance over Human Hand
Perceptual Aspects:
- Shape Perception
- Depth Perception
- Visual Attention

Cognitive Aspects:
- Selective Visualization
- Occlusion Management
- Process Visualization
- Visual Guidance
- Semantic Visualization

[Viola et al. 2004]
[Bruckner’n’Gröller 2006]
[Viola et al. 2006]
How are illustrators doing it?
Hype Cycle of Illustrative Visualization

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Mimicking
Analysis
Establishing Design Principles

Design principles **connect** the **visual design** of a visualization with the **viewer’s perception and cognition** of the underlying information the visualization is meant to convey.

Identifying and formulating good design principles often requires **analyzing** the best **hand-designed** visualizations, examining **prior research** on the **perception and cognition** of visualizations, and, **when necessary, conducting user studies** into how visual techniques affect perception and cognition.

Given a set of design rules and quantitative evaluation criteria, we can **use procedural techniques** and/or energy optimization to **build automated visualization-design systems.**

[Argawala et al. 2011]
Suggestive Contours

[DeCarlo et al. 2003]
Aparent Ridges

- Draw lines at rapid variation of normal with respect to the image position
- Aparent Ridge: loci of points that maximize view dependent curvature

[Judd et al. 2007]
Aparent Ridges vs Ridges

[Judd et al. 2007]
Rules for Cut-Aways and Section Views

- Inside and outside objects are differentiable
- Section view intersection of two half spaces
- Section aligned to main axis of outside object
- Jittering mechanism for cut-outs
- Cut-out walls should be visible
- Cut-out is a single hole
- Interior objects visible from any viewing angle

[Diepstraten et al. 2003] [Thurnher and Pflugfelder 2005]
Occluder-Based Cut-Away Design

- Consideration of geometrical properties of occluding structures
- Canonical viewpoint selection

[Li et al. 2007]
Cut-Away Illustrations for Geology

- Simple cut geometry
- Oblique cuts
- Cut alignment with context
Hierarchical Exploded Views

(a) Input model

(b) Explosion graph

(c) Exploded model

[Li et al. 2008]
Subway Map Design

- Straightening the subway lines
- Evenly spacing the stops to visually emphasize the sequence of stops and transfer points

[Argawala et al. 2011]
How are illustrators doing it?
But can we know for sure if we do not ask them?
And are they doing the right thing?
Hype Cycle of Illustrative Visualization

- Peak of Inflated Expectations
-模仿
- Plateau of Productivity
- 平台期
- Slope of Enlightenment
- 分析
- Trough of Disillusionment
- Validation
- 技术触发时刻
- 时间轴
Why are illustrators doing it this way?
Line Drawing: Illustrators vs. Silicon

About 20 artists were asked to draw objects based on shaded rendering

[Cole et al. 2008]
Line Drawing: Illustrators vs. Silicon

[Diagram showing comparisons between different artists and their work, including line drawings and recall charts.]

Bone
Mech.
Cloth
Synth.

[Graph showing recall metrics for different categories like RV (Regular Value), SC (Special Case), and AR (Artistic Rendering).]
## Canny edge detector - the best match with illustrator lines!

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<th>Feature</th>
<th>Bone</th>
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<th>Mech</th>
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Line Drawings Effectiveness in Conveying Shape

(a) shaded image  (b) human drawing  (c) contours  (d) apparent ridges

[Cole et al. 2009]
Light Positioning

[O’Shea et al. 2008]
Chromatic Shift in Shadows

[Solteszova et al. 2011]
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[Cole et al. 2007]
[Cole et al. 2008]
[O'Shea et al. 2008]
[Solteszova et al. 2011]
High-rated features | Low-rated features
---|---
1. Action diagrams | 1. No diagrams/parts only
2. Step-by-Step diagrams | 2. Omitting steps
3. Clear order of steps | 3. Order unspecified or impossible ordering
4. Views of relevant parts and attachments | 4. Occluded views of parts and attachments
5. Use of diagrammatic elements to indicate actions (ex. arrows and guidelines) | 5. Lengthy text

[Heiser et al. 2004]
Cut-Aways for Medical Tasks

- Breaking a cognitive task into perceptual subtasks
- Evaluating by means of psychophysical studies

[Baer et al. 2011]
Hype Cycle for Illustrative Visualization

VISIBILITY

Peak of Inflated Expectations

Plateau of Productivity

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[Heiser et al. 2004]

[Baer et al. 2011]
Methodological Levels

1. **Mimicking** the craft of illustration, basic perception bg
2. **Analyzing** illustration for design of new technology
3. **Validating** analysis by means of perception and cognition
Hype Cycle for Illustrative Visualization

Perceptual Aspects:
- Shape Perception
- Depth Perception
- Visual Attention

Cognitive Aspects:
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