

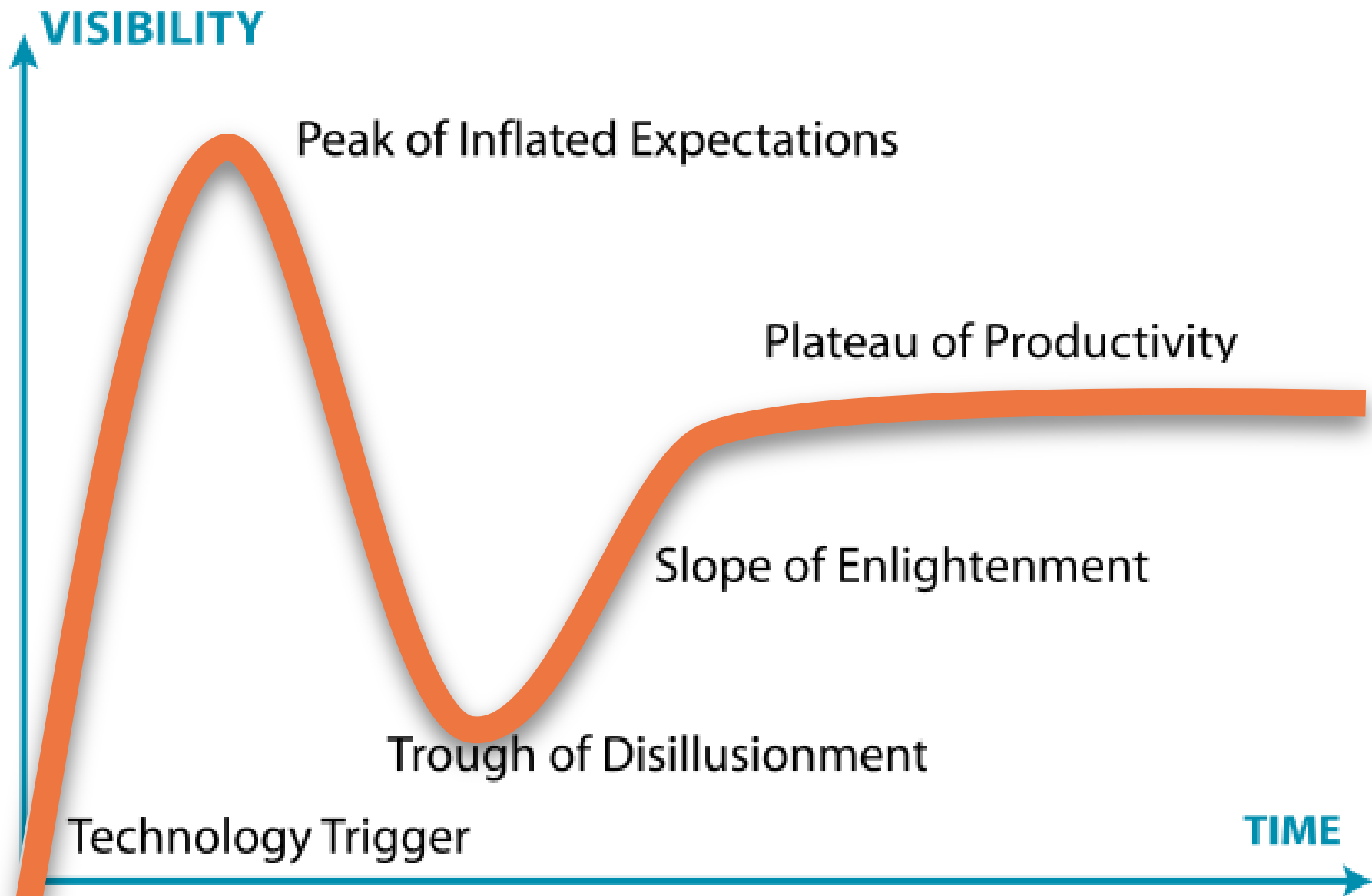
Passing Through the Trough of Disillusionment of Illustrative Visualization

Ivan Viola



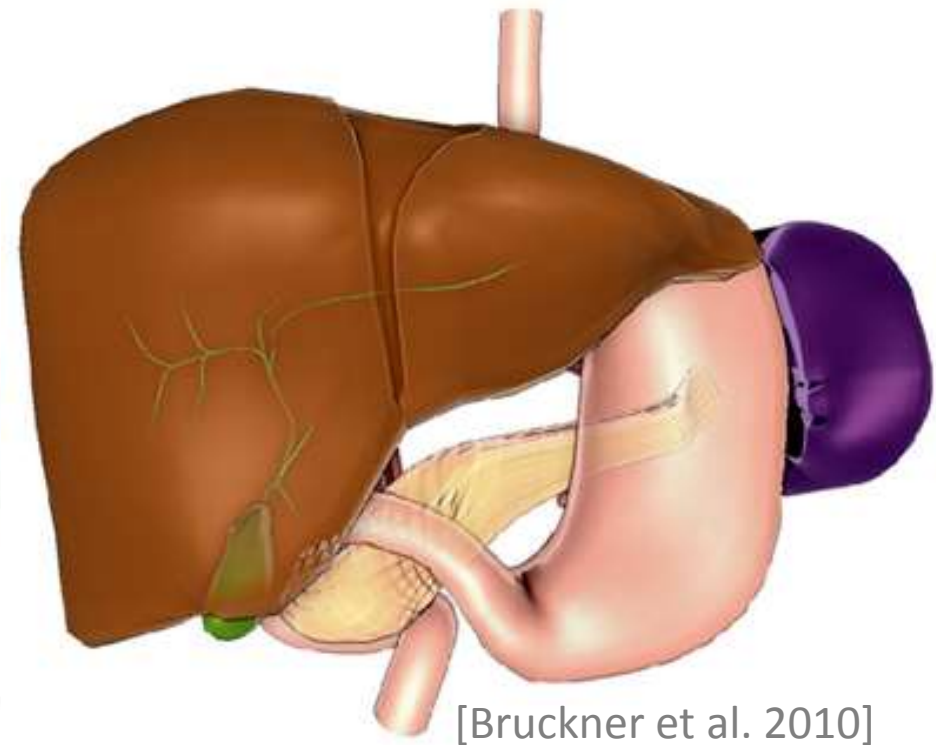
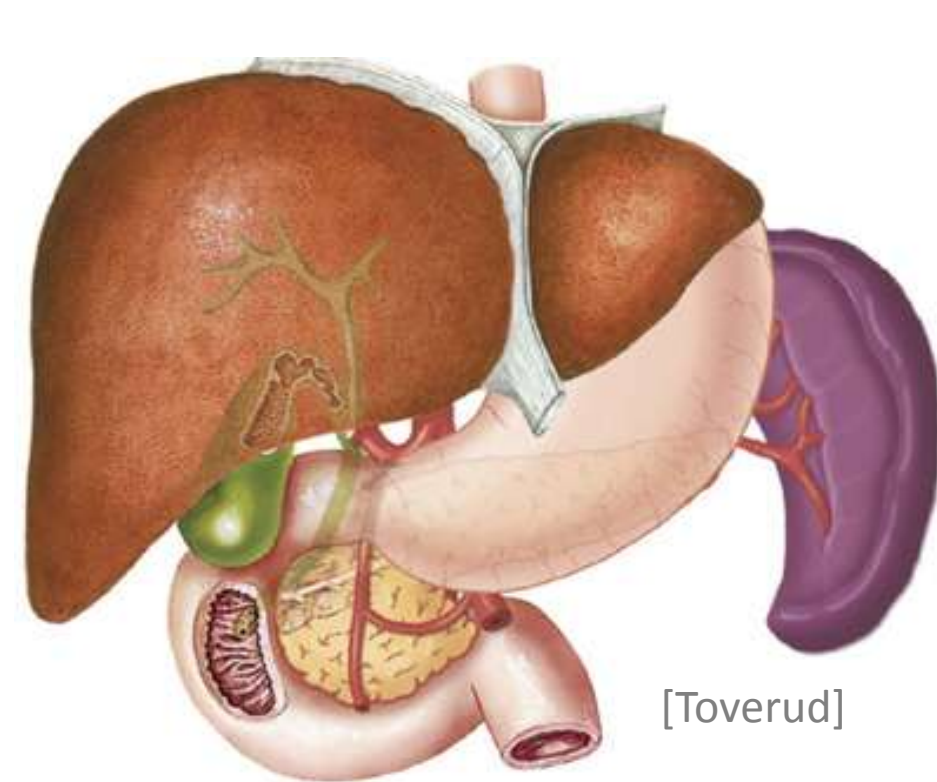
UNIVERSITETET I BERGEN

Hype Cycle



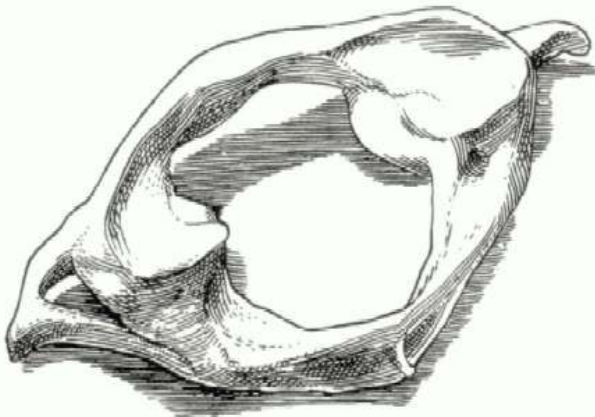
Illustrative Visualization

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



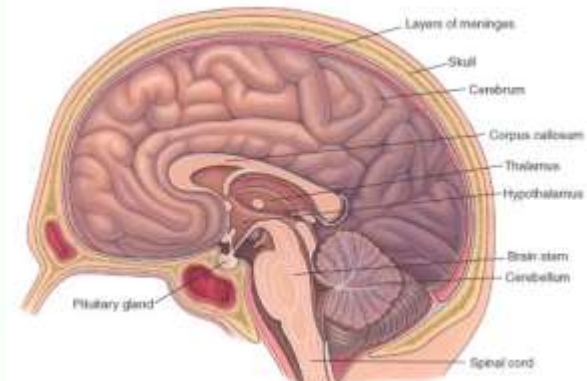
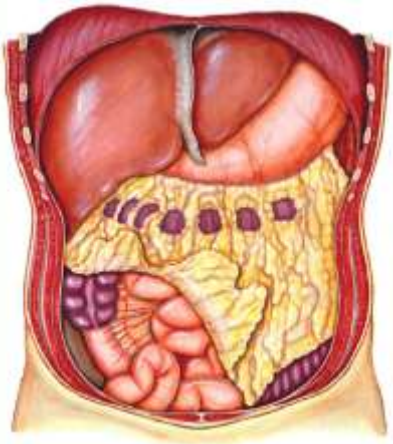
Low-Level Visual Abstractions

- 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...

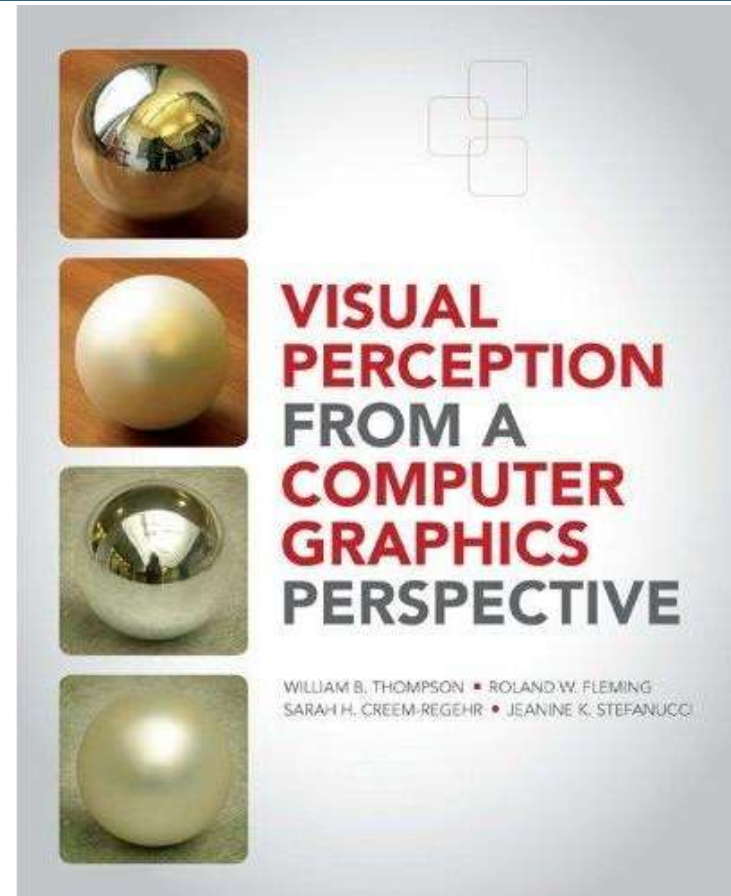


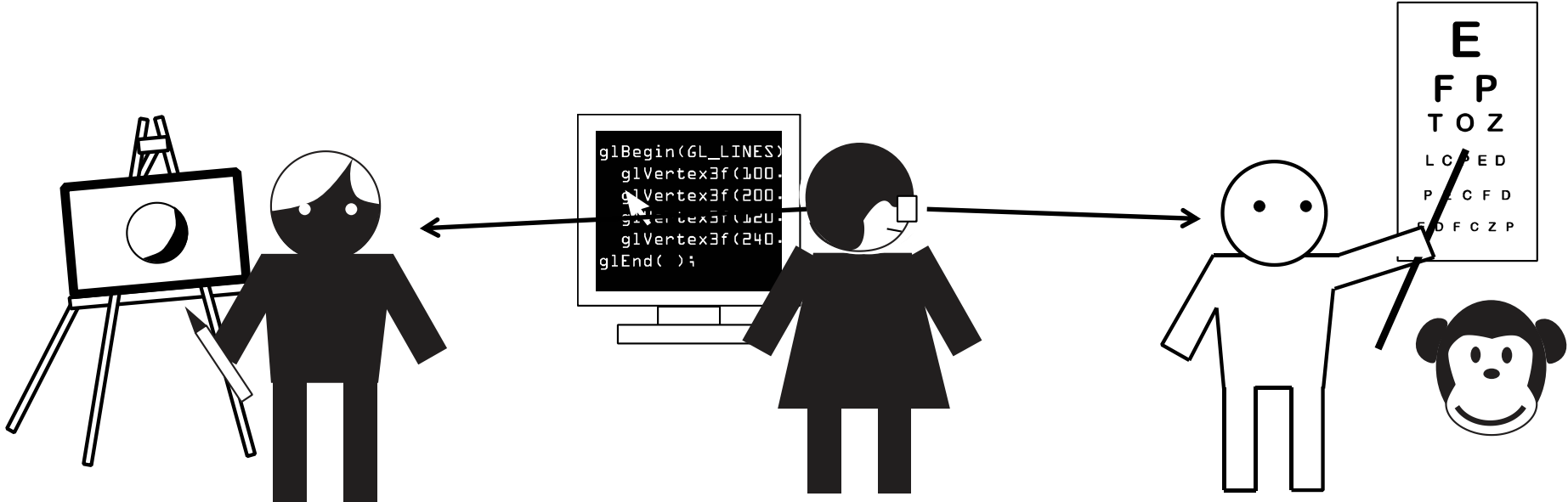
Perception–Computer Graphics–Illustration

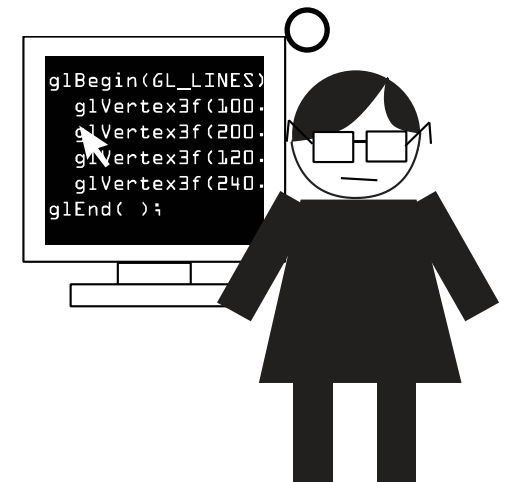
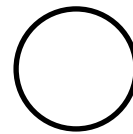
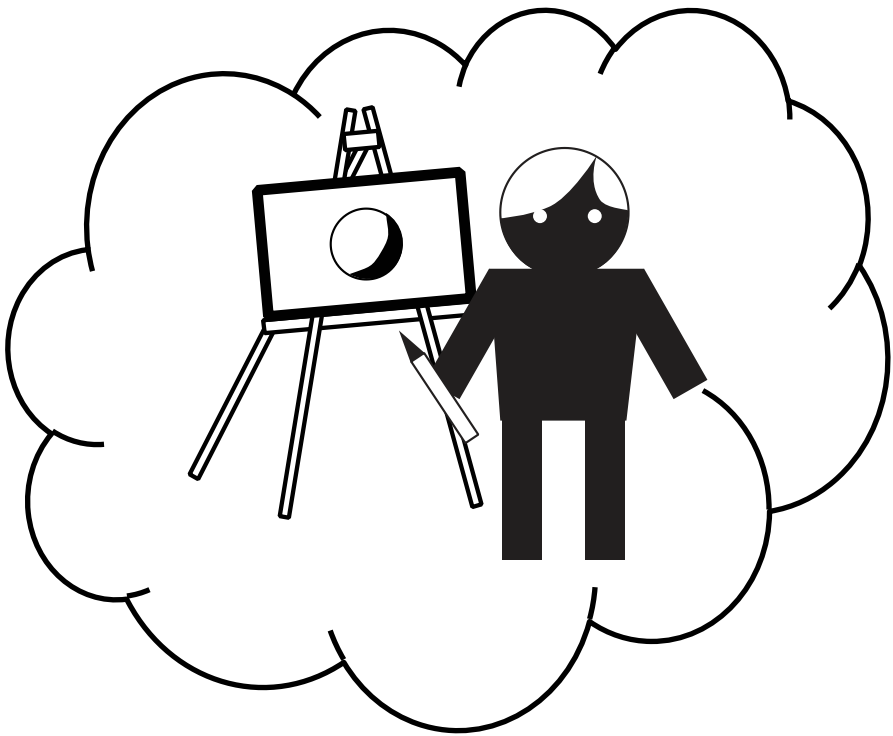
One approach to improving the perceptual effectiveness of computer graphics is to adapt tools and techniques for conveying visual information used by artists and illustrators.

*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....



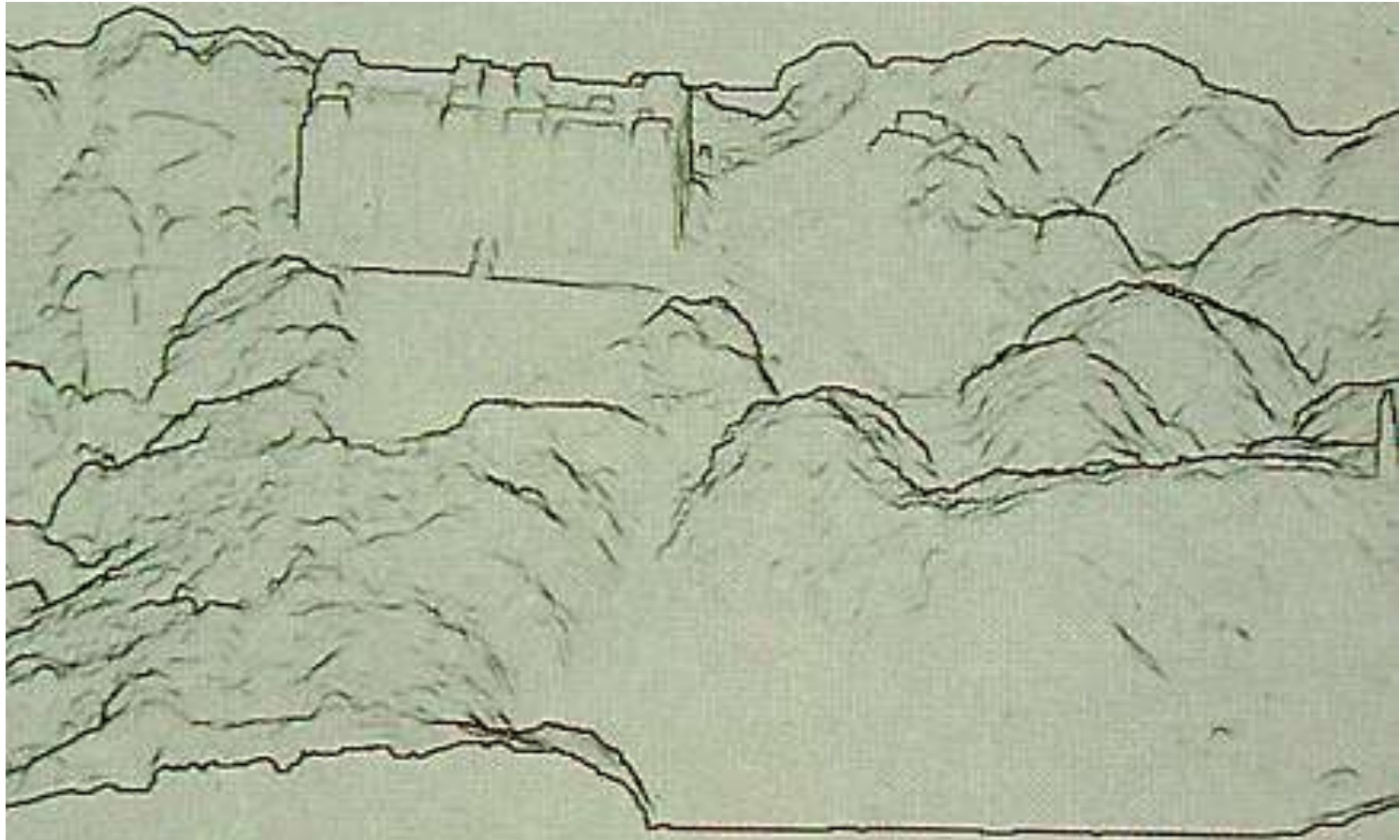




Hype Cycle of Illustrative Visualization

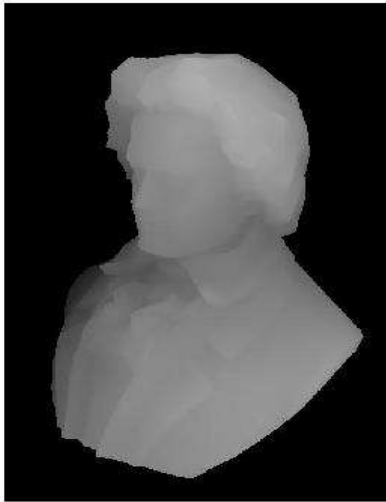


Line Drawing

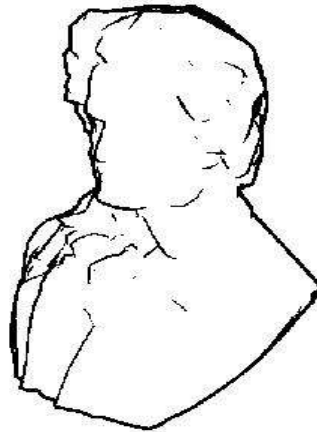


Contour Composition in Image Space

■ Combination Depth + Normal map



(a)



(b)



(c)



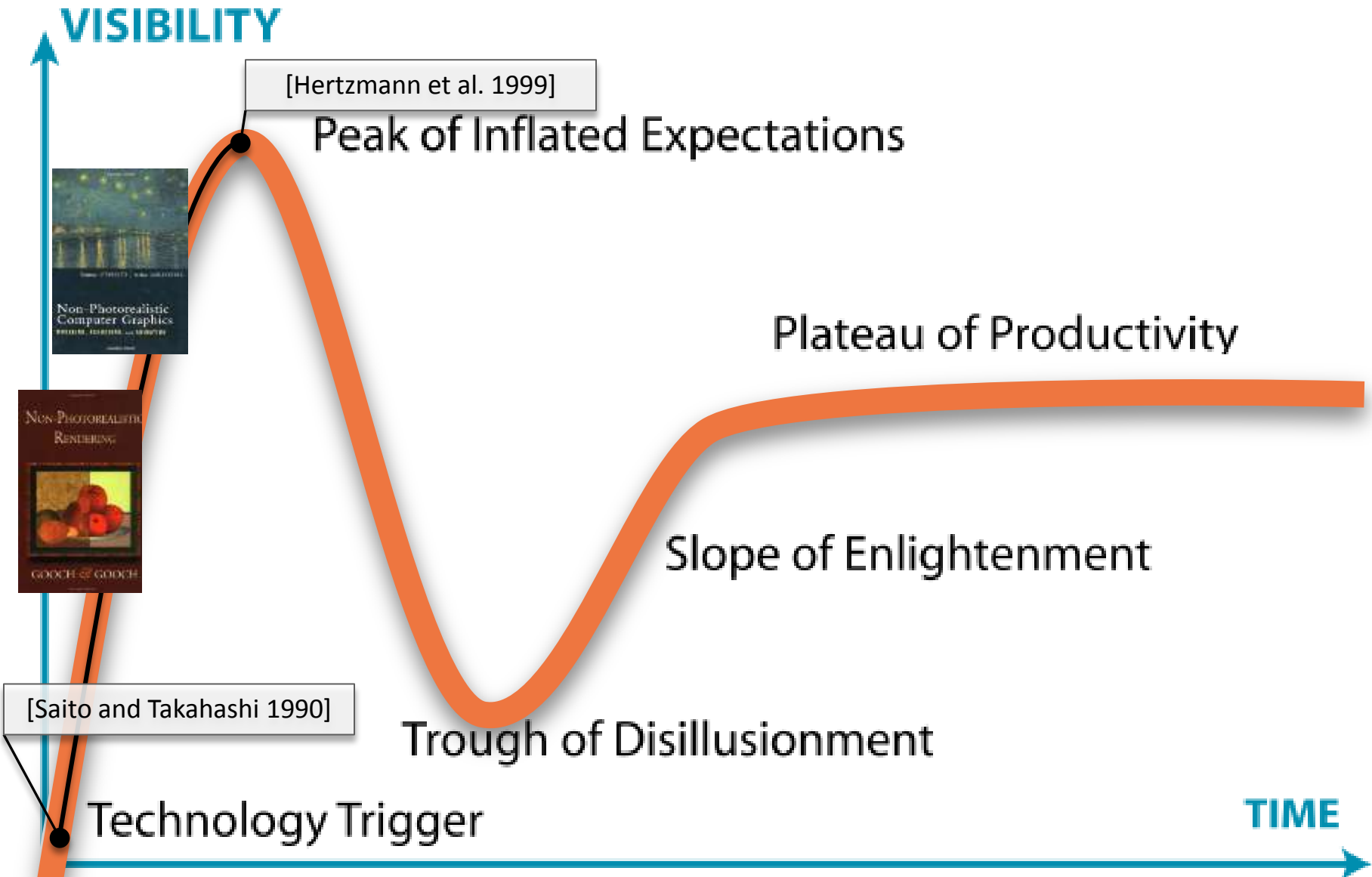
(d)



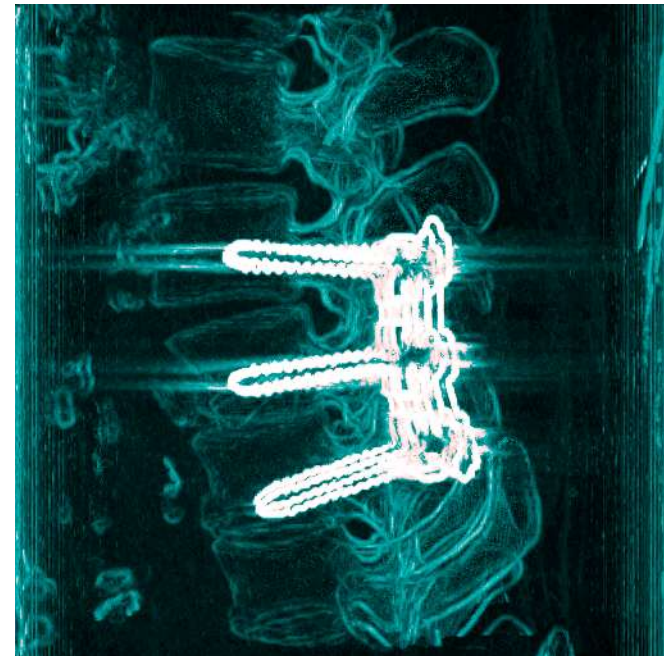
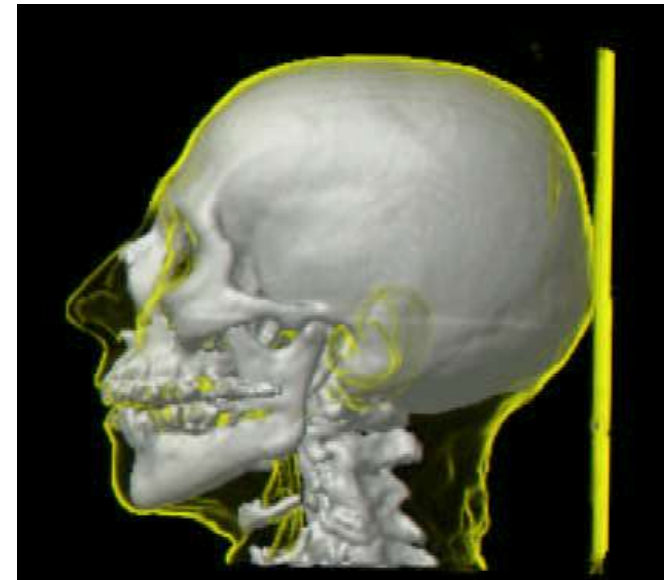
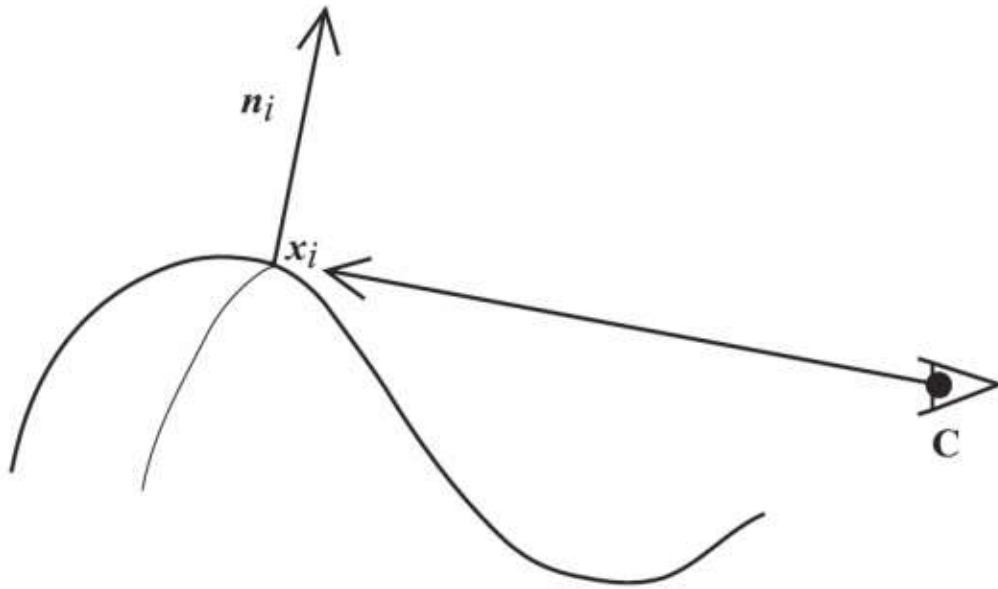
(e)

[Hertzmann et al. 1999]

Hype Cycle for Illustrative Visualization



Contour Extraction in Object Space



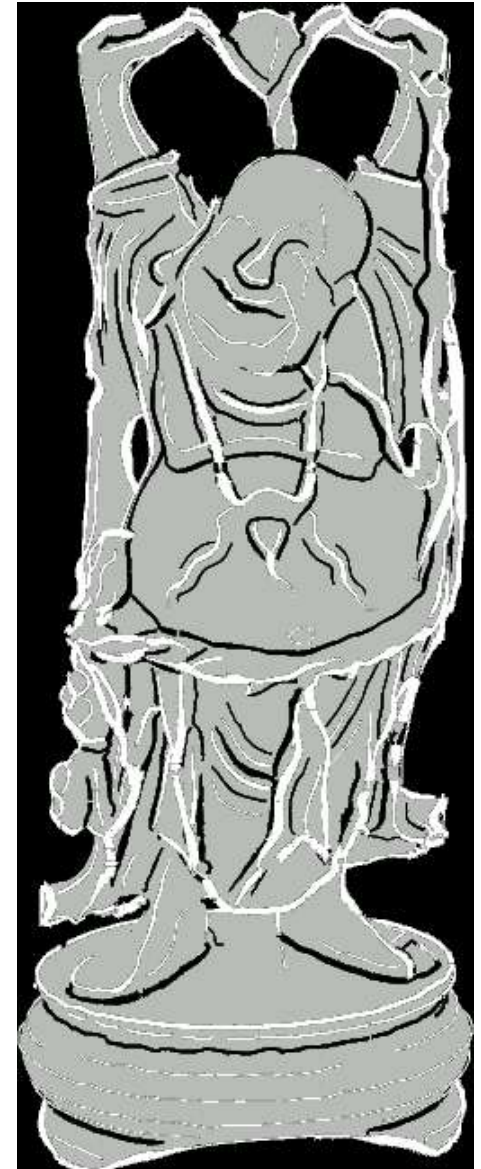
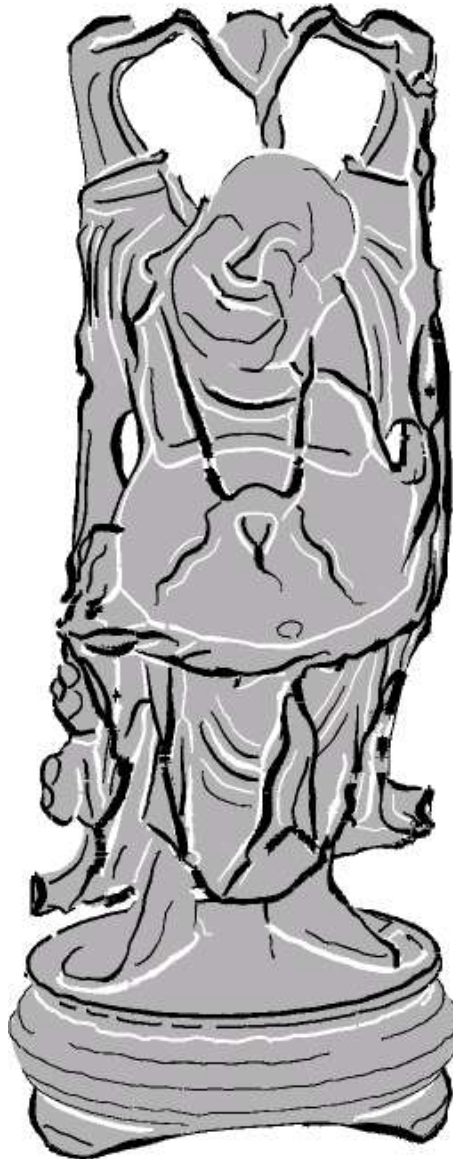
[Ebert and Rheingans 2000]

[Csebfalvi et al. 2001]

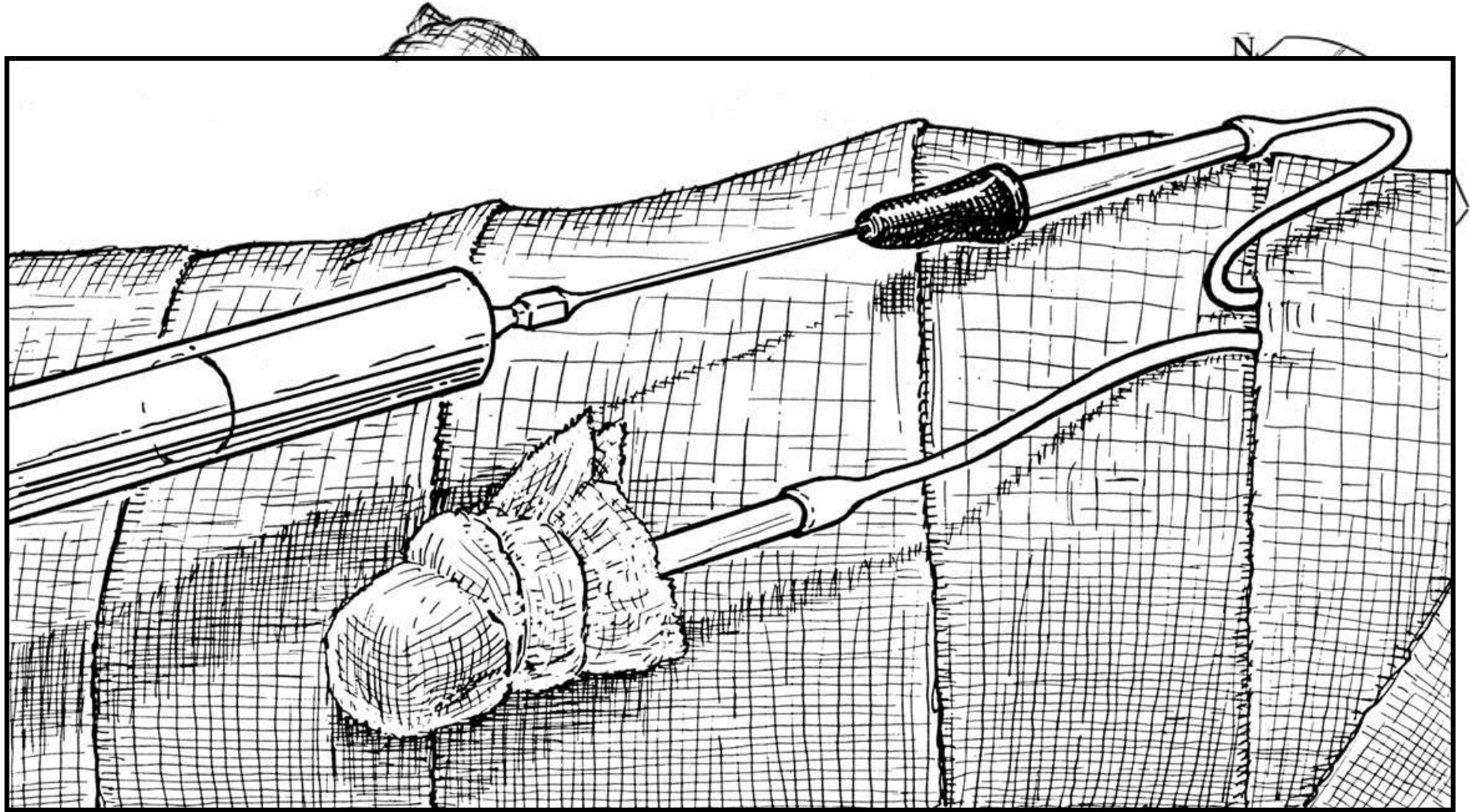
Line Drawing



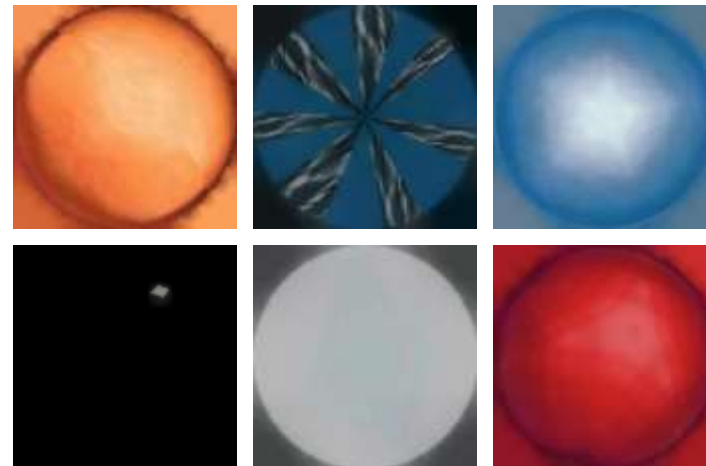
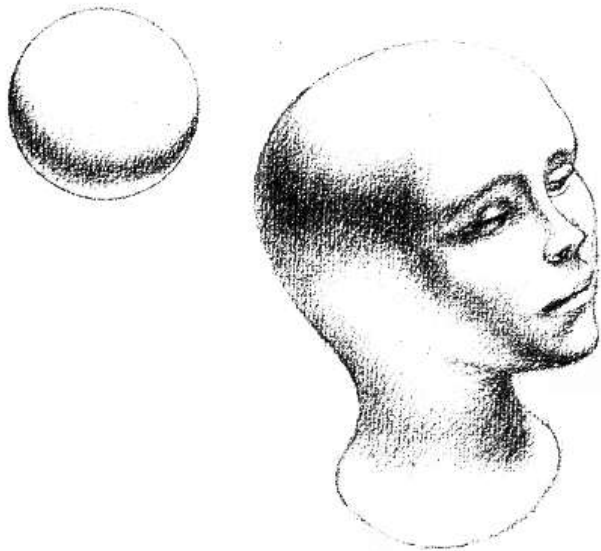
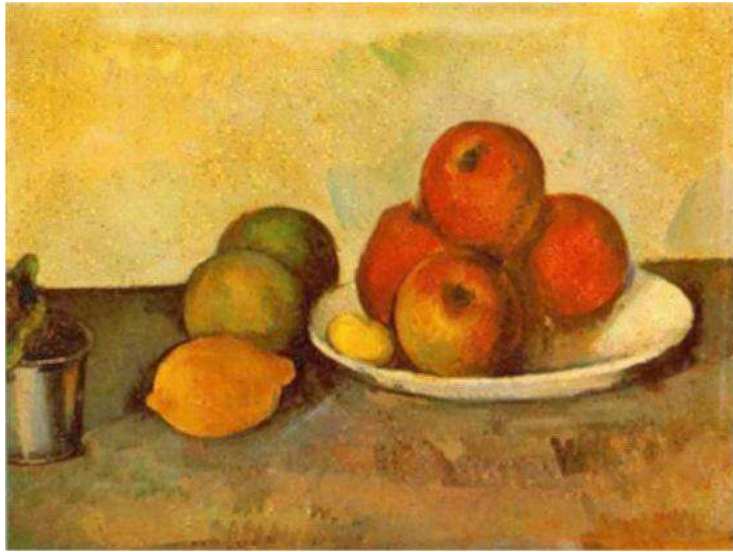
Ridge and Valley Lines



Hatching



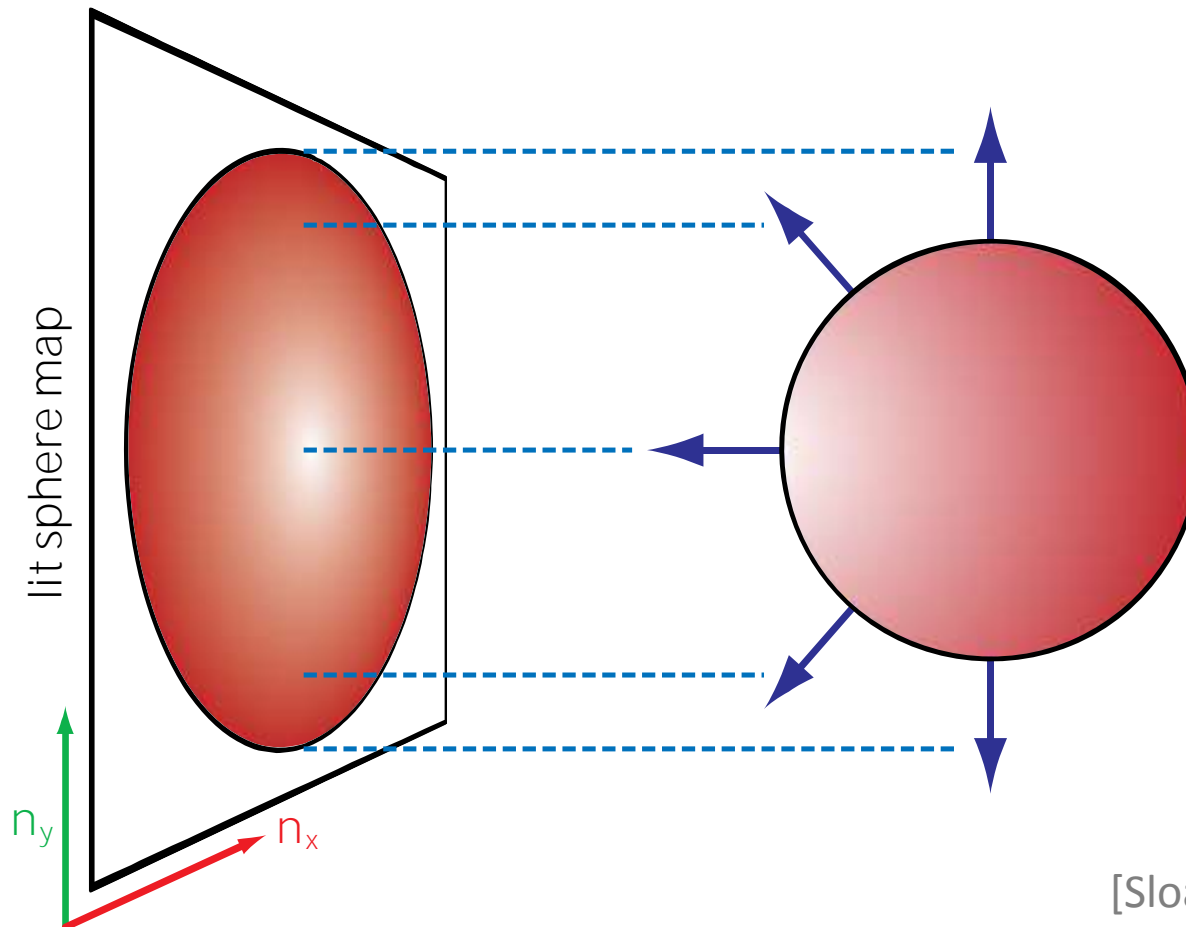
Lit Sphere Style Transfer



[Sloan et al. 2001]

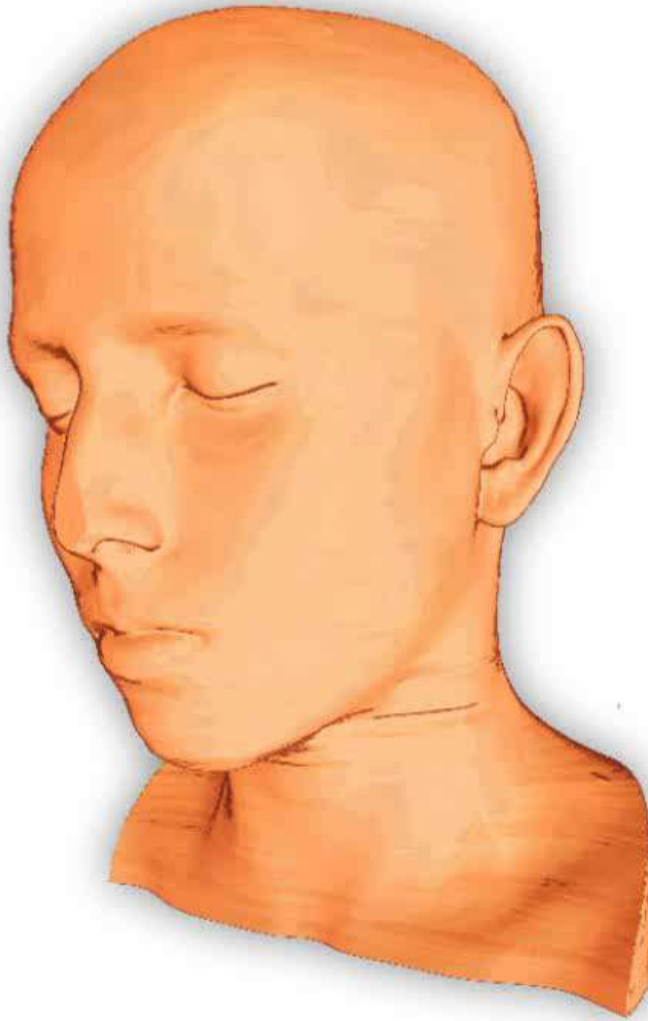
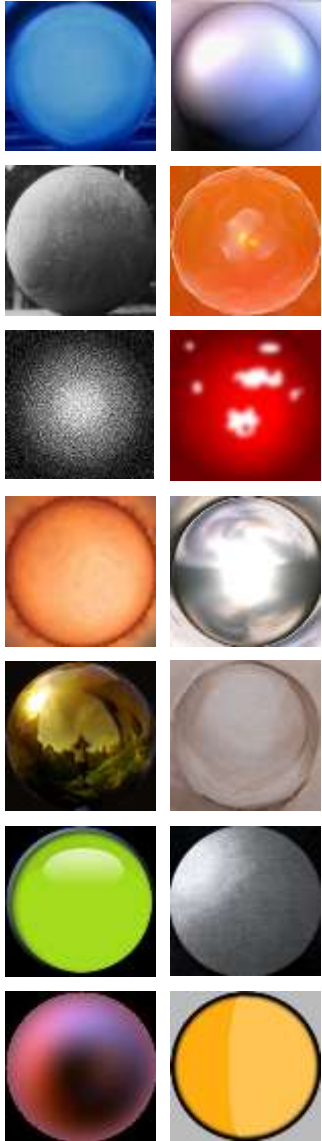
Lit Sphere Concept

- Use a sphere map indexed by the eye-space normal to determine the color of a point

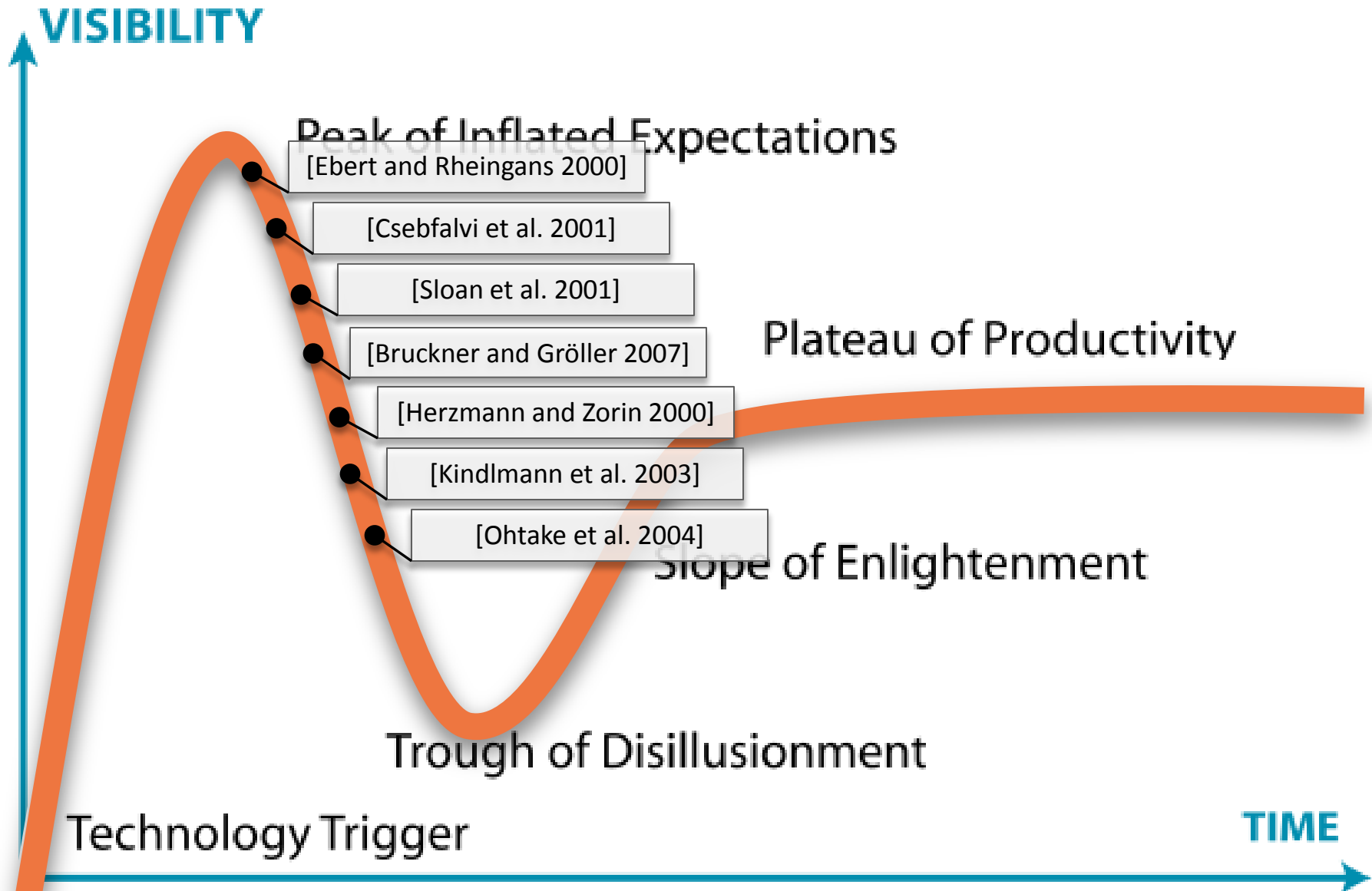


[Sloan et al. 2001]

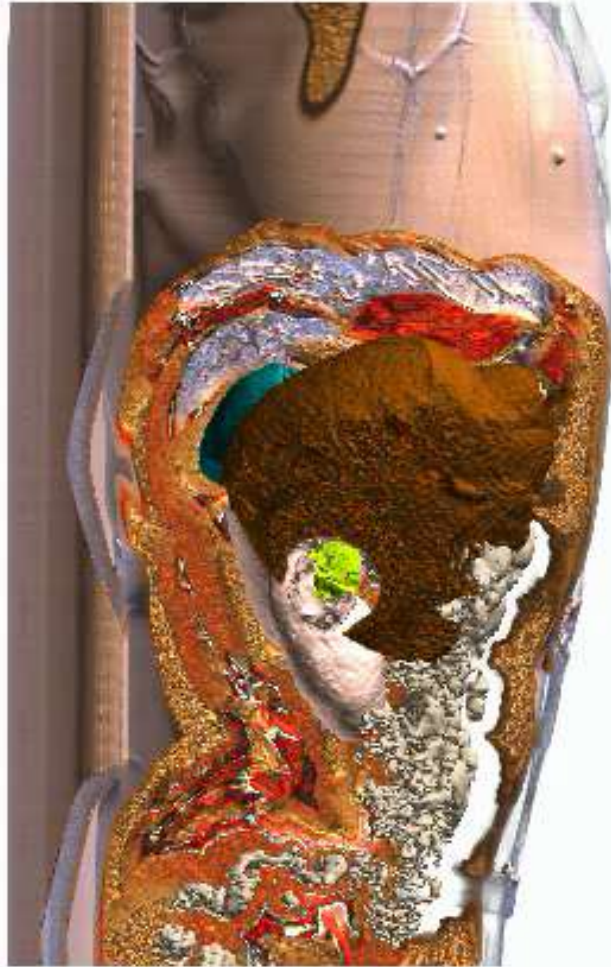
Style Transfer Functions



Hype Cycle for Illustrative Visualization



Cut-Away Views



Exploded Views



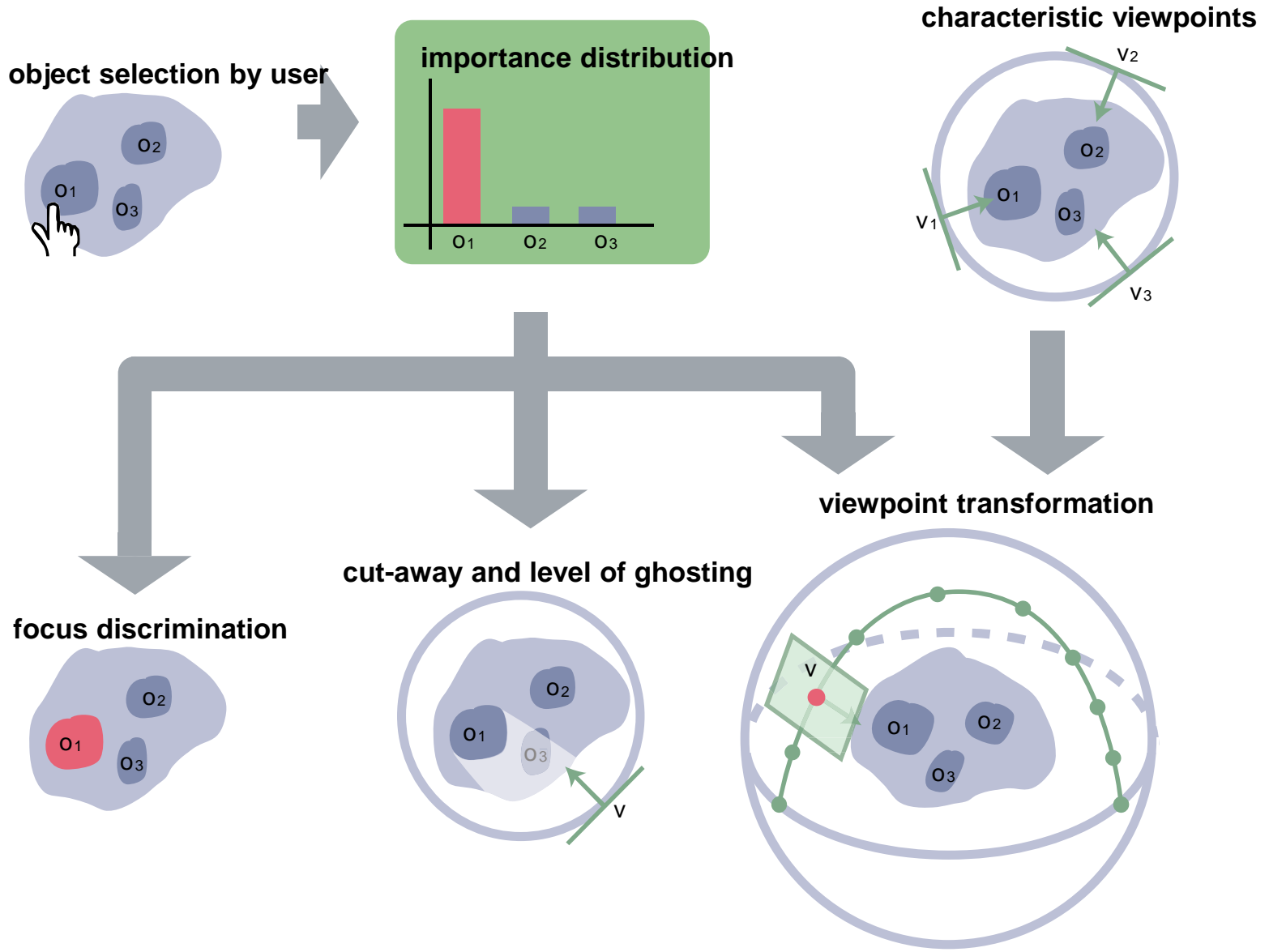
Visual Guidance in Data

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

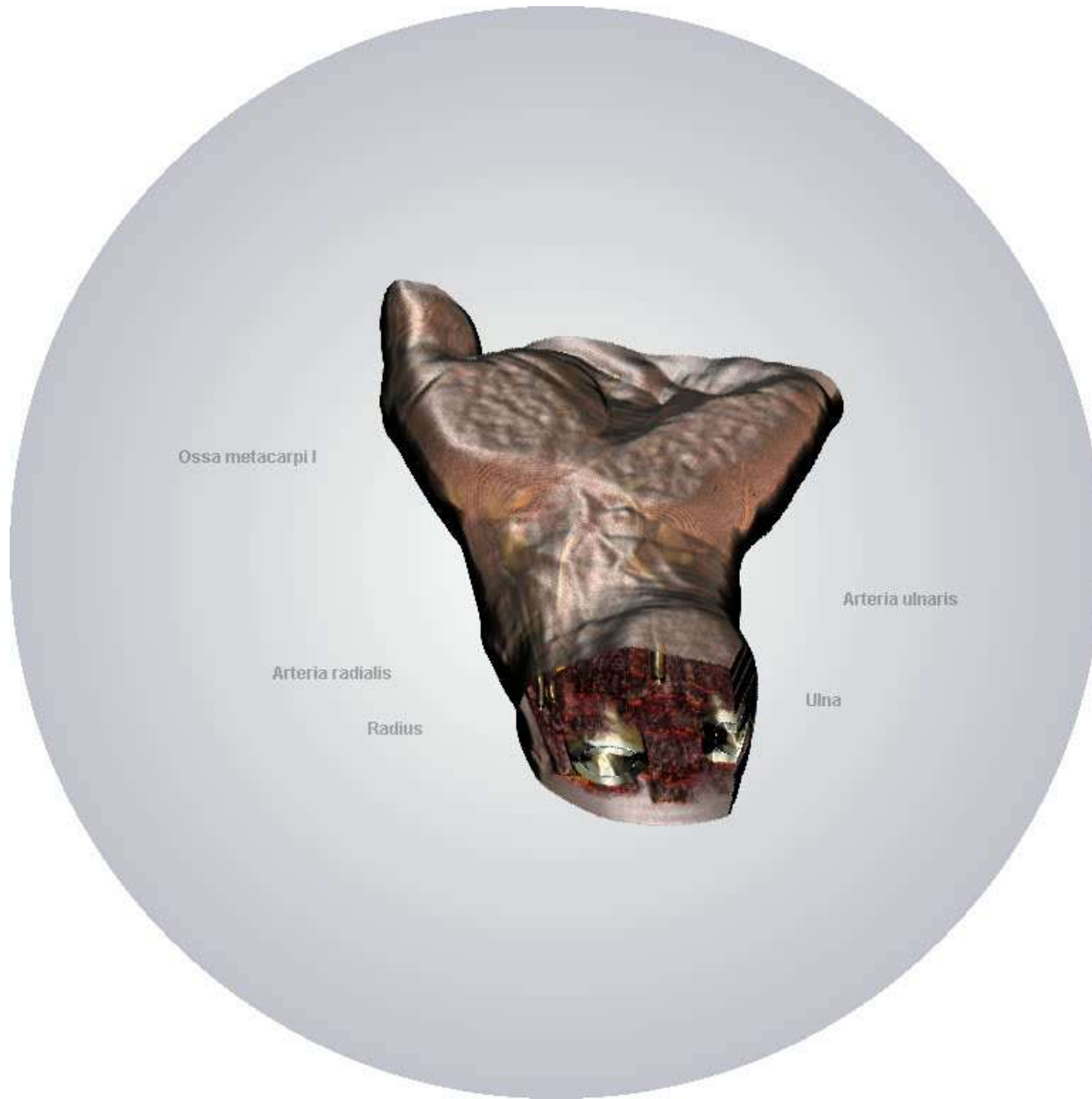


[Viola et al. 2006]

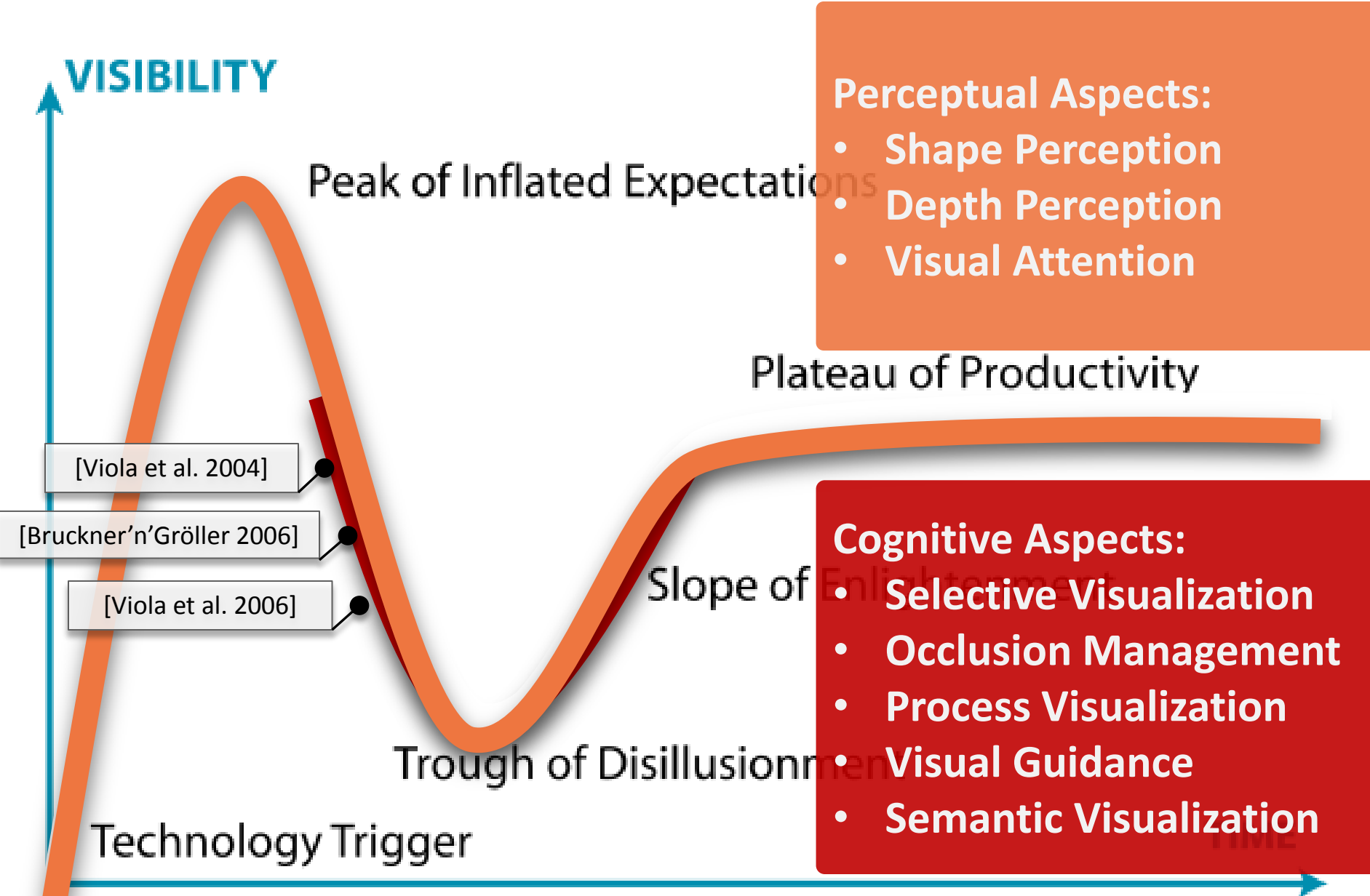
Guidance Elements

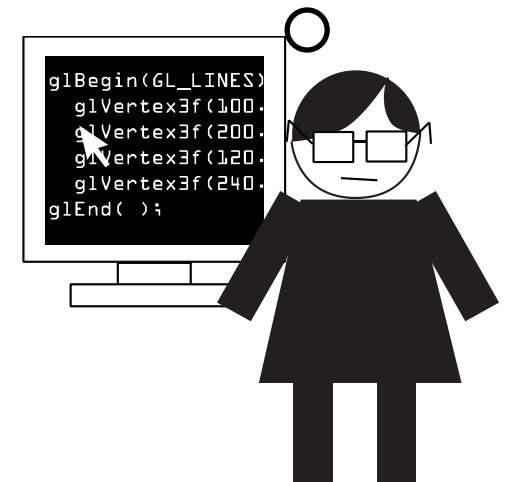
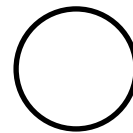
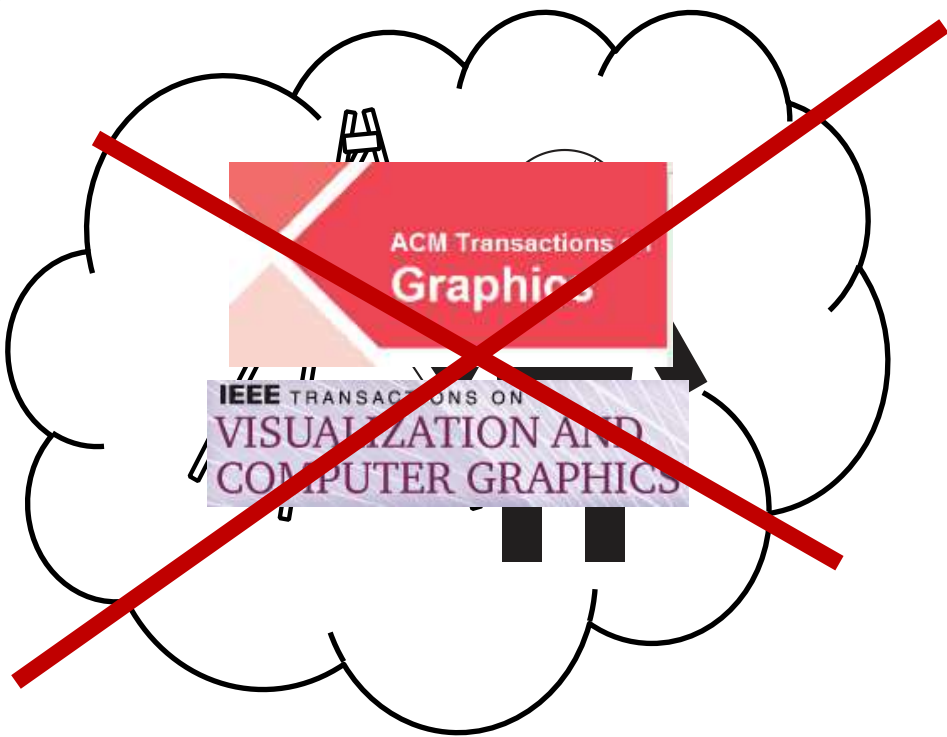


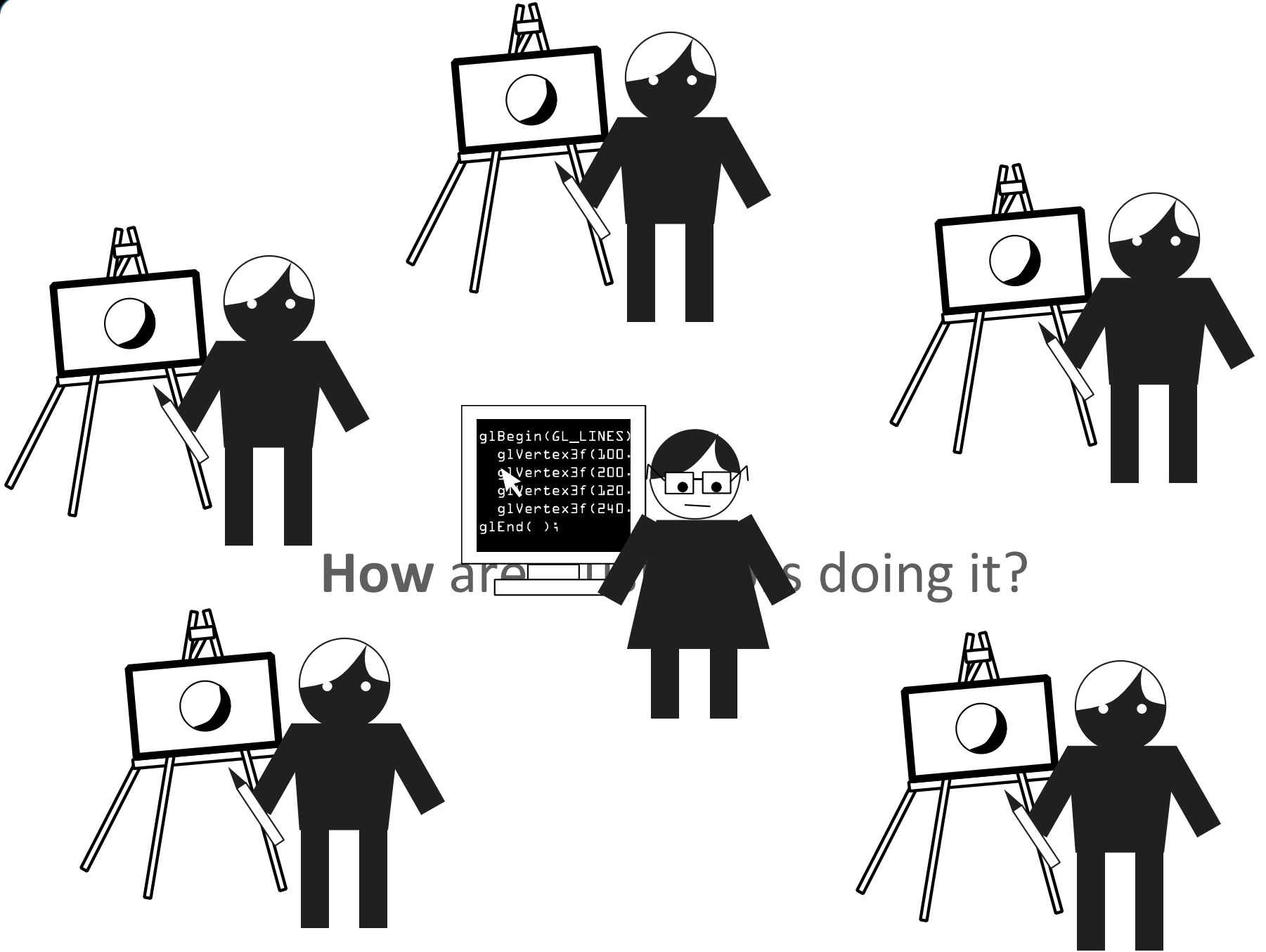
Visual Guidance over Human Hand



Hype Cycle for Illustrative Visualization

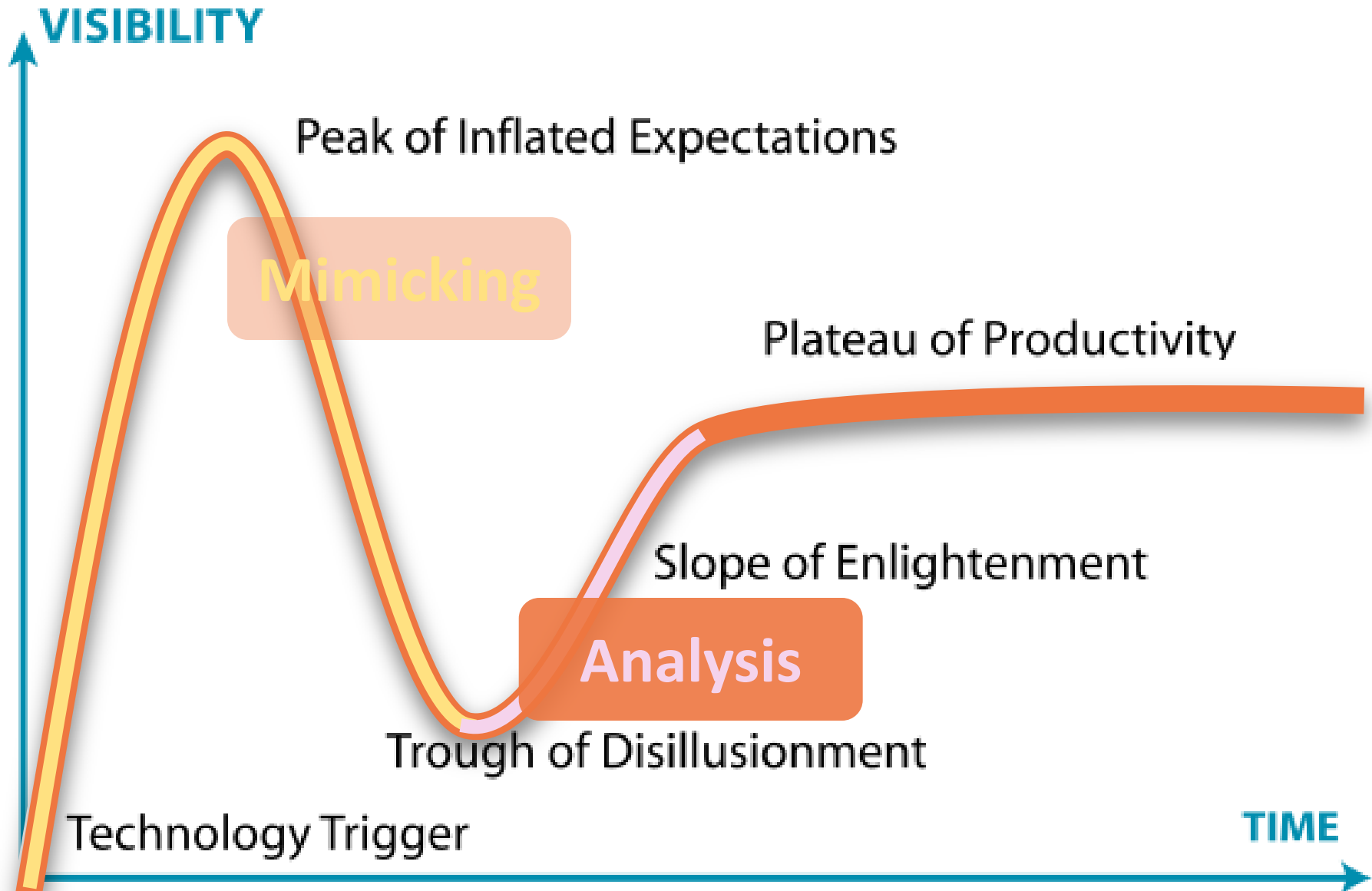






How are students doing it?

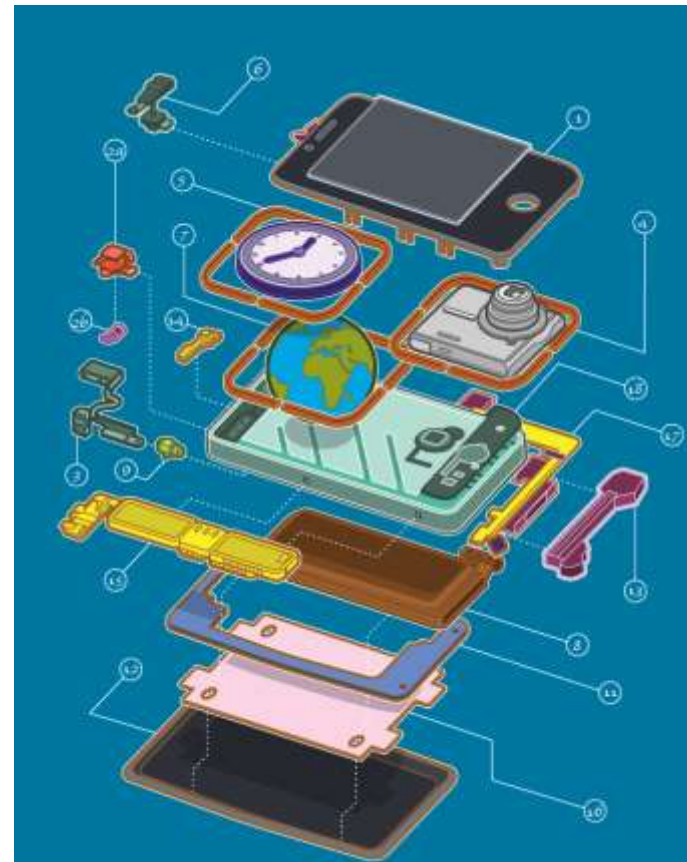
Hype Cycle of Illustrative Visualization



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



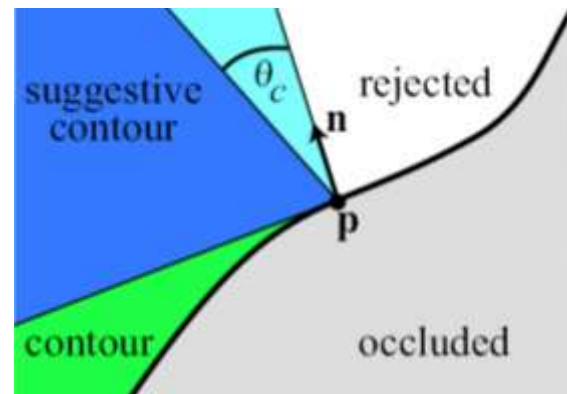
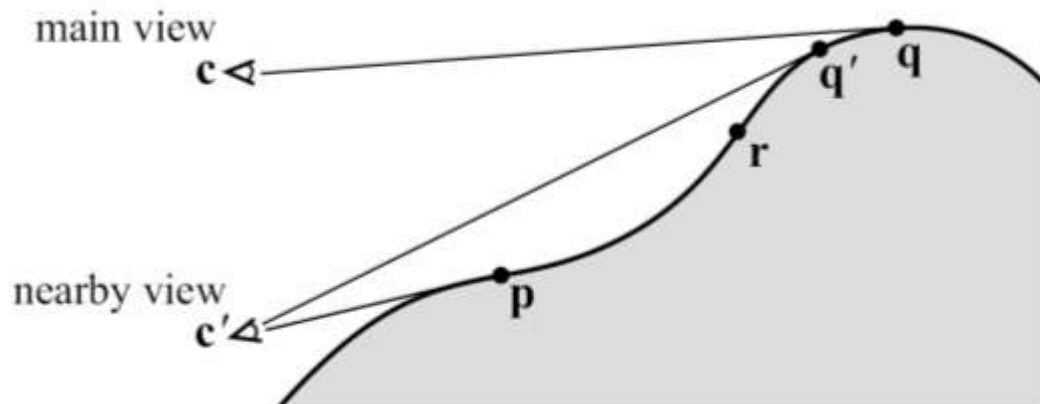
silhouette



contours

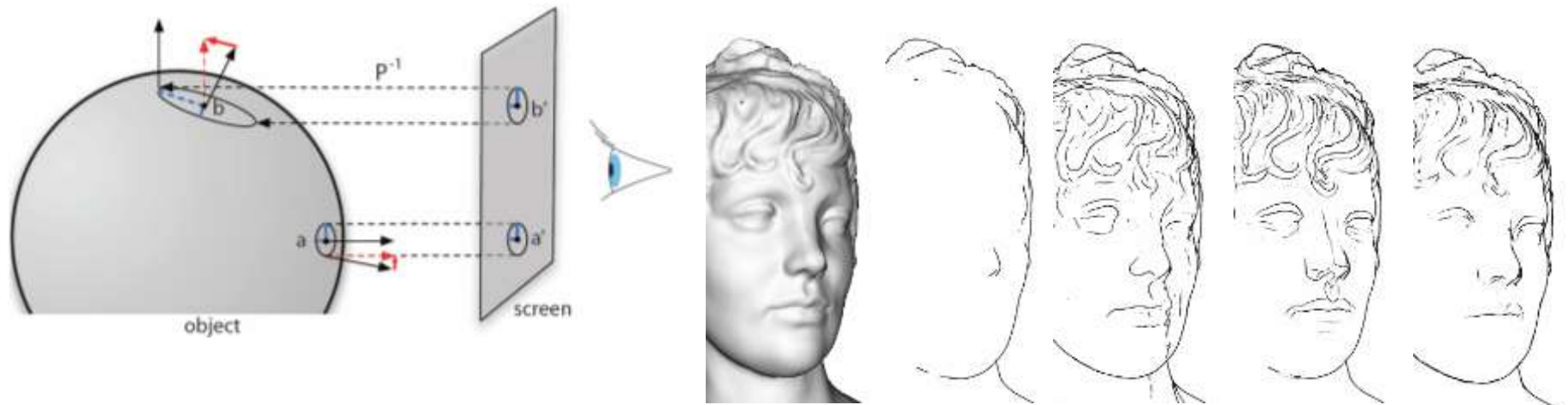


contours and suggestive contours

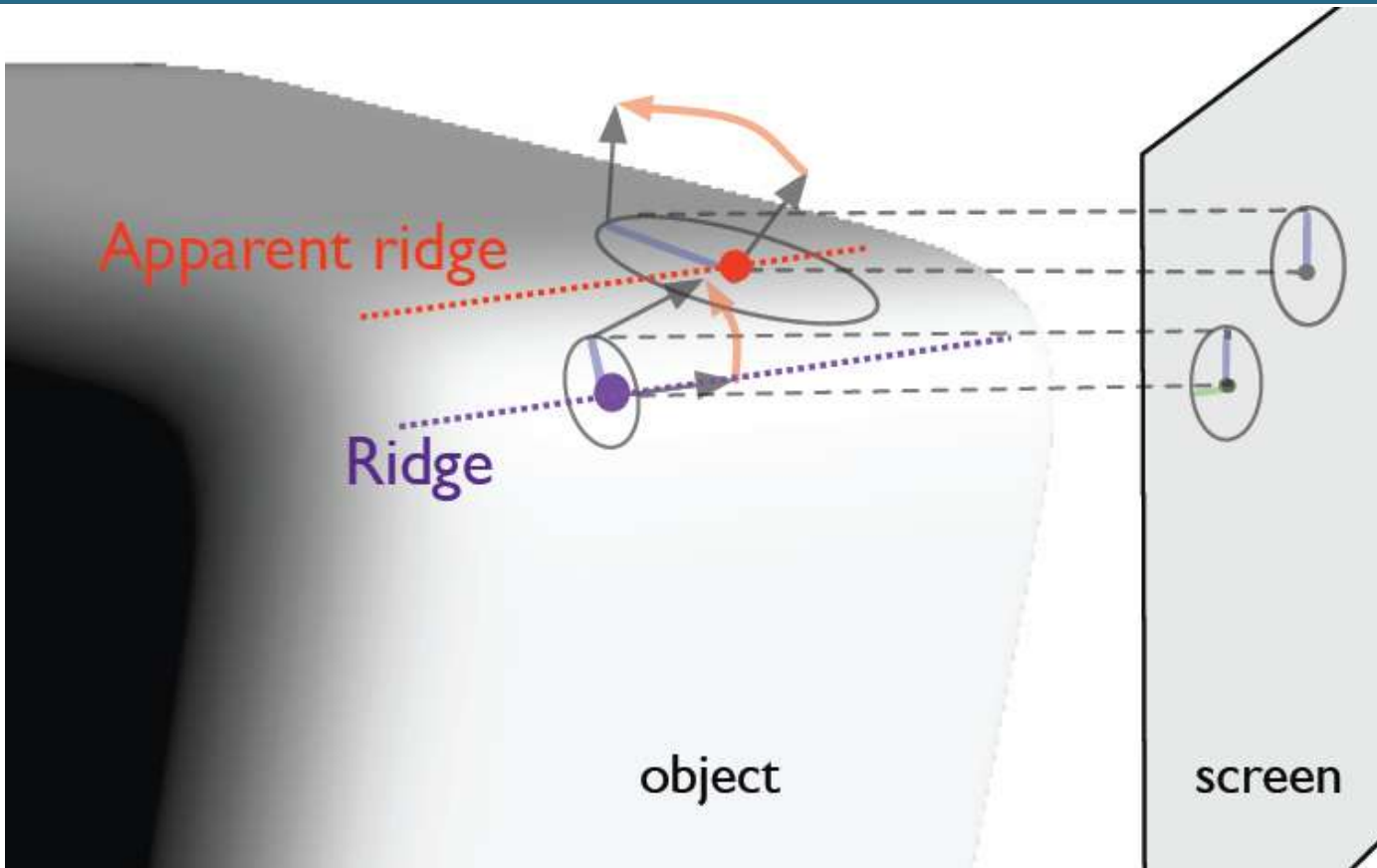


Apparent Ridges

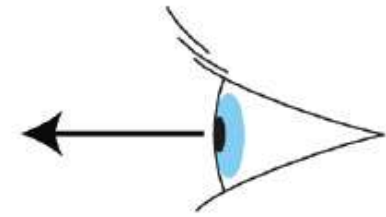
- Draw lines at rapid variation of normal with respect to the image position
- Apparent Ridge: loci of points that maximize view dependent curvature



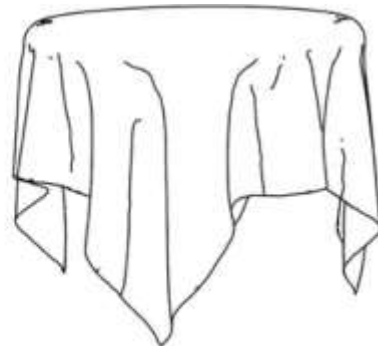
Apparent Ridges vs Ridges



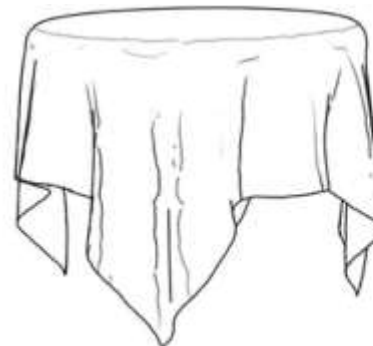
[Judd et al. 2007]



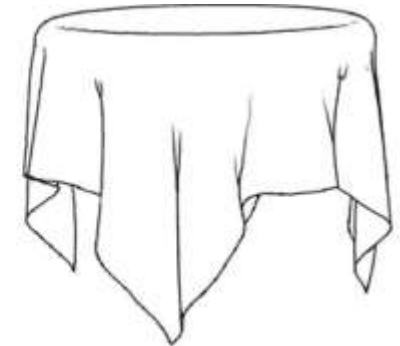
Shaded View



Suggestive Contours

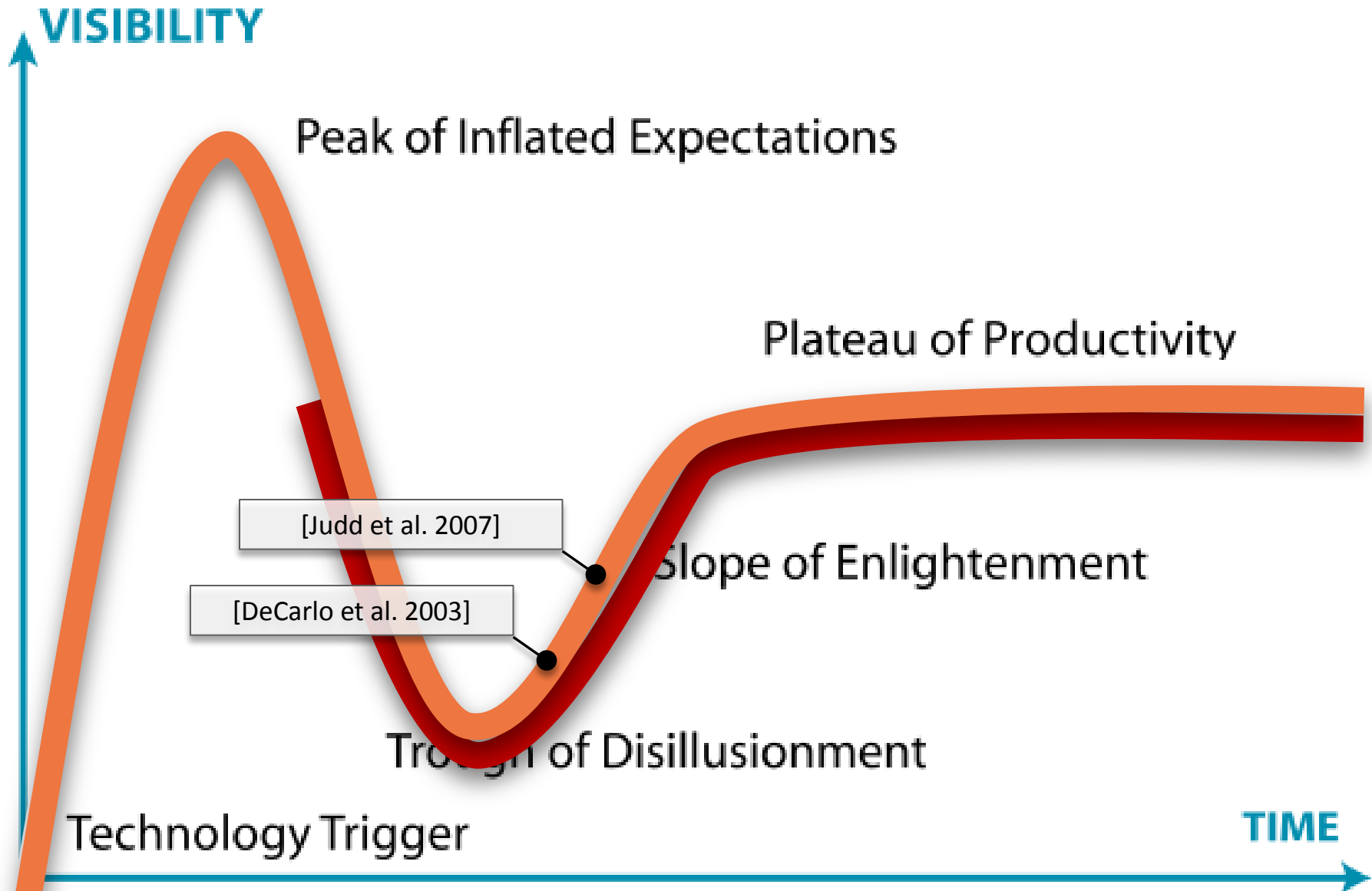


Ridges & Valleys



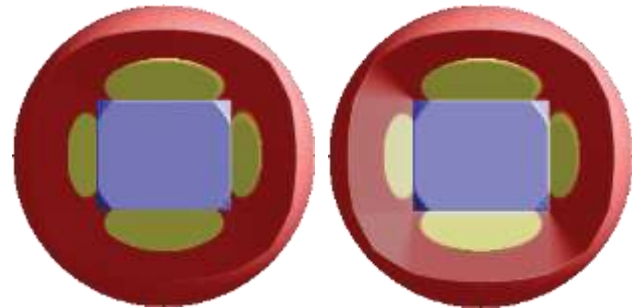
Apparent Ridges

Hype Cycle for Illustrative Visualization



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

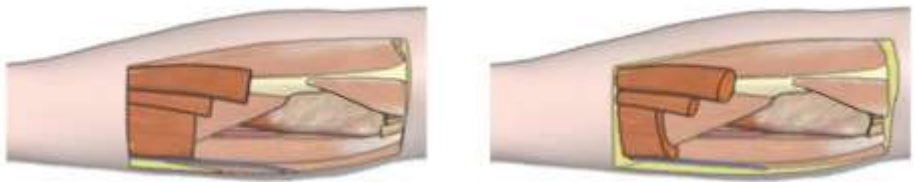
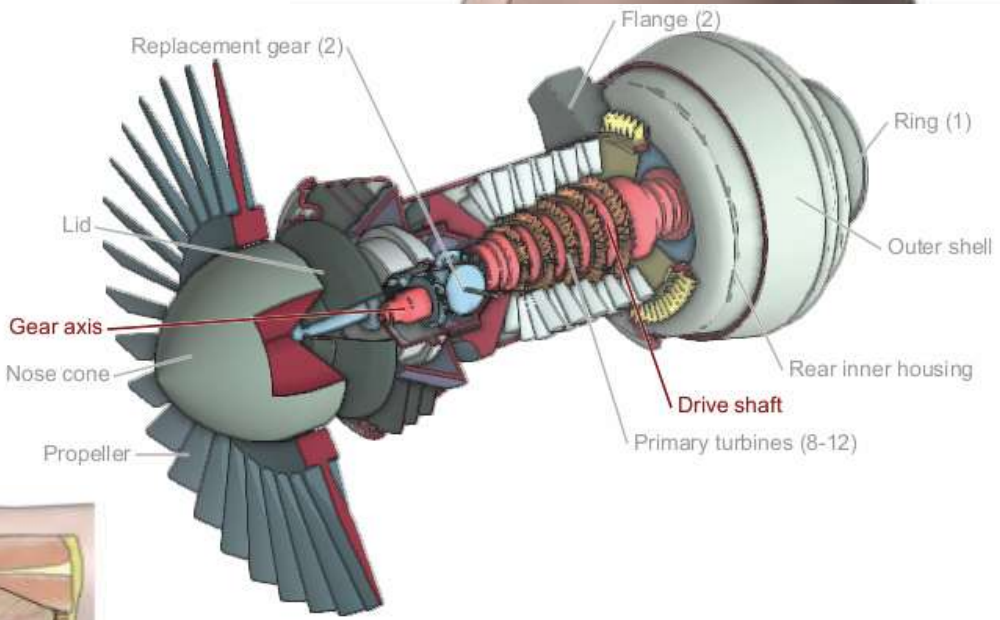
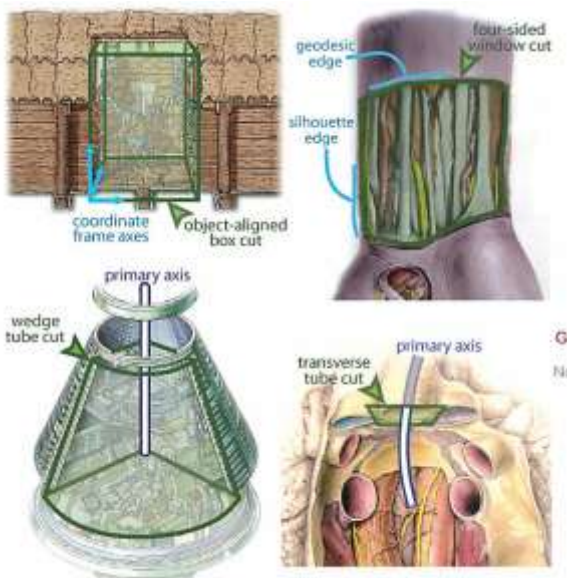
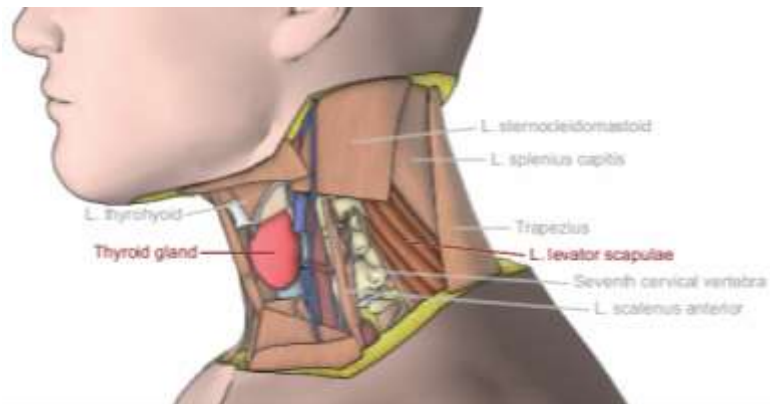


[Diepstraten et al. 2003]

[Thurnher and Pflugfelder 2005]

Occluder-Based Cut-Away Design

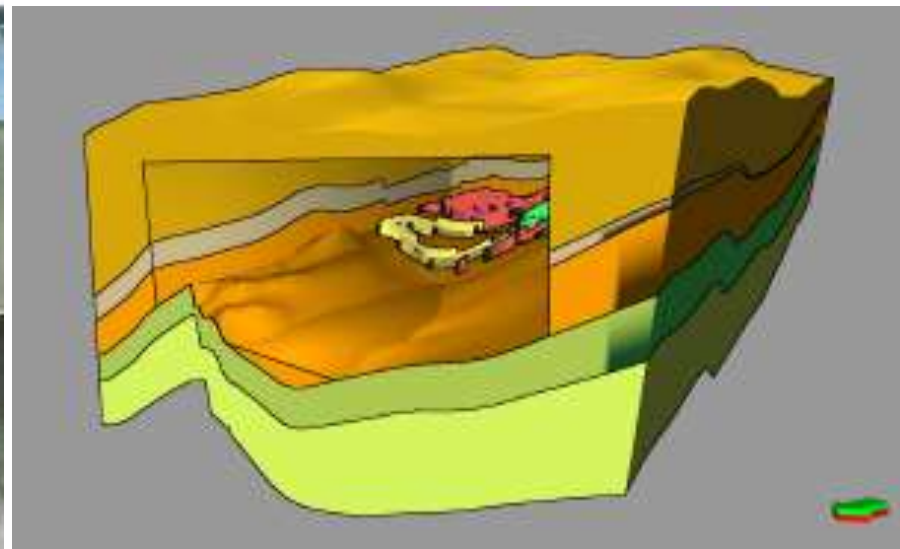
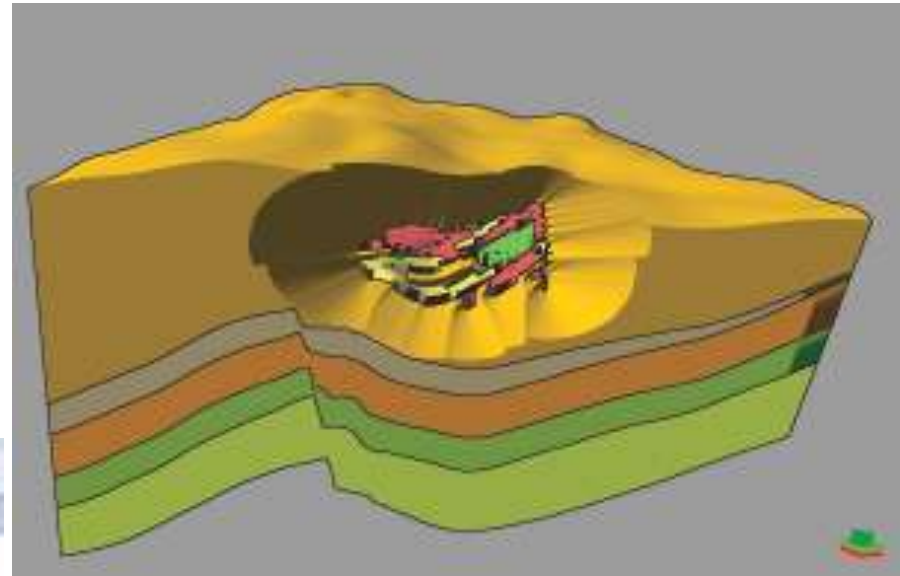
- Consideration of geometrical properties of occluding structures
- Canonical viewpoint selection



[Li et al. 2007]

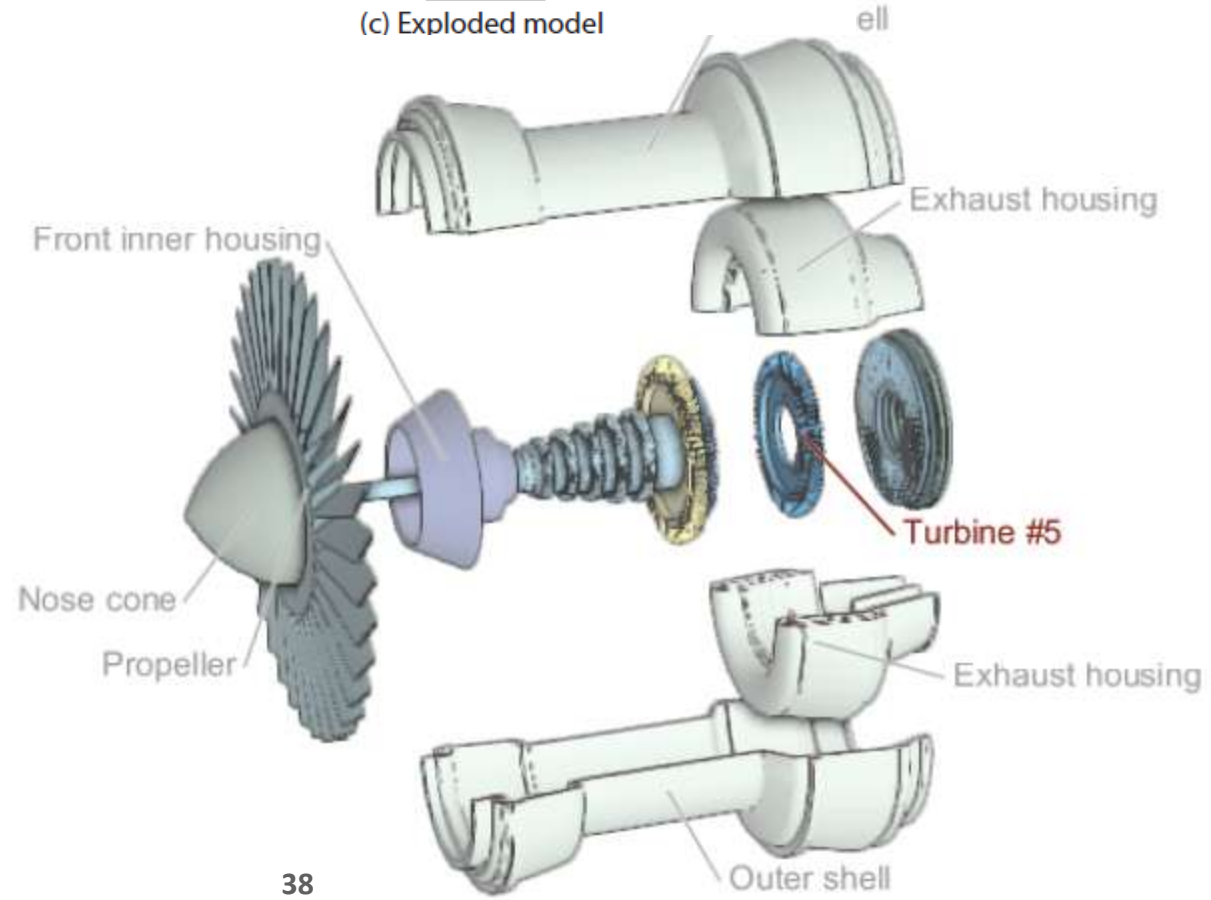
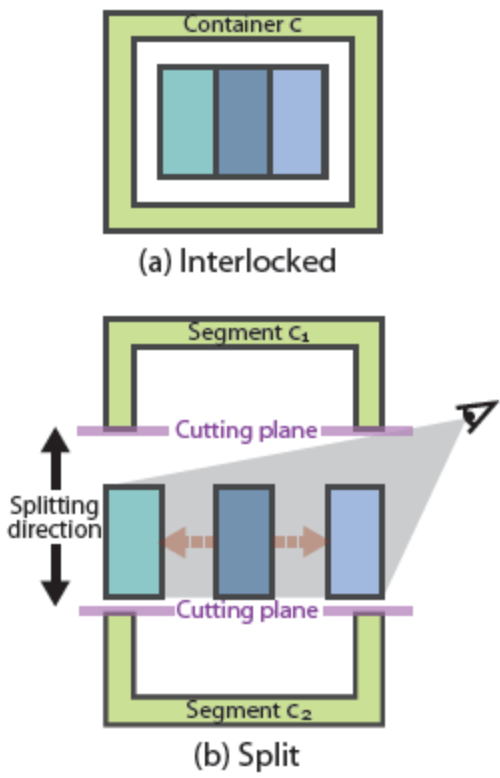
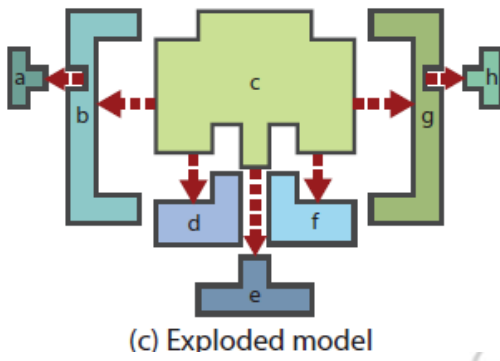
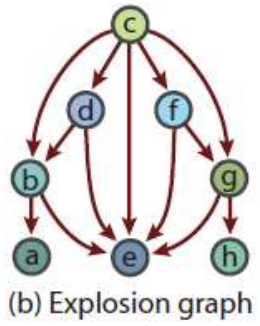
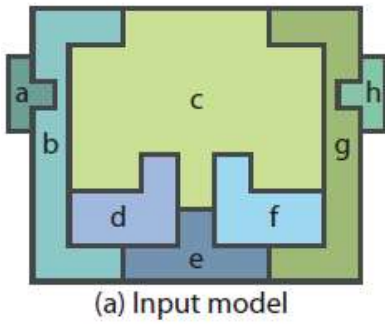
Cut-Away Illustrations for Geology

- Simple cut geometry
- Oblique cuts
- Cut alignment with context



Hierarchical Exploded Views

[Li et al. 2008]



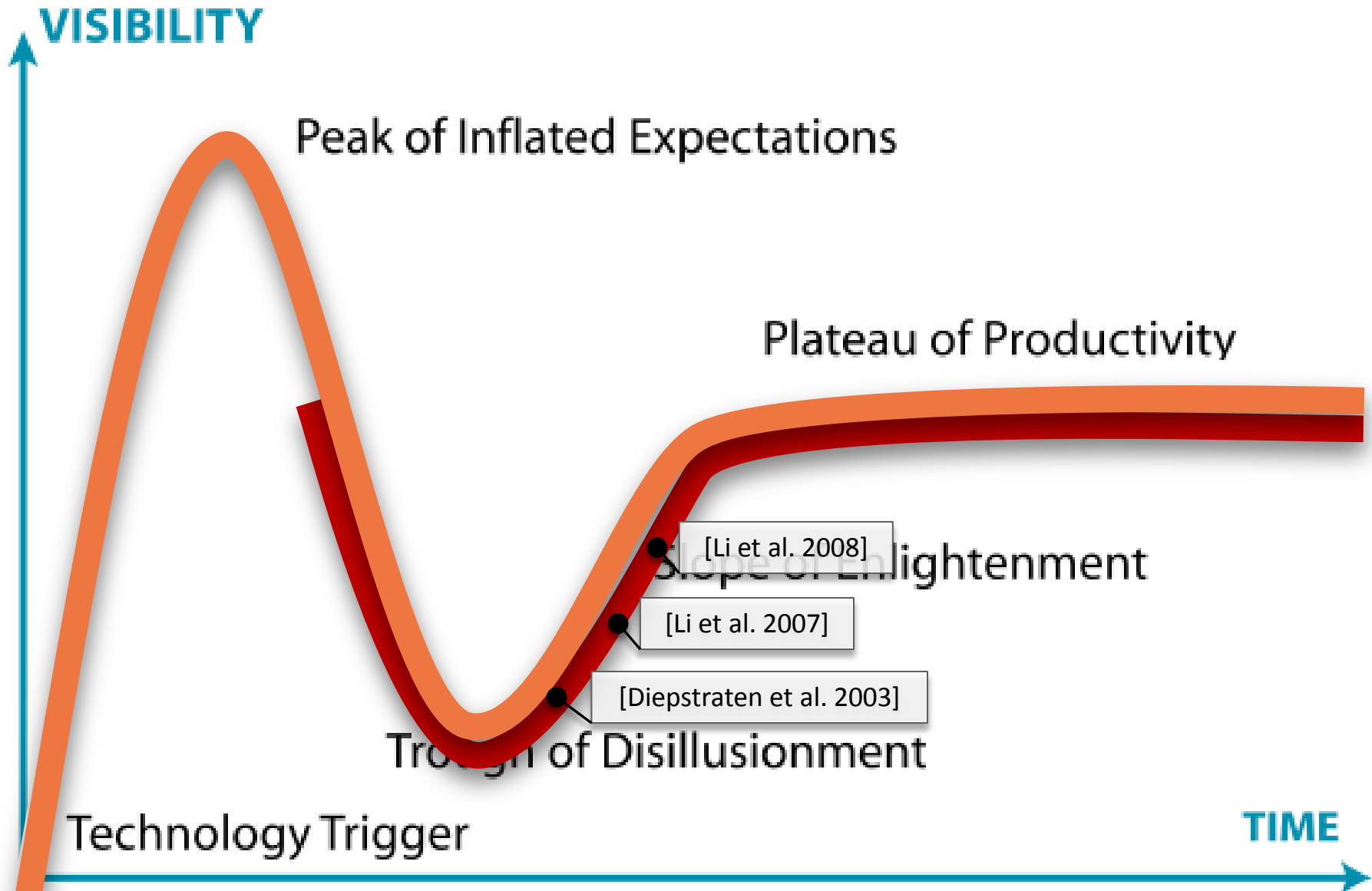
Subway Map Design

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

[Argawala et al. 2011]



Hype Cycle for Illustrative Visualization

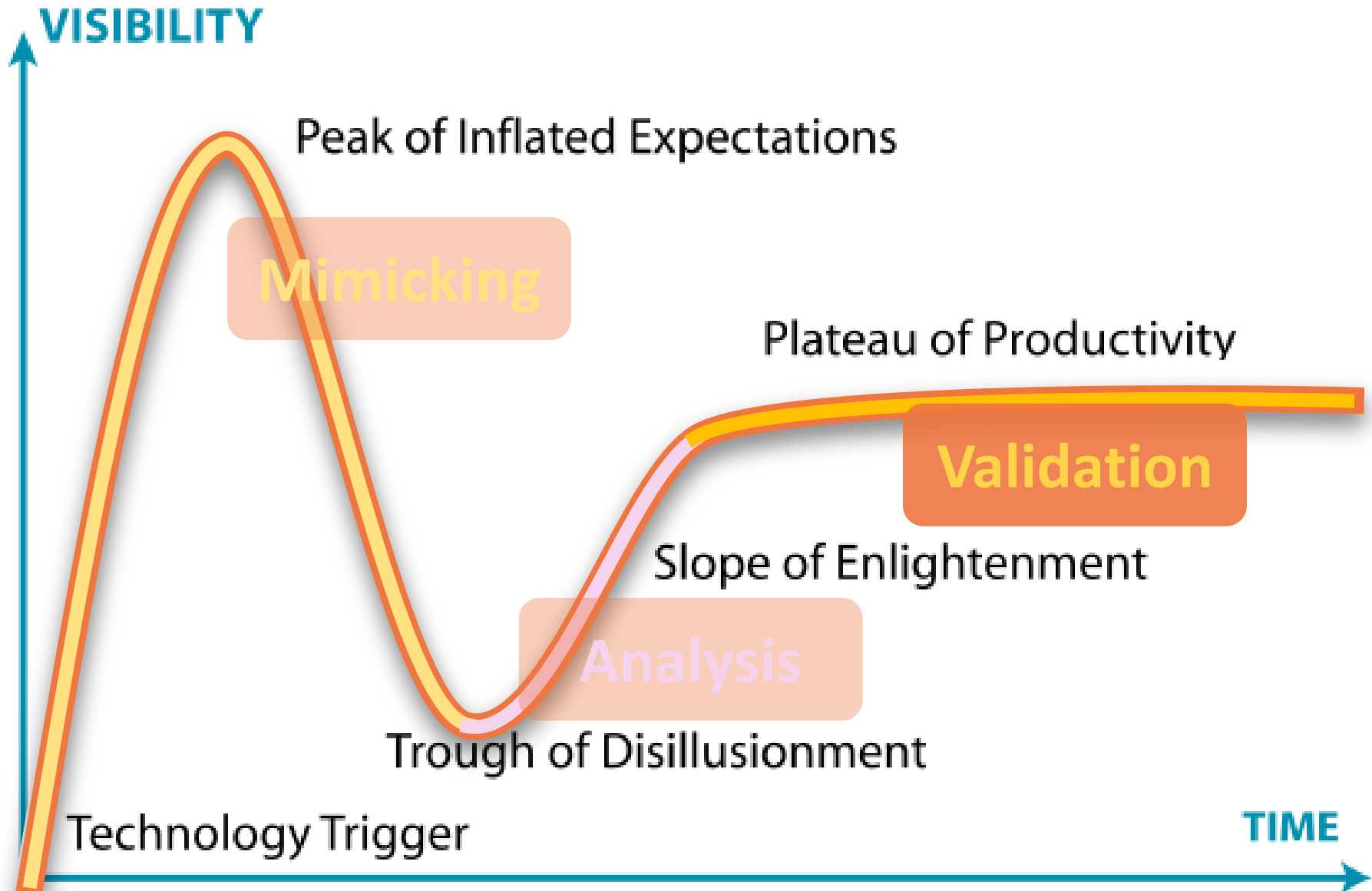


How are illustrators doing it?

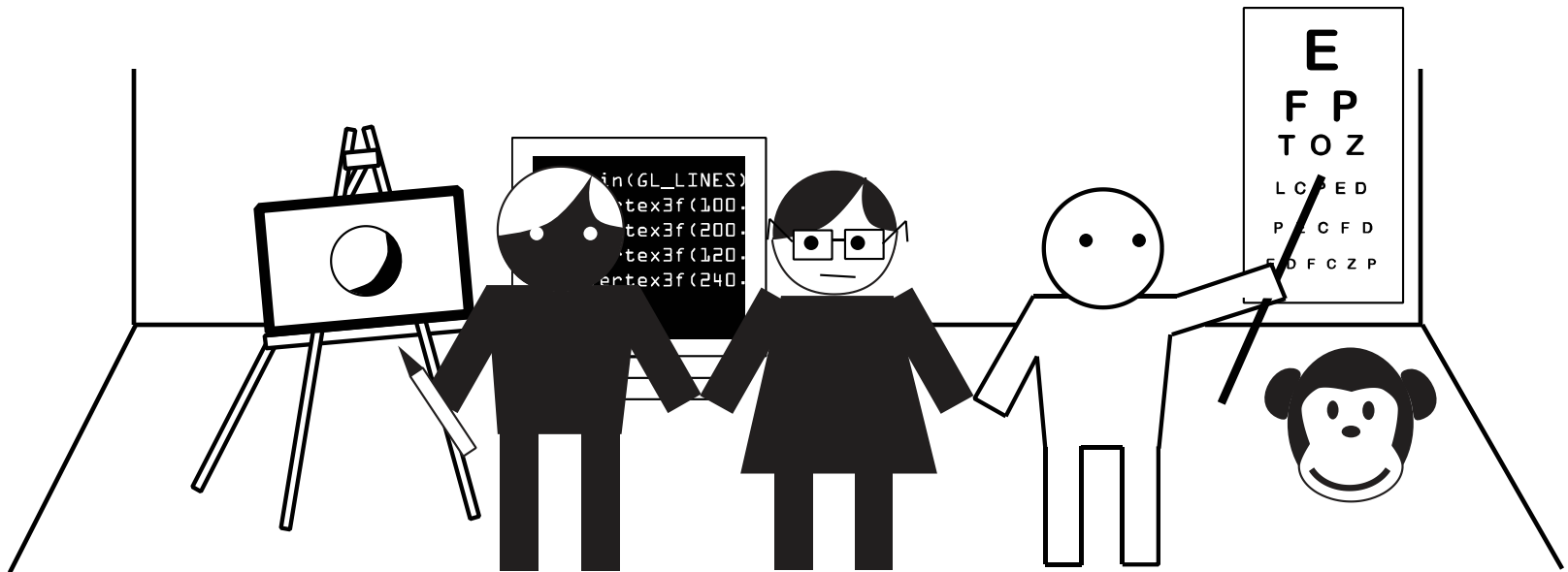
But can we **know** for sure if we do not ask them?

And are they doing the **right** thing?

Hype Cycle of Illustrative Visualization

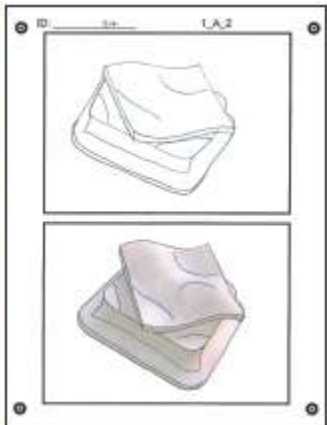
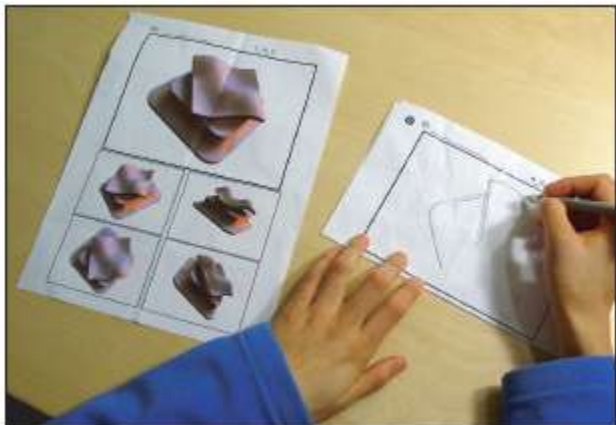


Why are illustrators doing it this way?

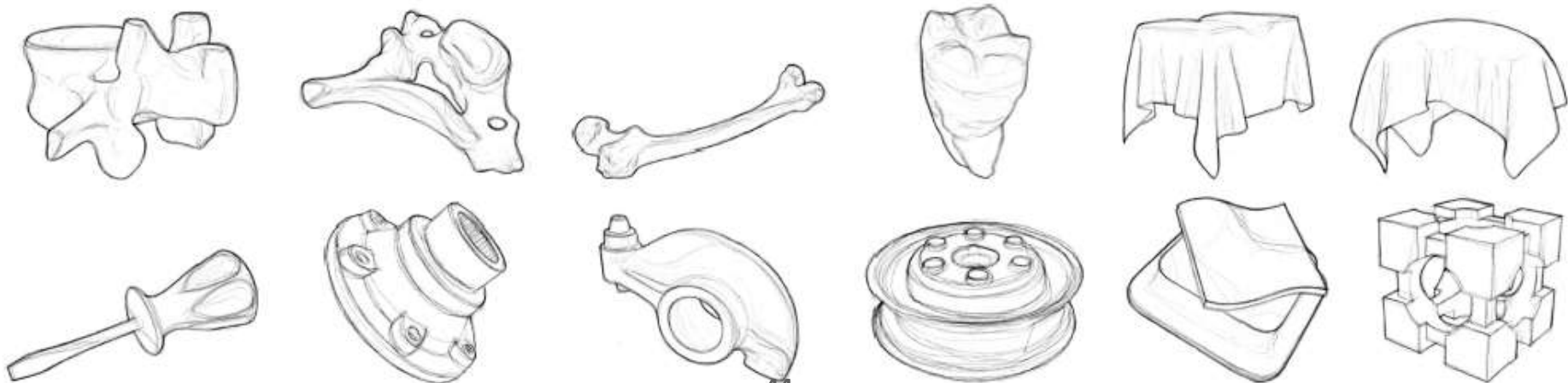
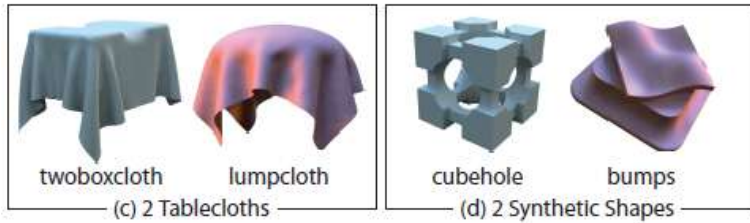
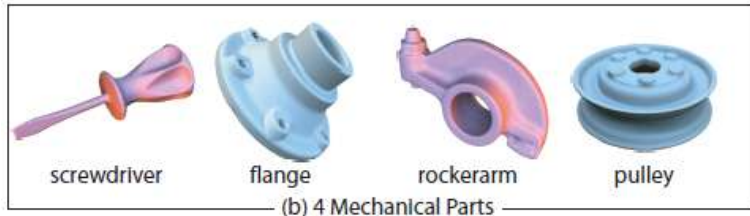
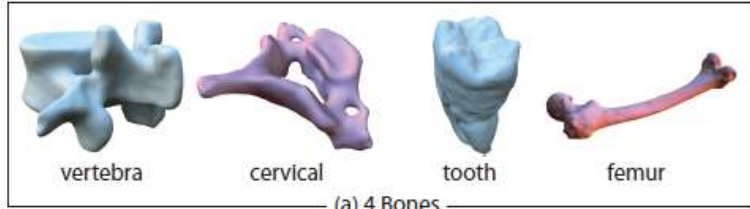


Line Drawing: Illustrators vs. Silicon

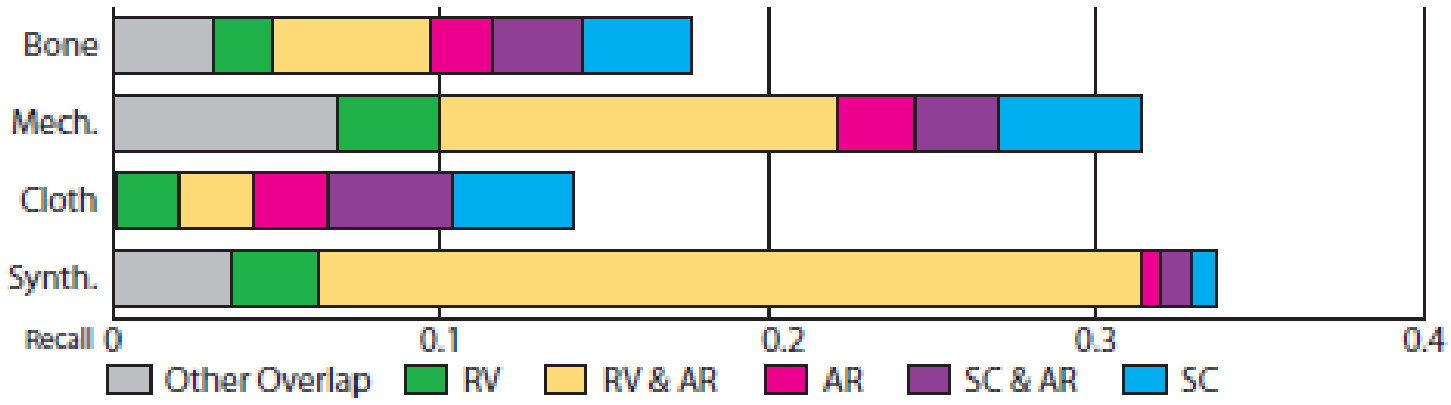
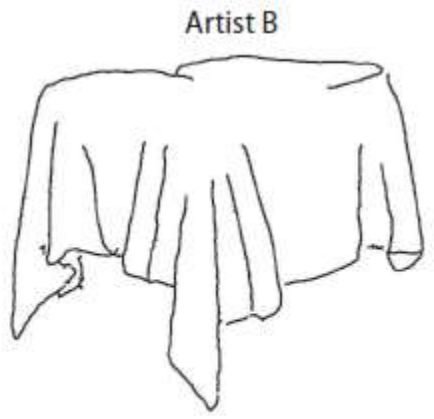
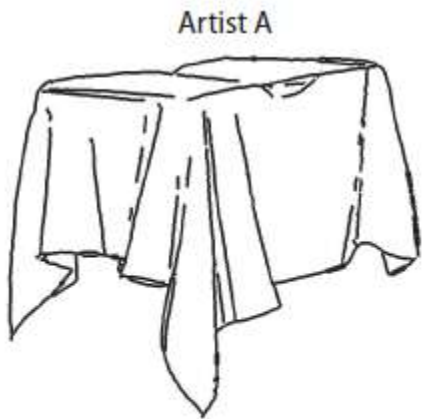
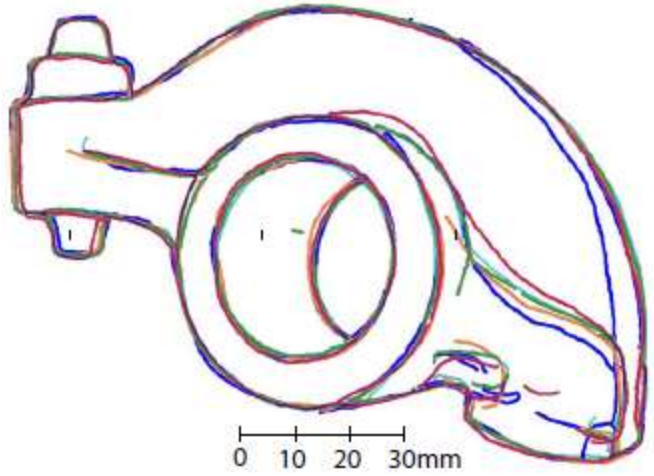
About 20 artists were asked to draw objects based on shaded rendering



[Cole et al. 2008]



Line Drawing: Illustrators vs. Silicon



Line Drawing: Illustrators vs. Silicon

■ Canny edge detector - the best match with illustrator lines!

	Feature	Bone	Cloth	Mech	Synth	Avg
Image Space	ImgGradMag	31.3	36.0	73.8	147.8	72.2
	ImgMaxCurv	38.0	15.8	55.5	64.4	43.4
	ImgMinCurv	15.1	15.3	23.4	56.6	27.6
	ImgLuminance	20.2	19.8	33.9	33.6	26.9
View Dependent	$N \cdot V$	23.6	13.9	31.3	36.9	26.4
	ViewDepCurv	21.5	17.2	49.8	10.1	24.7
	ViewDepCurvDeriv	22.8	14.4	31.9	9.5	19.7
	RadialCurvDeriv	19.2	15.0	29.8	8.0	18.0
	RadialTorsion	14.6	10.3	27.8	7.2	15.0
	RadialCurv	14.8	10.3	26.2	7.2	14.6
View Independent	SurfMaxCurvDeriv	16.9	11.0	27.3	8.9	16.0
	SurfMaxCurv	13.9	8.8	25.1	7.6	13.9
	SurfMinCurv	13.9	8.1	27.0	5.1	13.5
	SurfMeanCurv	14.1	8.9	22.5	7.0	13.1
	SurfGaussianCurv	13.1	8.5	25.7	4.9	13.1
	Feature	Bone	Cloth	Mech	Synth	Avg
	Canny edges	18.2	37.2	50.9	145.0	53.4
	Apparent Ridges	8.7	11.2	21.2	77.9	24.8
	Ridges & valleys	6.8	7.4	24.4	77.1	24.5
	Suggestive Contours	9.8	11.9	17.4	1.6	11.3

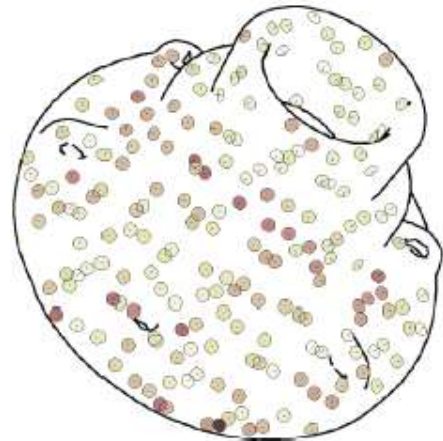
Line Drawings Effectiveness in Conveying Shape



(a) shaded image



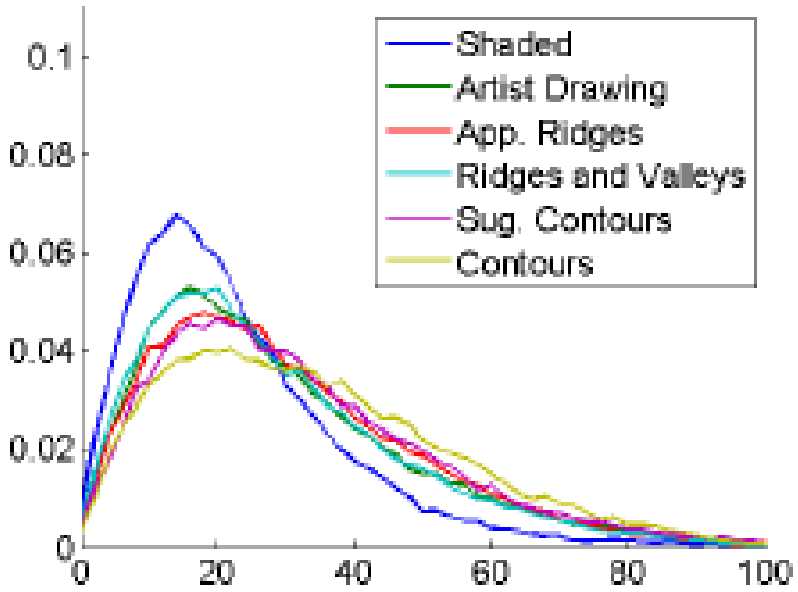
(b) human drawing



(c) contours

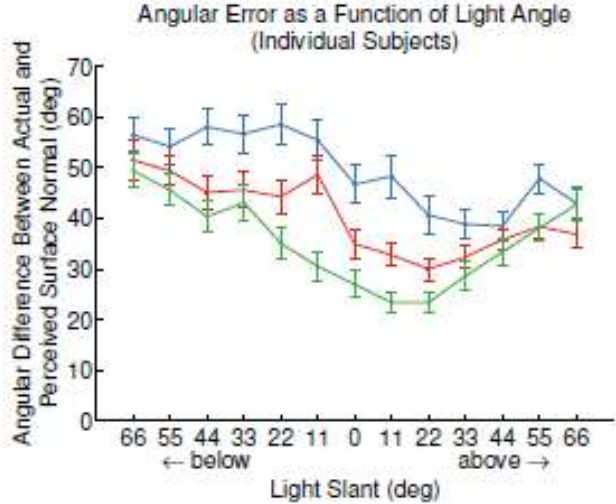
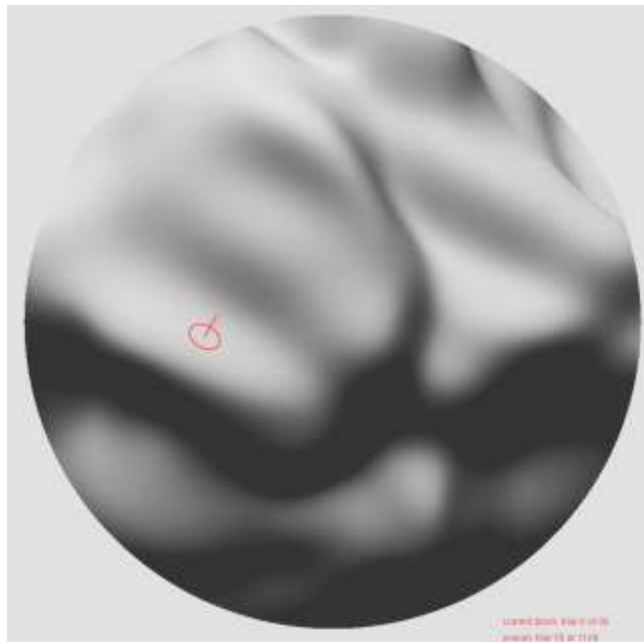
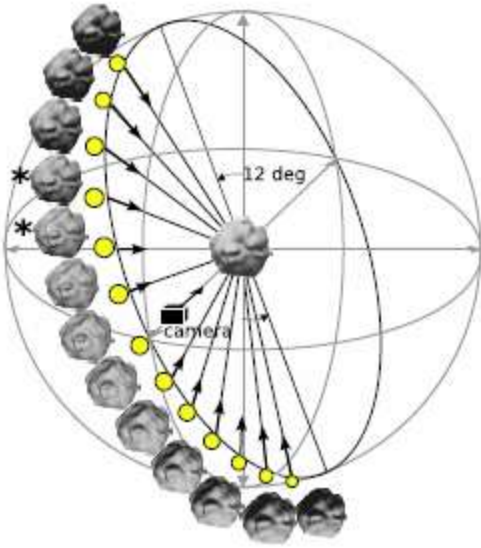


(d) apparent ridges

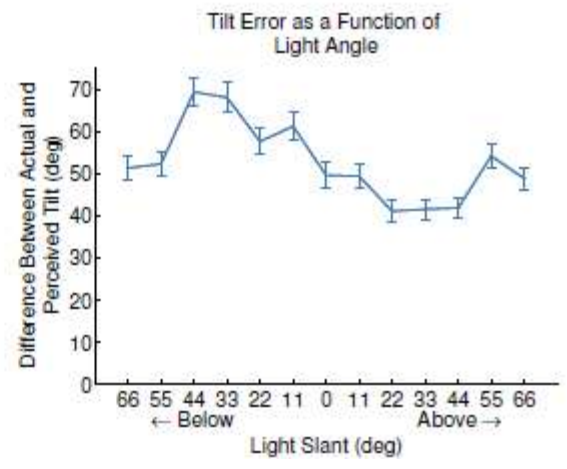
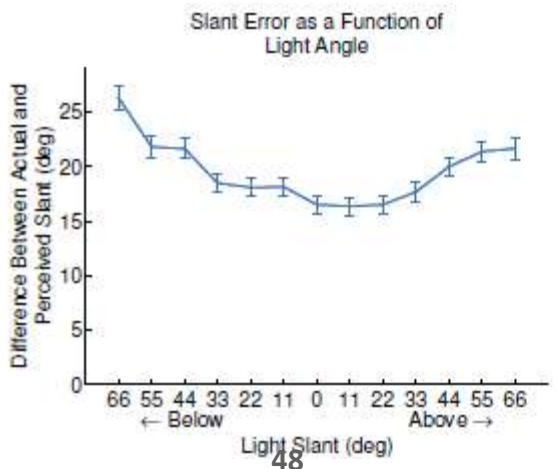
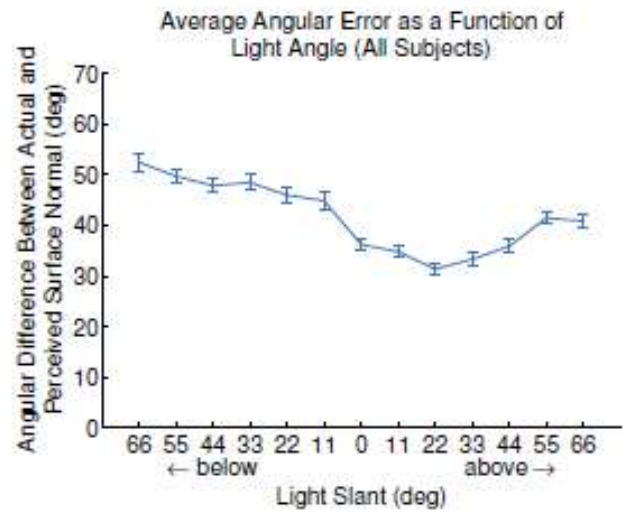


Model	S	H	AR	RV	SC	C
cubehole	12	18	-	14	-	26
rockerarm	15	21	19	21	23	26
screwdriver	20	25	31	29	27	34
flange	21	26	25	22	32	32
pulley	21	29	27	29	29	30
bumps	22	29	27	27	36	36
femur	22	28	25	25	26	25
tooth	22	32	30	28	29	32
twoboxcloth	23	25	25	26	26	32
vertebra	24	38	42	35	37	42
cervical	25	37	35	35	37	38
lumpcloth	26	27	28	29	28	27
average	21	28	29	27	30	32

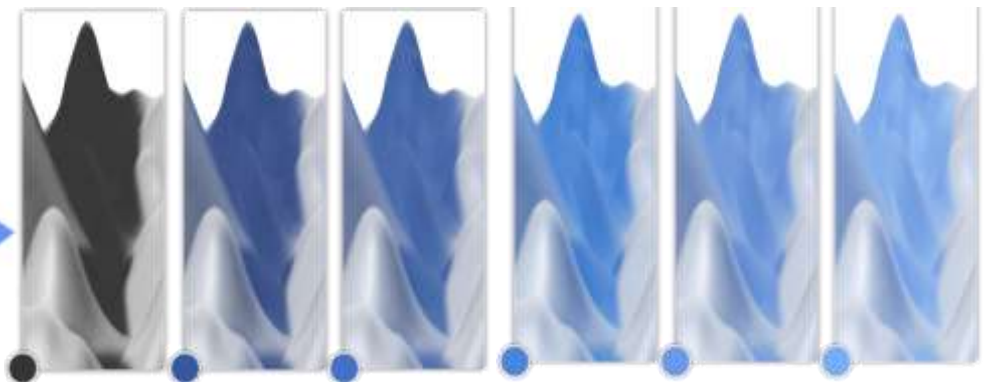
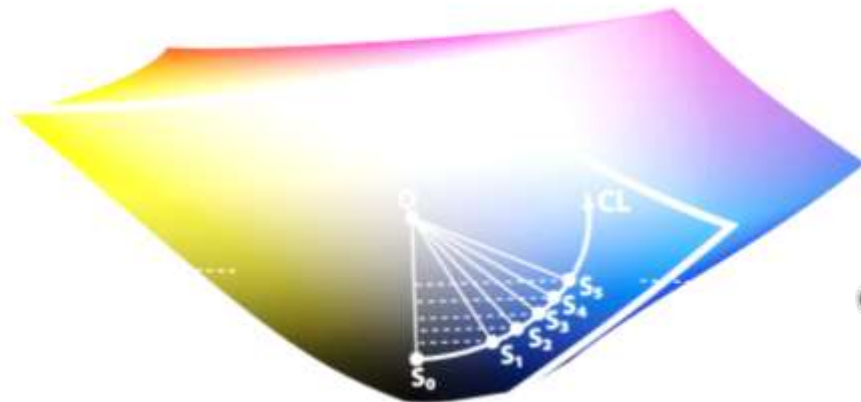
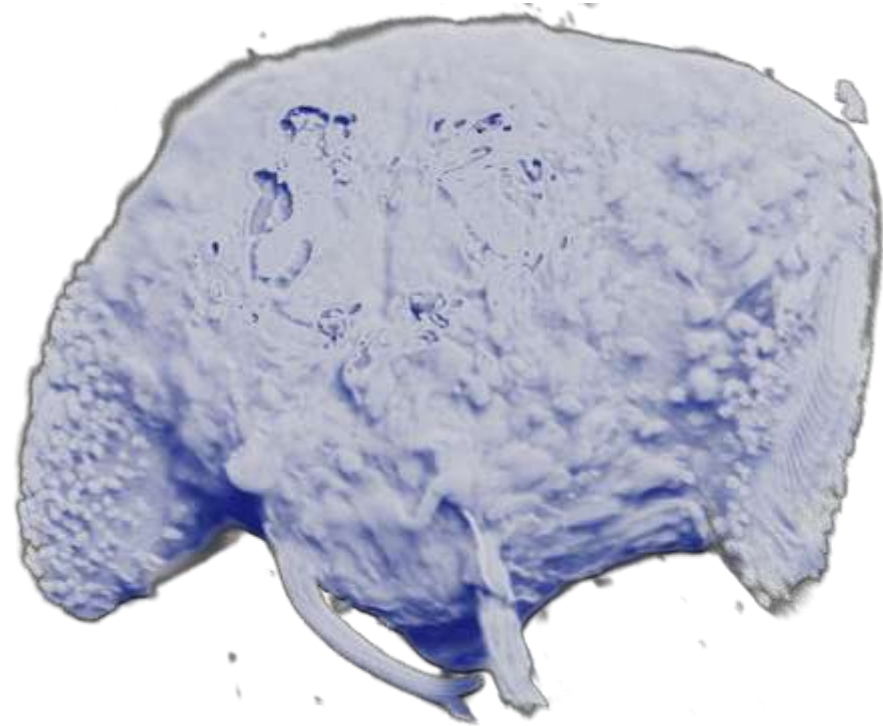
Light Positioning



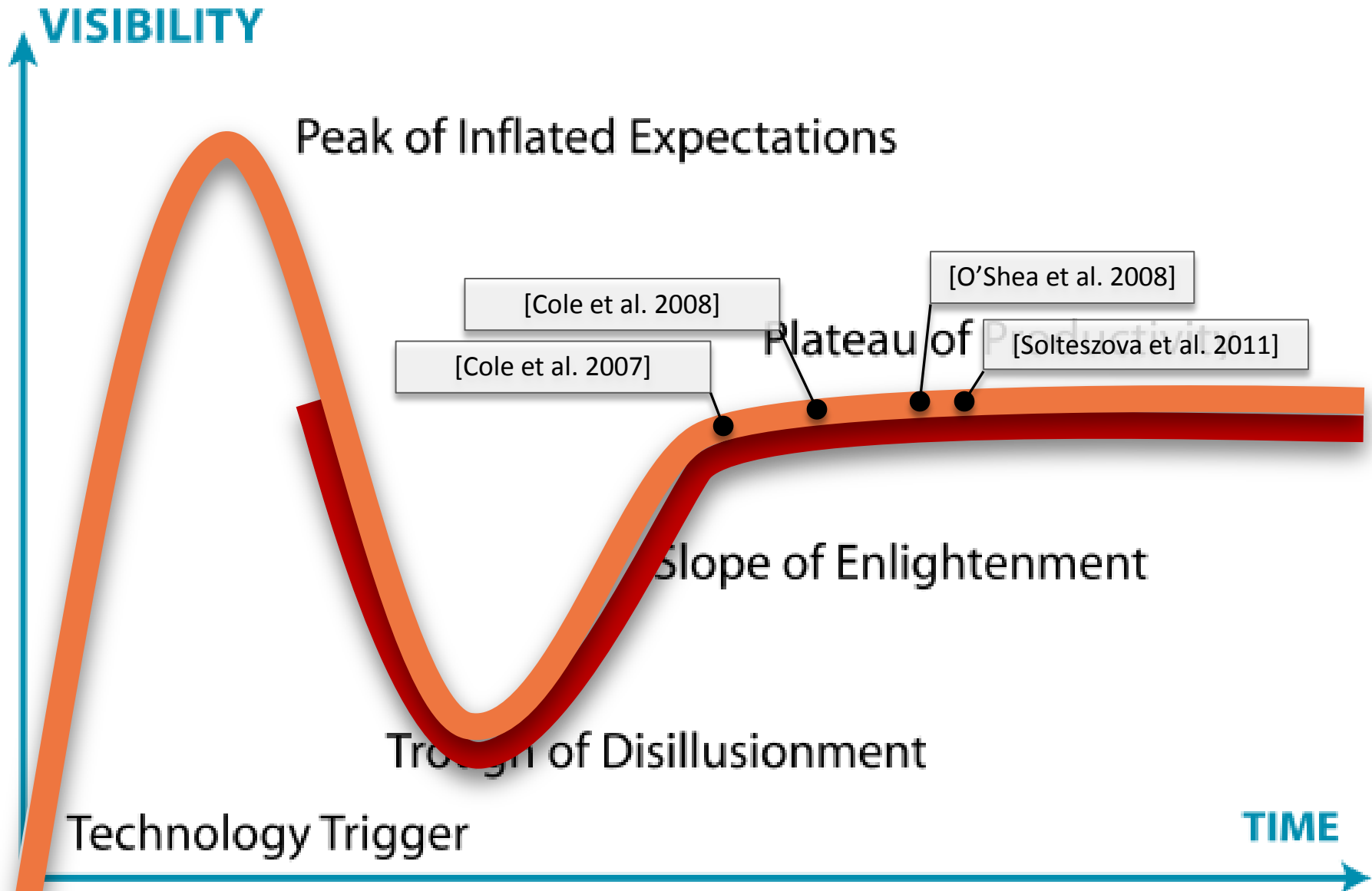
[O'Shea et al. 2008]

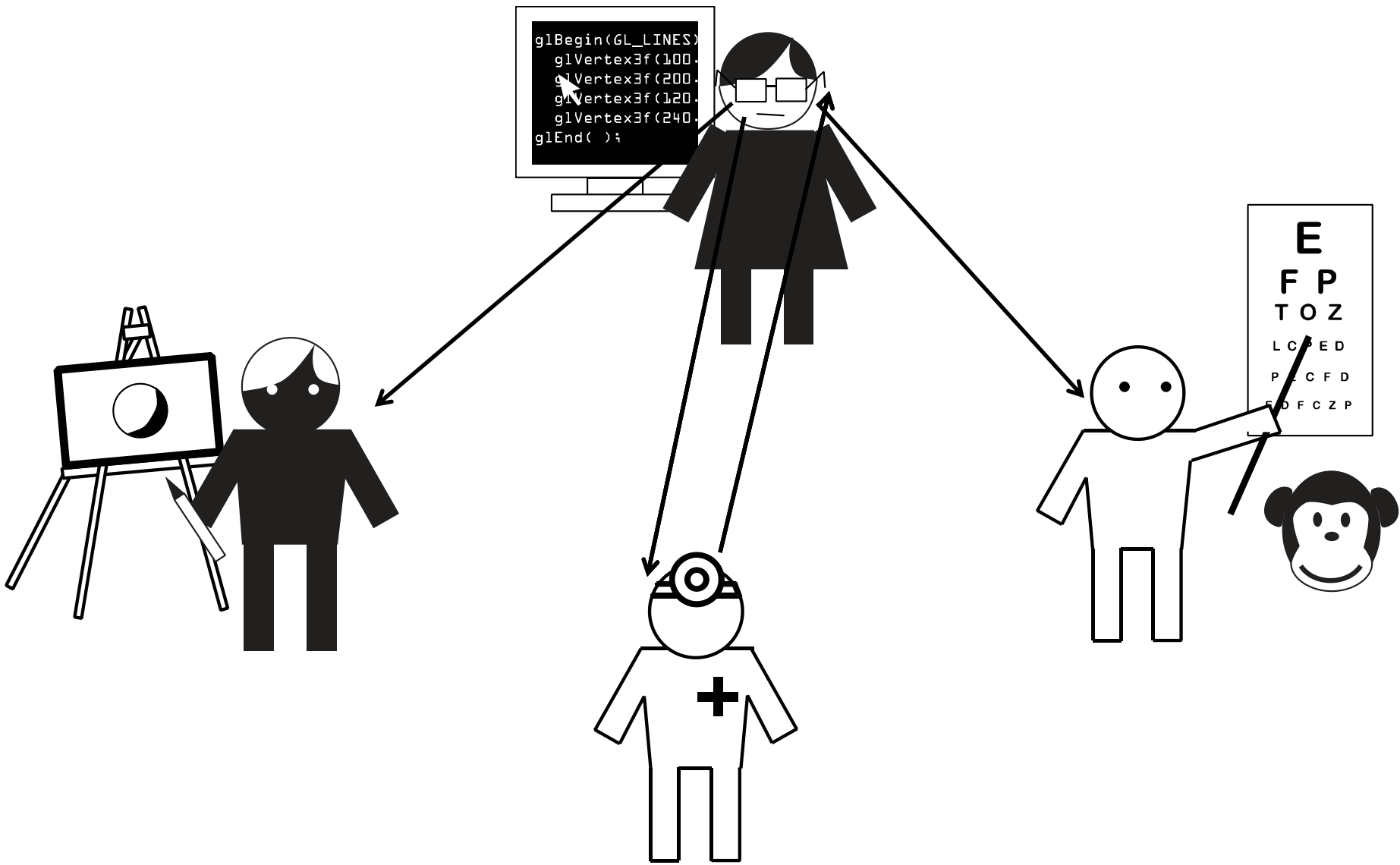


Chromatic Shift in Shadows



Hype Cycle for Illustrative Visualization

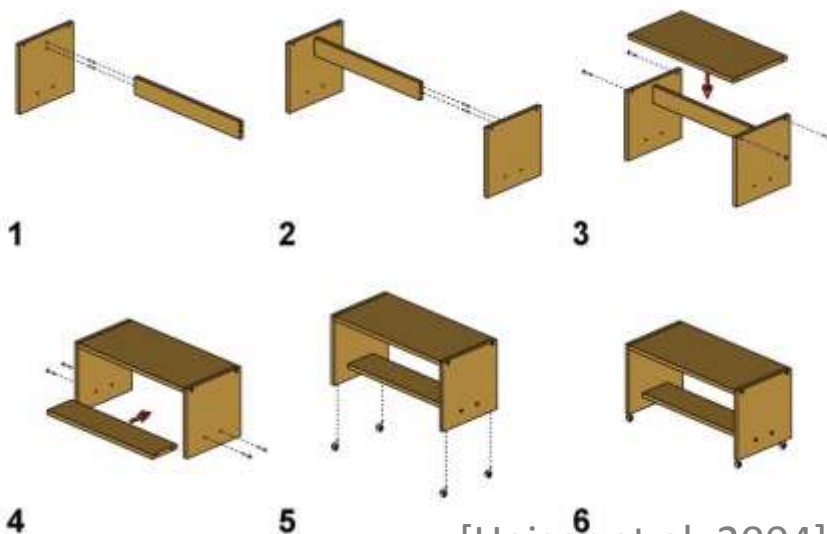
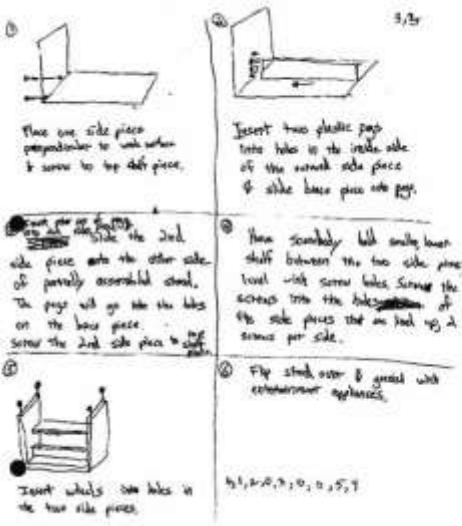
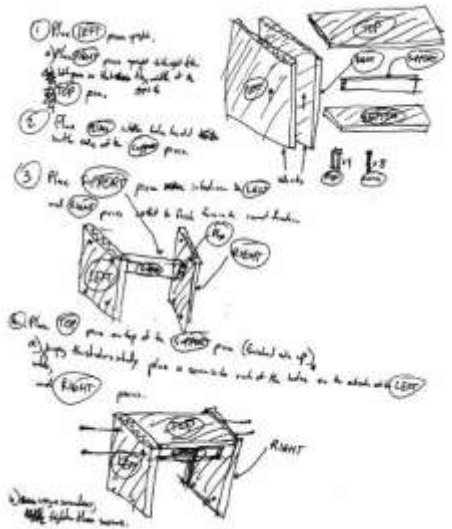




Assembly Instructions Illustrations



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

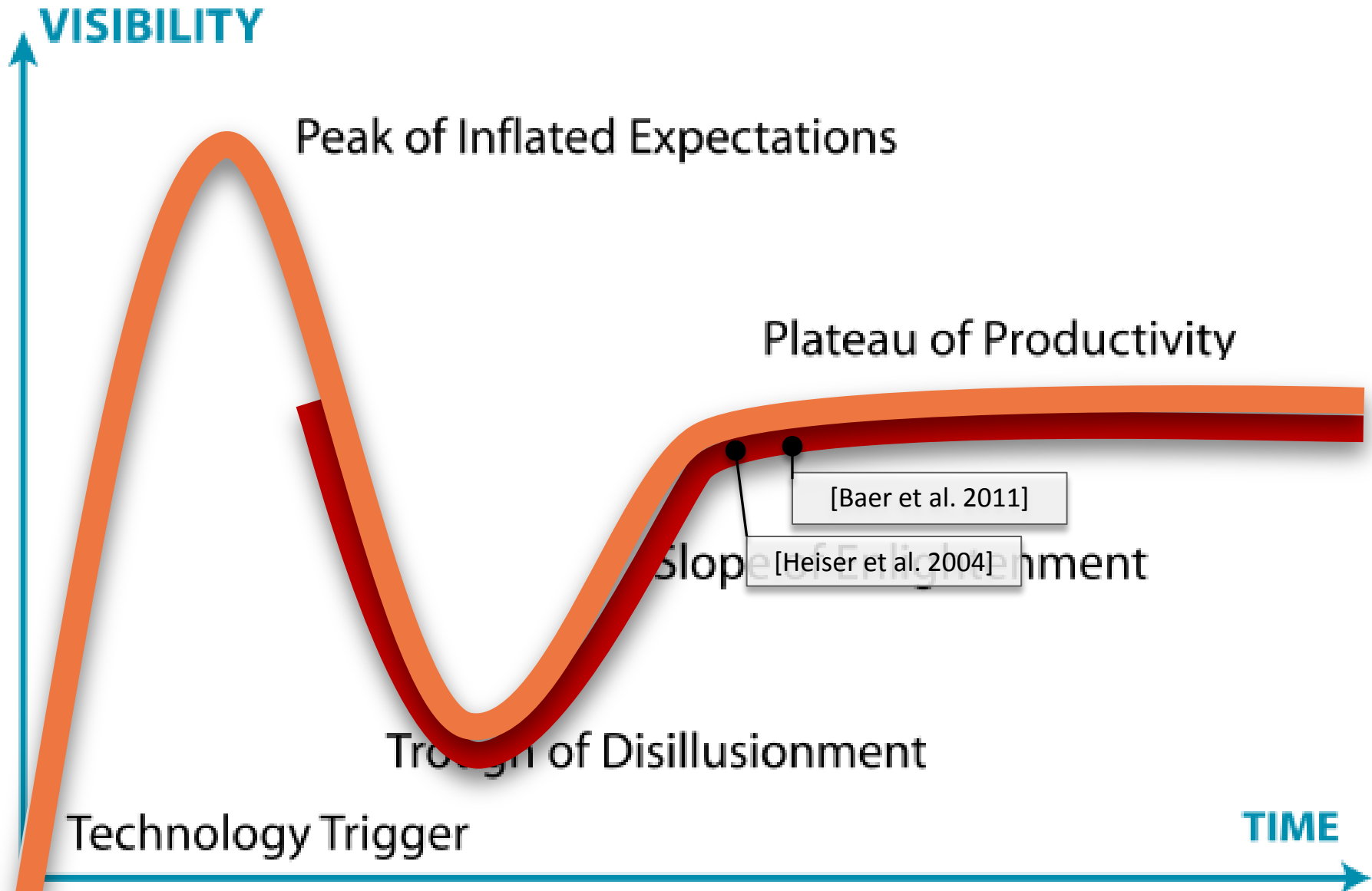


Cut-Aways for Medical Tasks

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

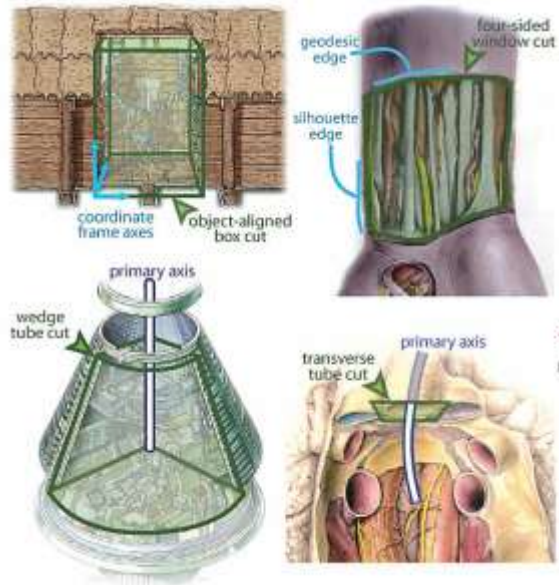
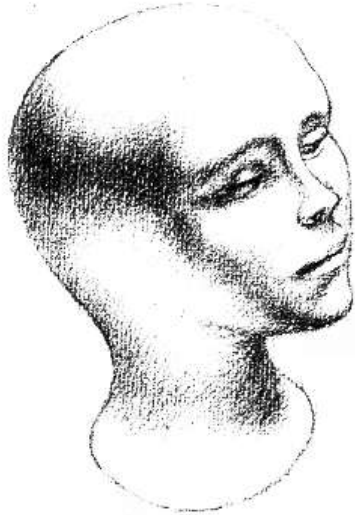
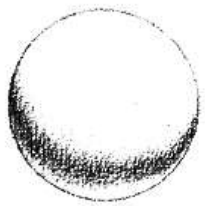


Hype Cycle for Illustrative Visualization



Methodological Levels

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



Hype Cycle for Illustrative Visualization

