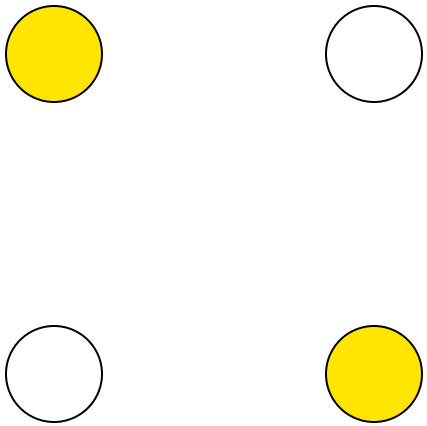
Stroke Perception

Karan Singh, Ryan Schmidt

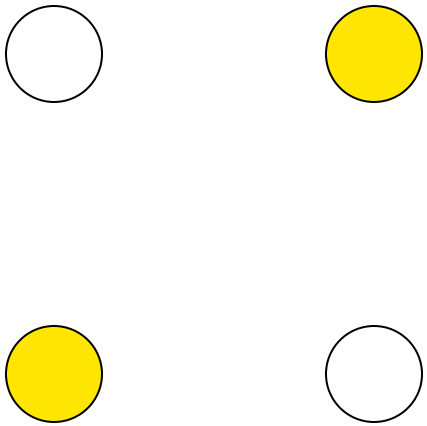
dgp
Dynamic Graphics Project
University of Toronto
www.dgp.toronto.edu

Warning lights



http://www.michaelbach.de/ot/mot_sam/index.html

Warning lights

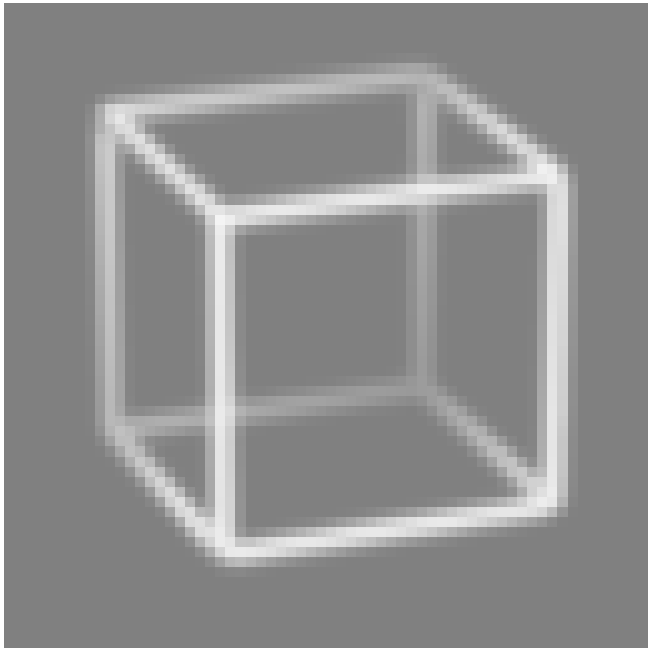


http://www.michaelbach.de/ot/mot_sam/index.html

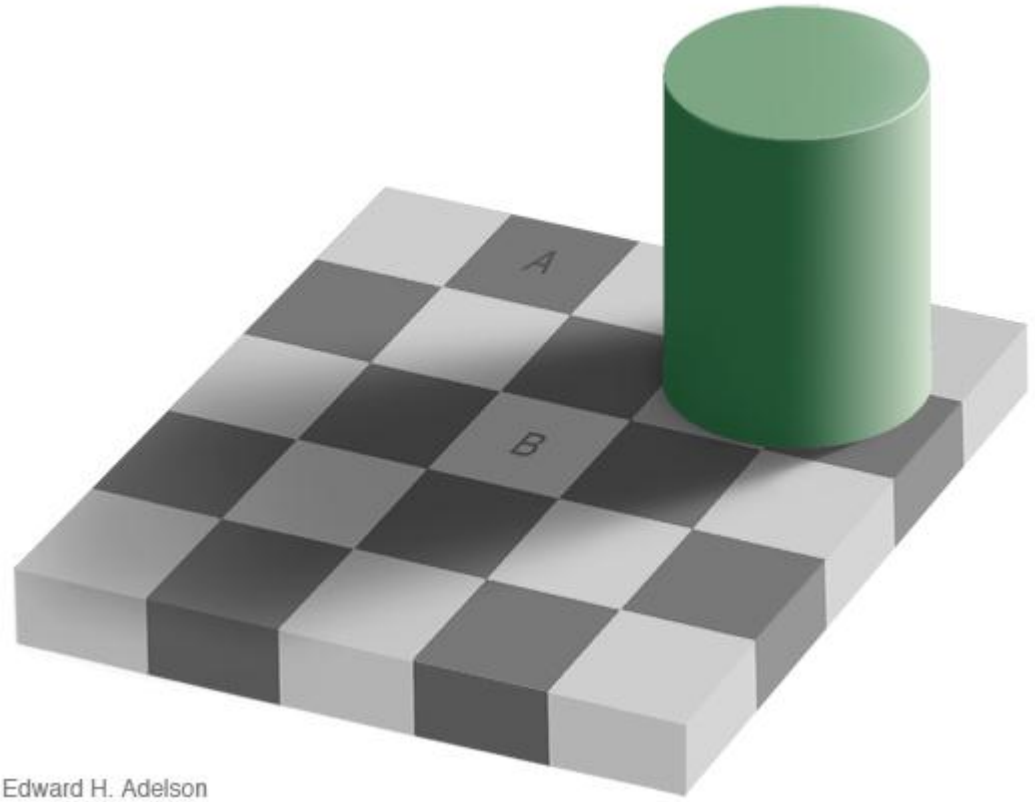
Why do we see things?

- Shape (silhouettes, features, lines).
- Value (shading, curvature, lighting).
- Space (Segments, relationships of parts).

Shape (Necker Cube)

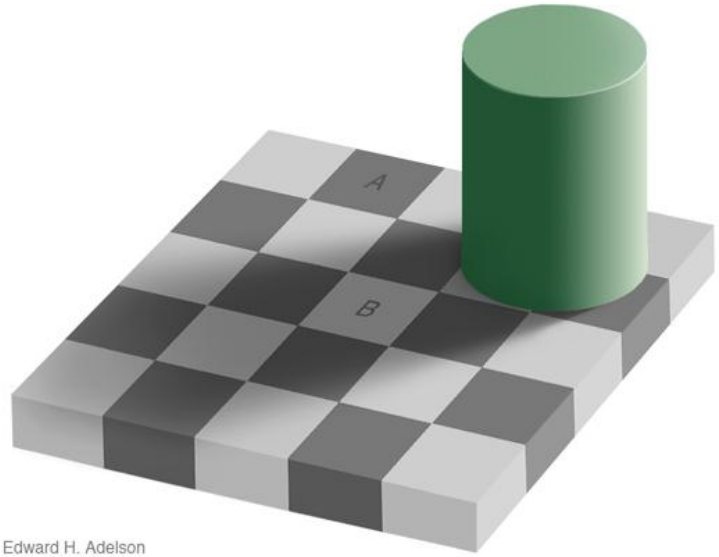


Value

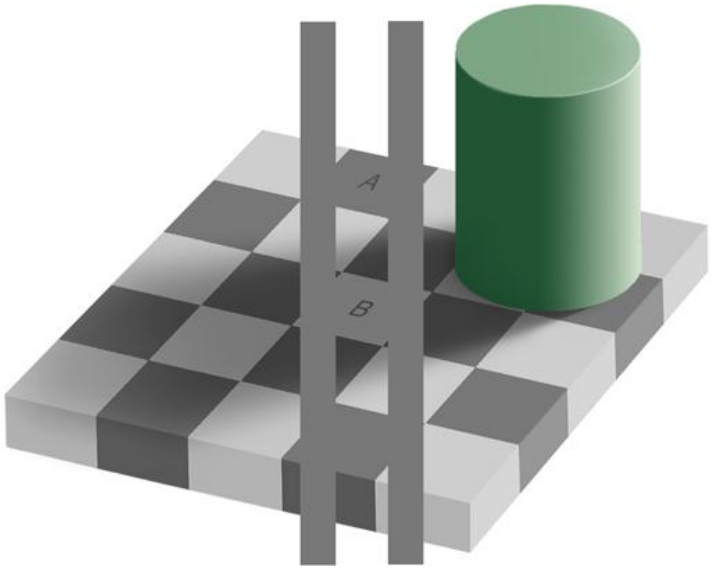


Edward H. Adelson

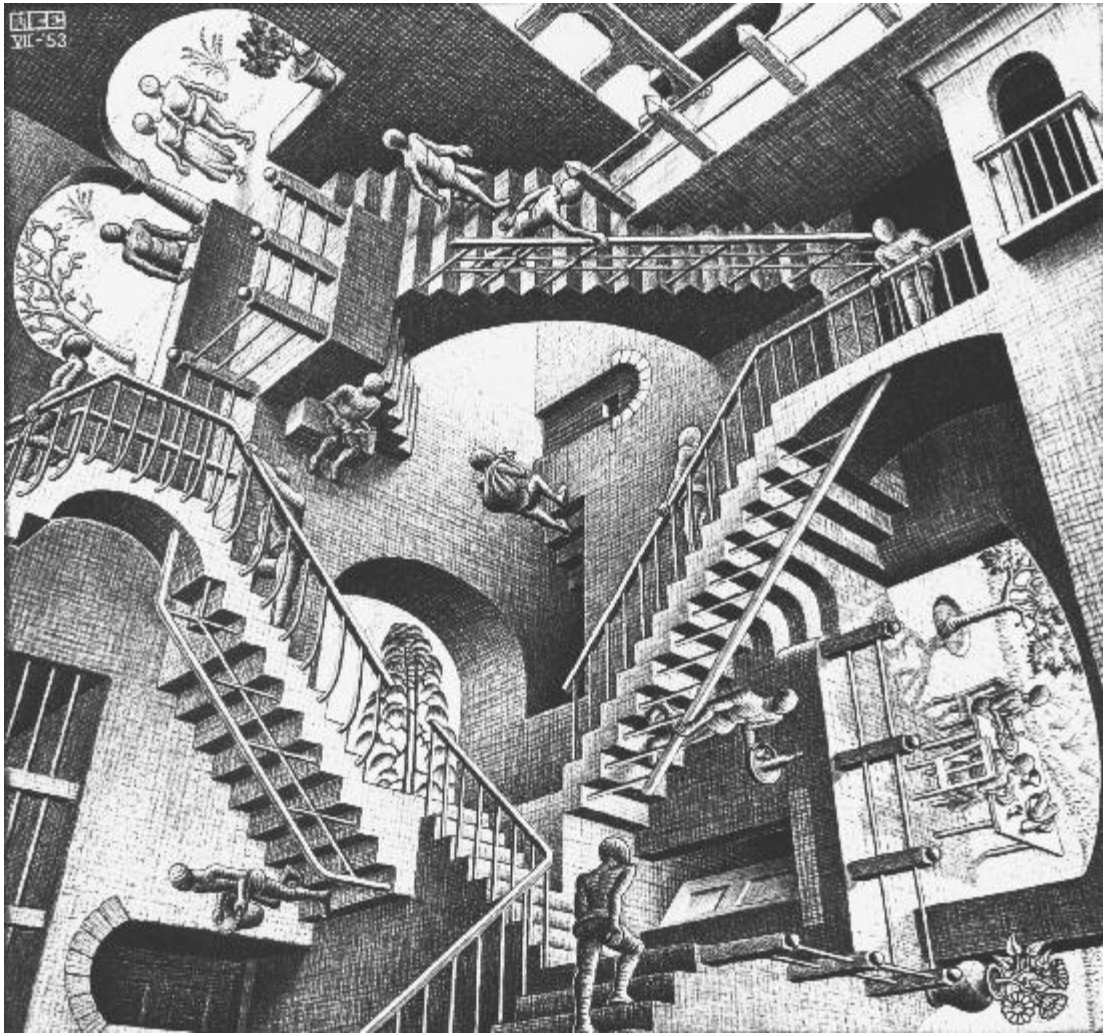
Value



Edward H. Adelson



Space



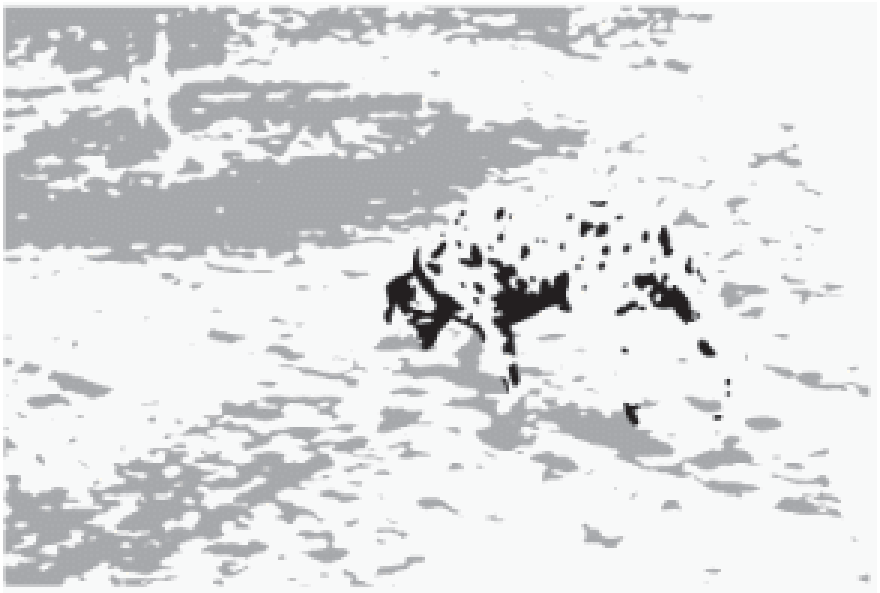
Shape Understanding

- Gestalt (shape, value, space)
- NPR (shape, value, space)
- Geometry and Projection (shape, space)

Gestalt

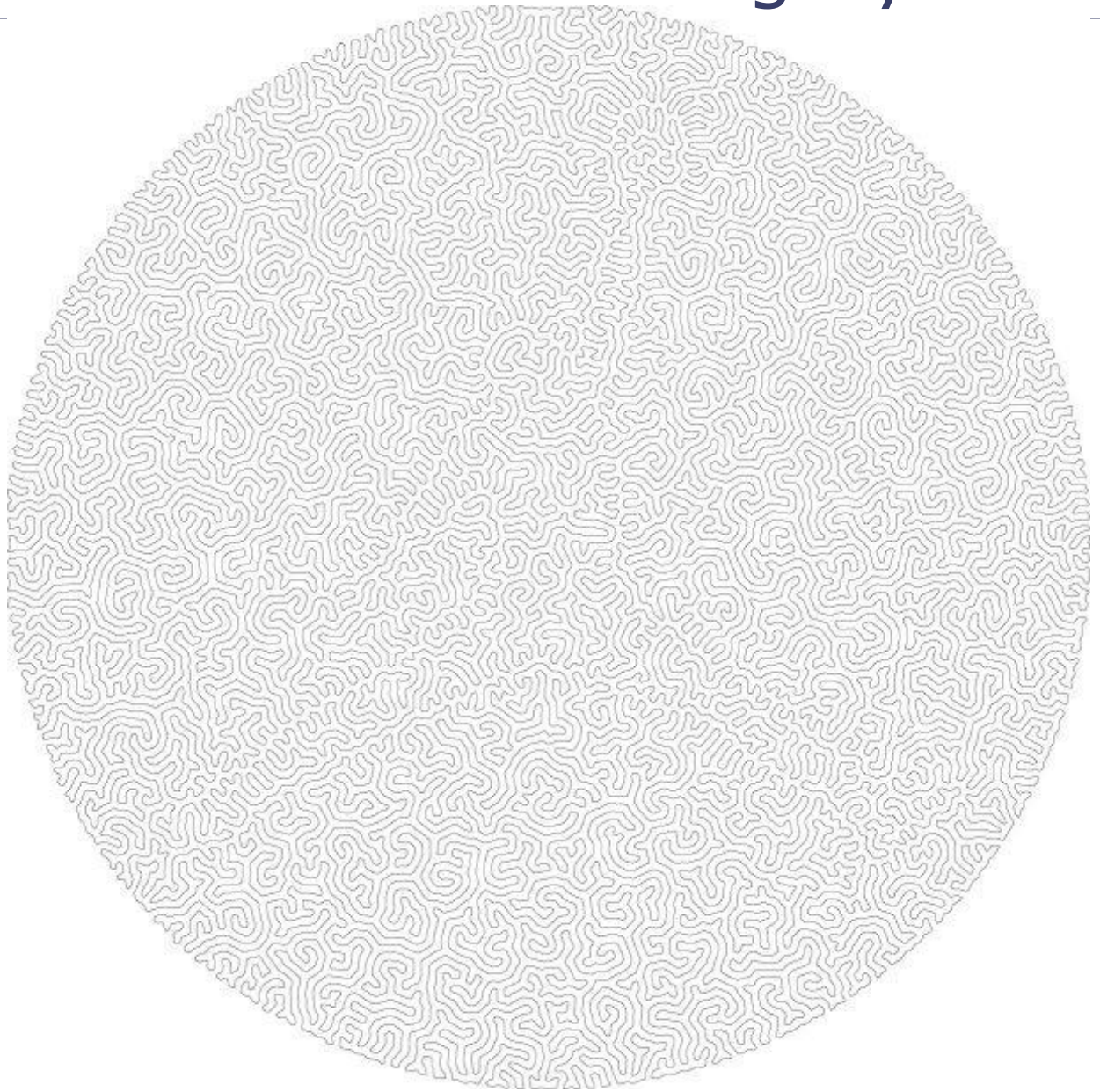
http://graphics.stanford.edu/~niloy/research/emergence/emergence_image_siga_09.html

Gestalt (Emergence)

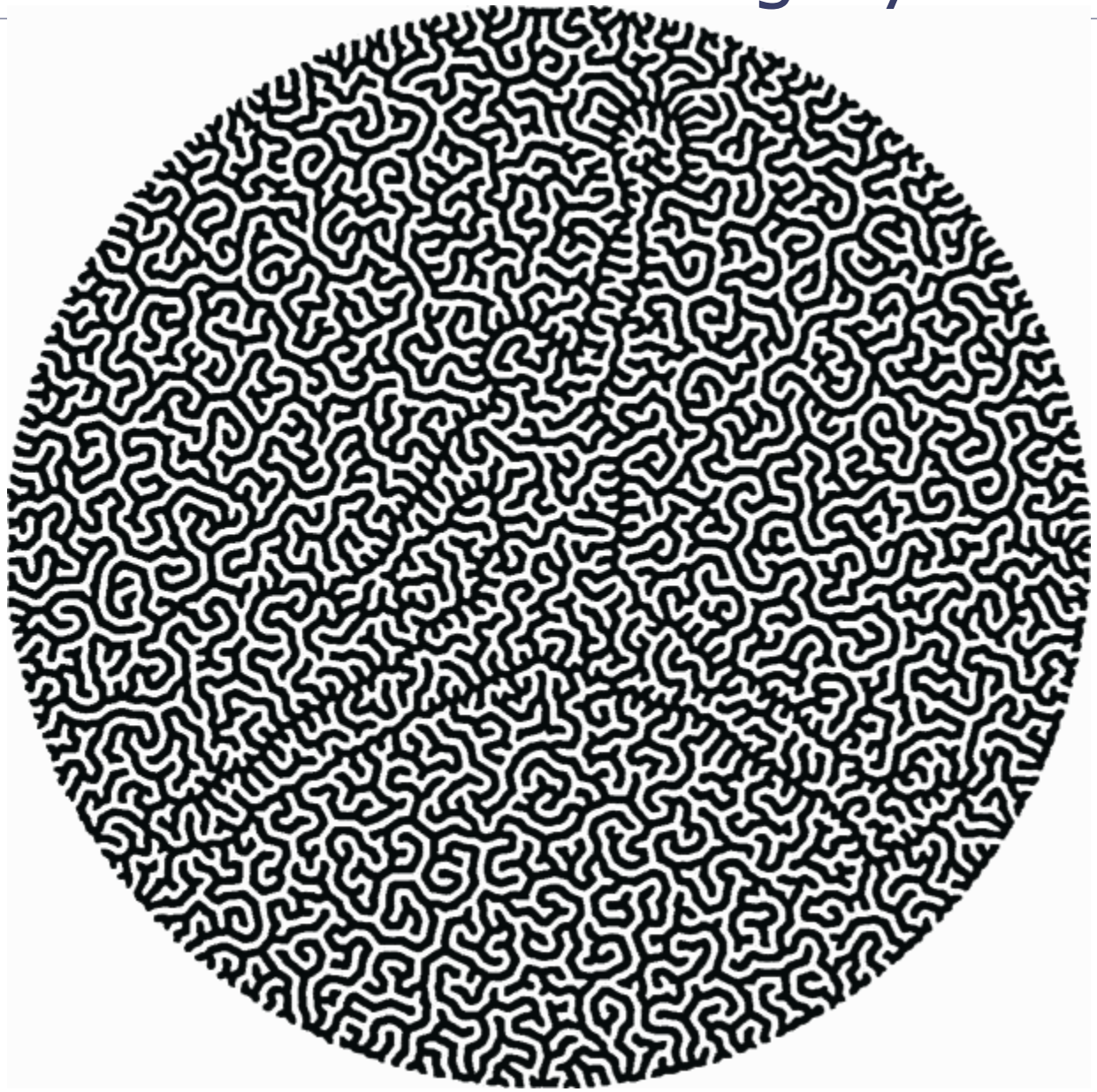


http://graphics.stanford.edu/~niloy/research/emergence/emergence_image_siga_09.html

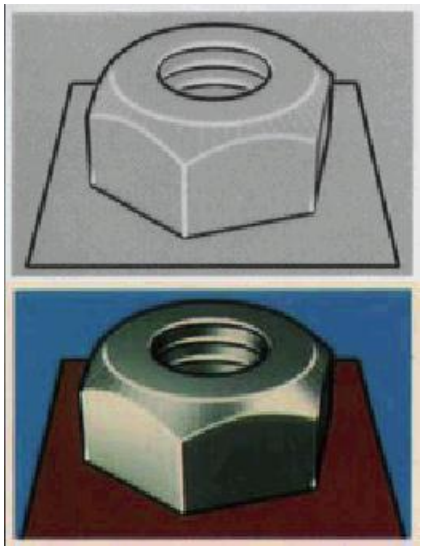
Gestalt and Hidden Imagery



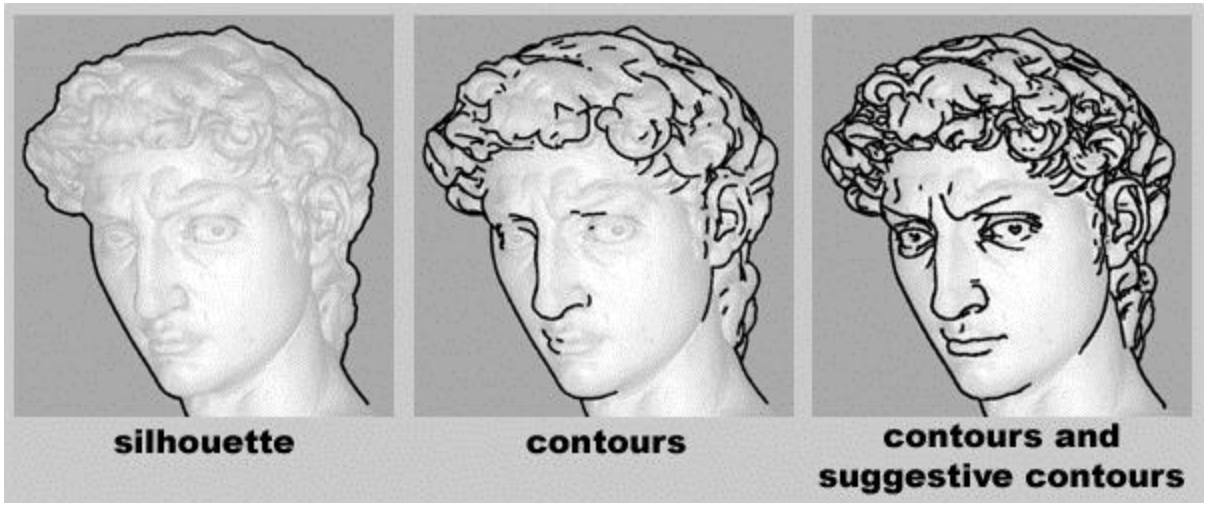
Gestalt and Hidden Imagery



NPR: Important lines

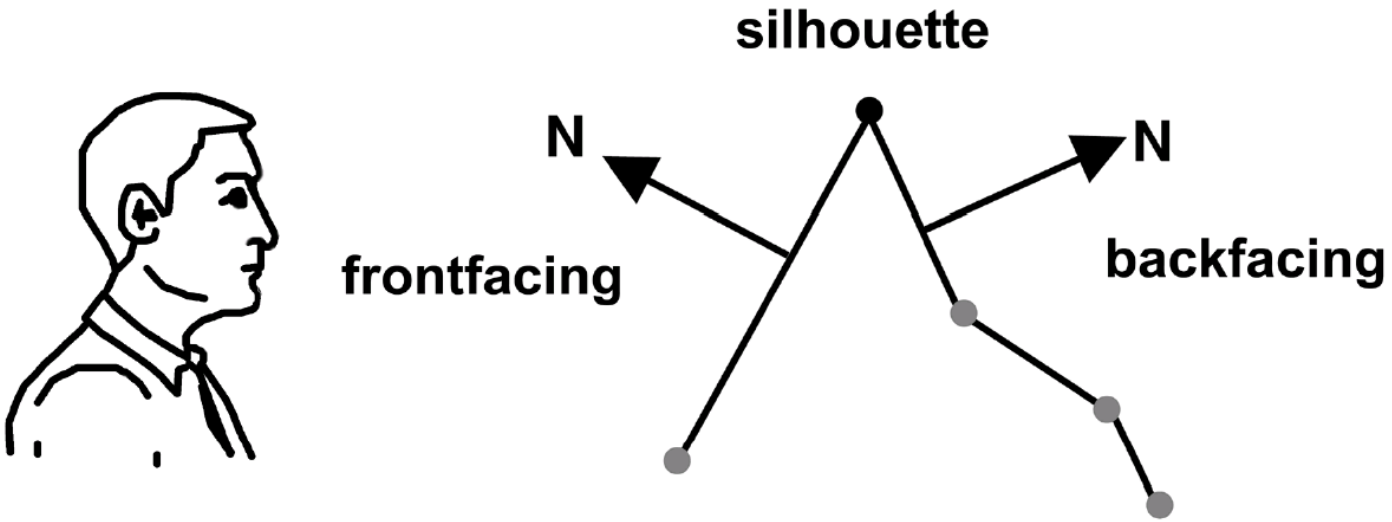


ridges & valleys

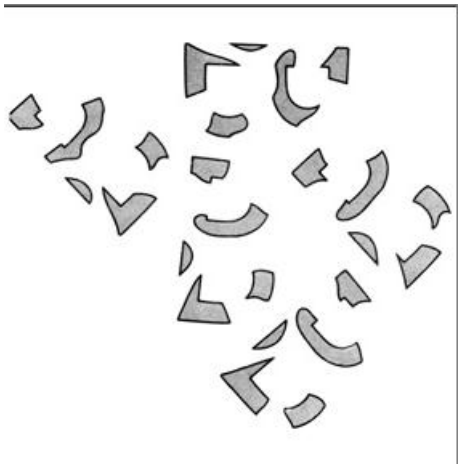


Rusinkiewicz et al. SIGGRAPH course notes 2008

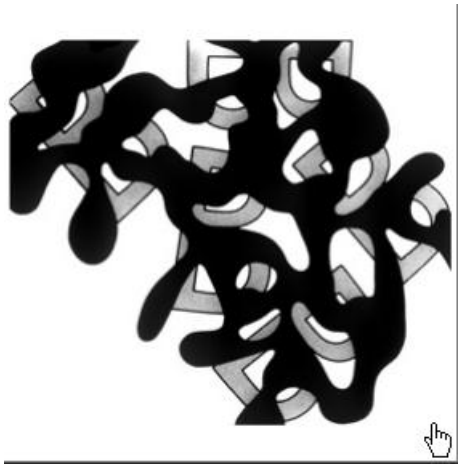
Silhouettes



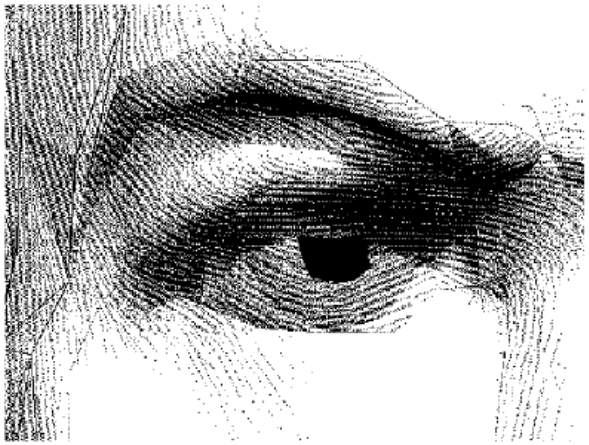
Lines



Lines

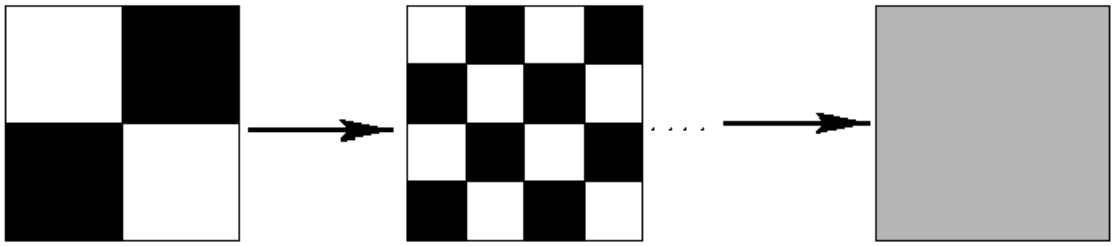


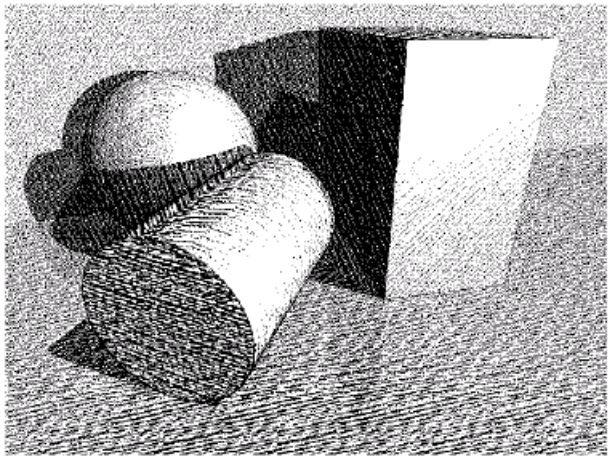
Lines+Shading



Dithering/Halftoning

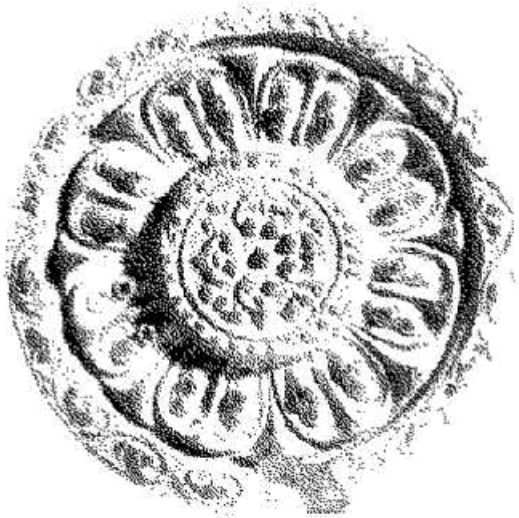
- Halftoning:
  - process to represent continuous tone in binary media -print or display.
- Necessary loss of information due to limited resolution
- Approximate tone by using the human visual system

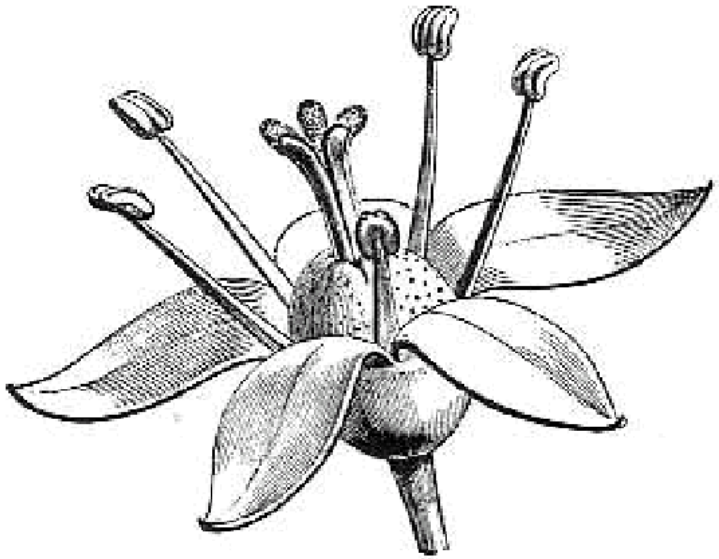




Stippling and Cross-hatching

- Stippling:use a series of properly scaled and spaced spots.
- Crosshatching consists in crossing a series of lines of various lengths, widths and at various angles with which the artist constructs areas of tone and texture.

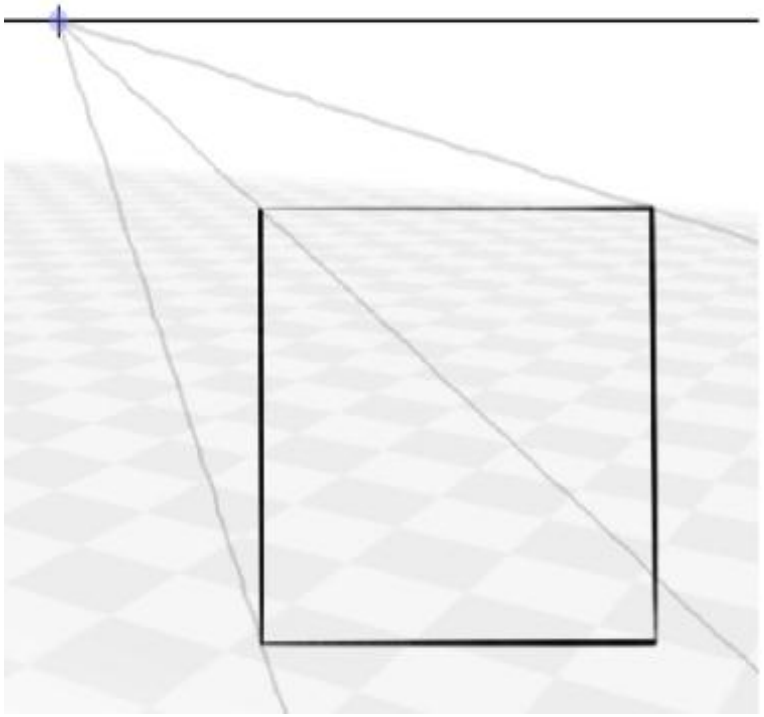




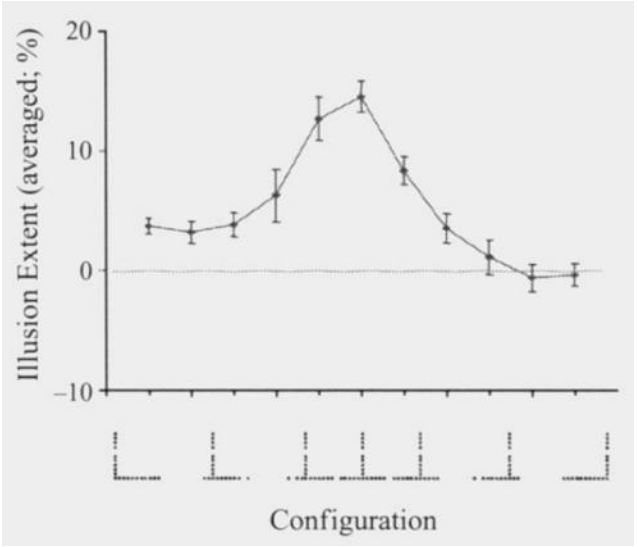
Shape Understanding

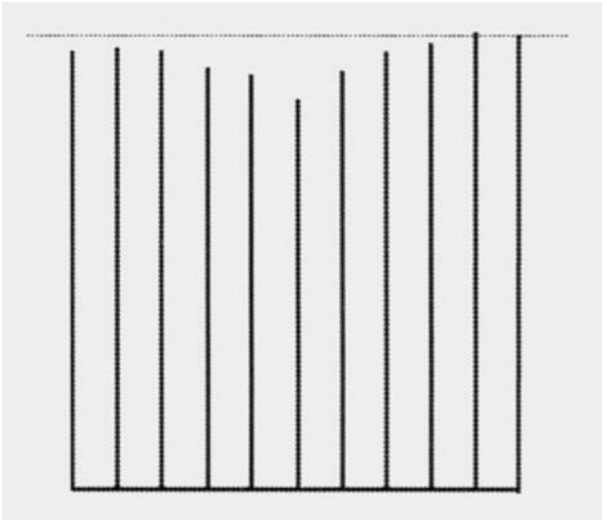
- Gestalt (shape, value, space)
- NPR (shape, value, space)
- Geometry and Projection (shape, space)

Geometry and projection (maya)



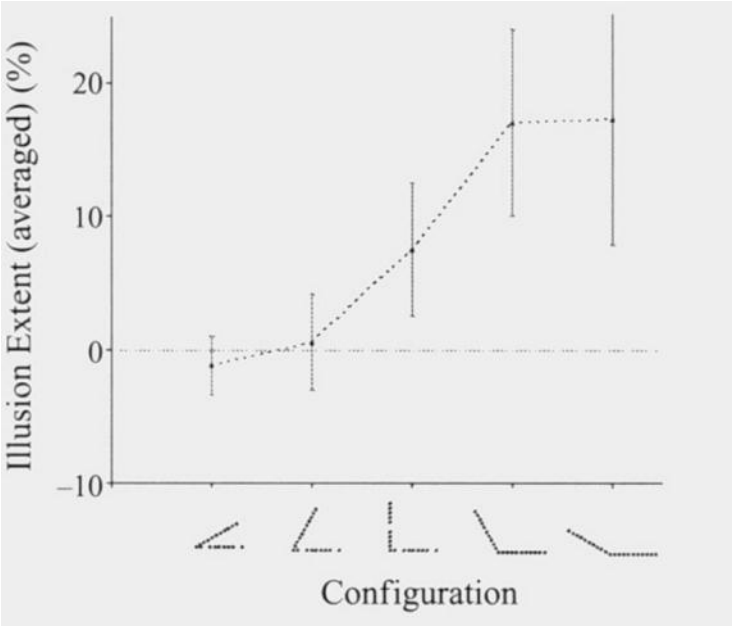
Perceptual Bias (low level)

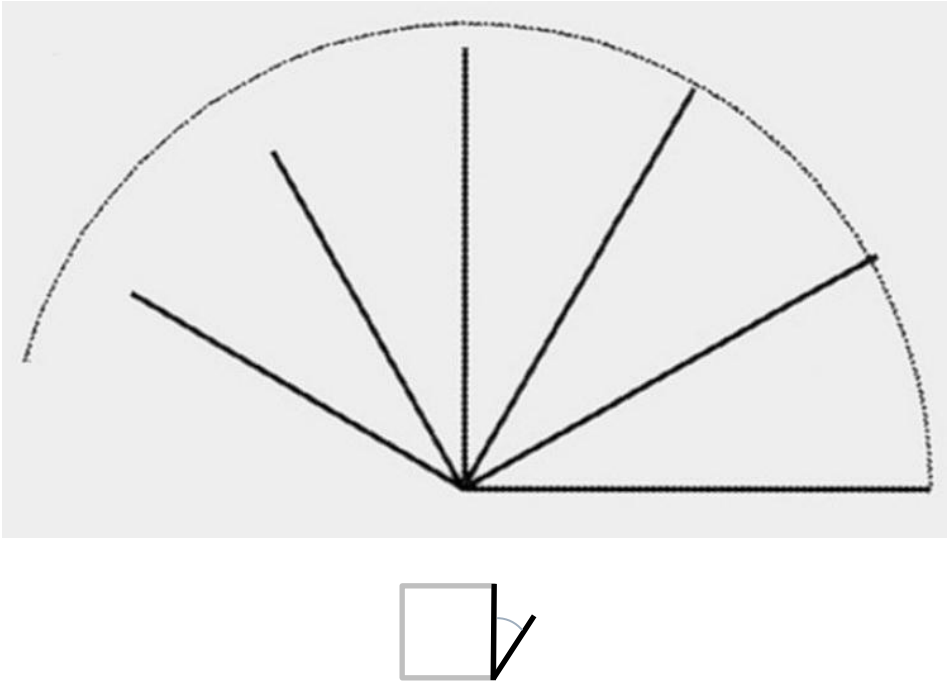




[**Wolfe, Maloney & Tam**, Distortions of perceived length in the frontoparallel plane: tests of perspective theories, *Perception & pyschophysics, 2005*]

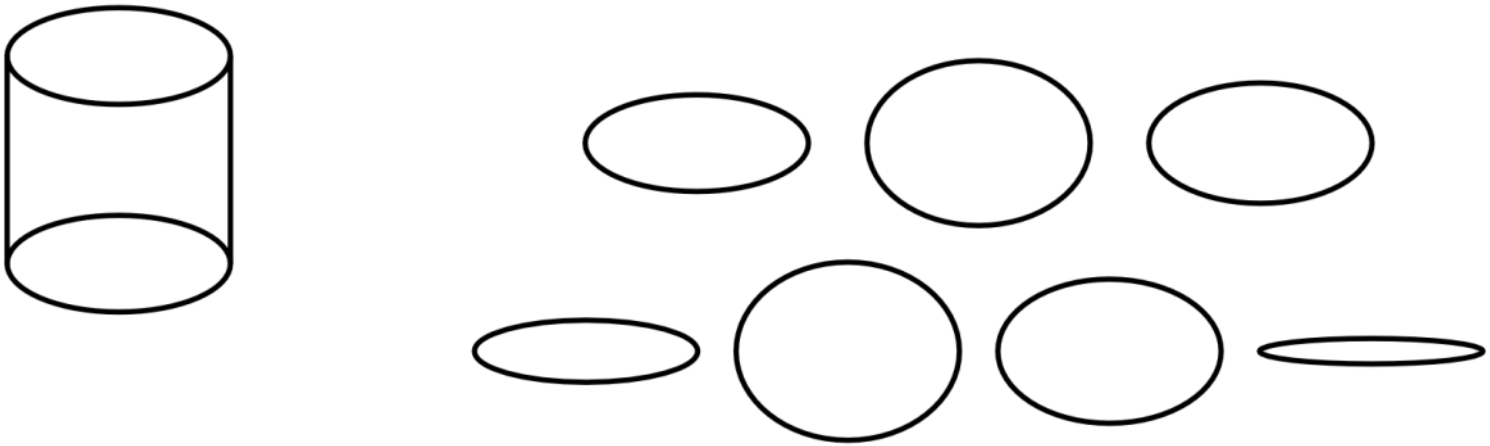
Perceptual Bias (low level)



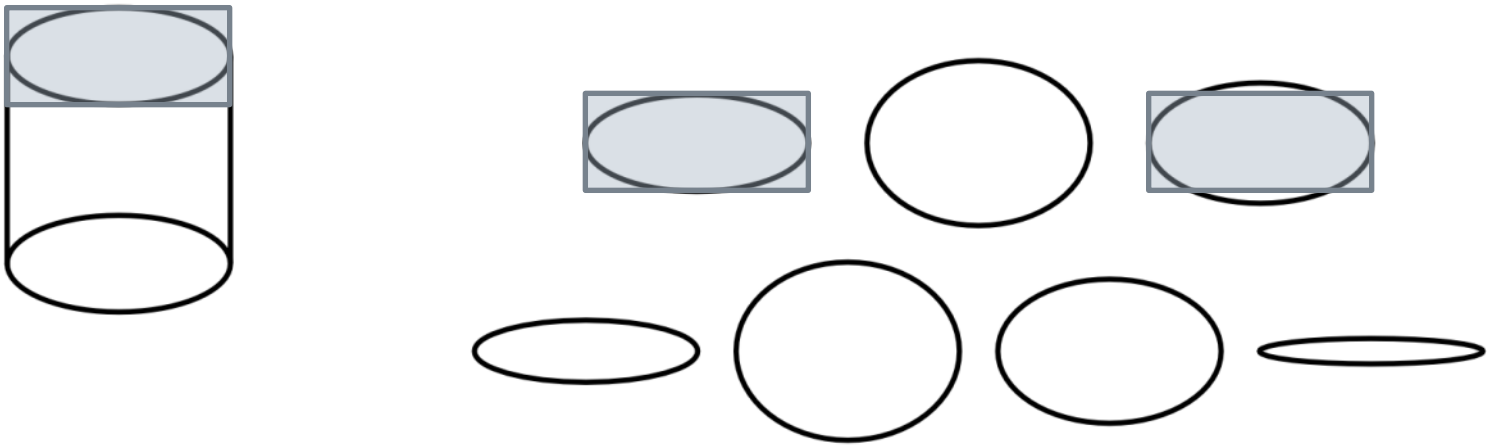


[**Wolfe, Maloney & Tam**, Distortions of perceived length in the frontoparallel plane: tests of perspective theories, *Perception & pyschophysics, 2005*]

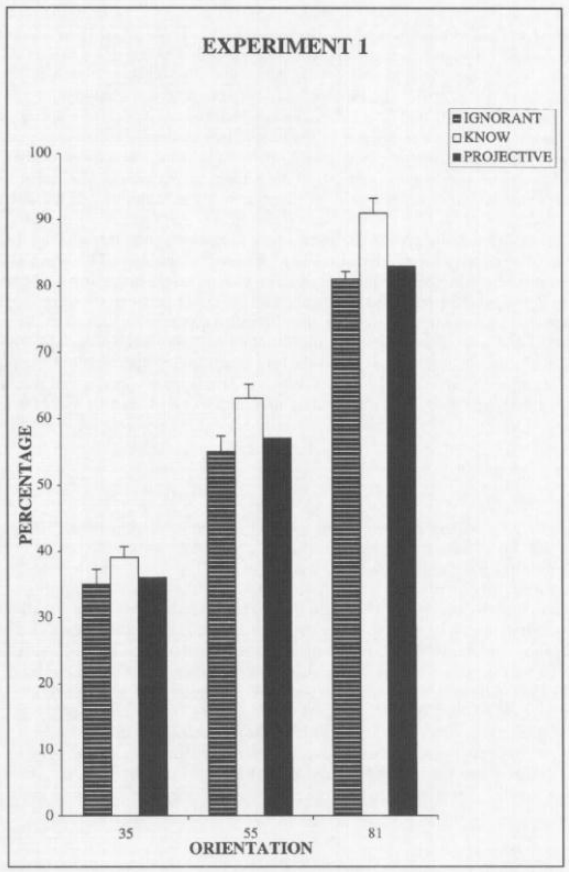
Perceptual bias (high level)

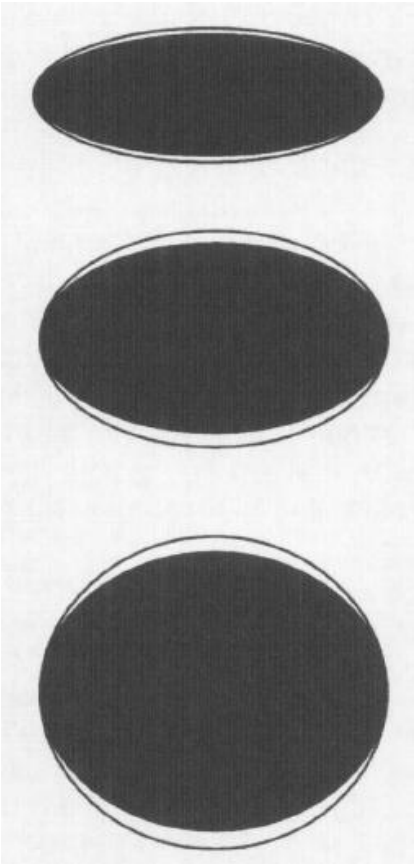


Perceptual bias (high level)



Perceptual bias (high level)





[**Taylor & Mitchell**, Judgements of apparent shape contaminated by knowledge of reality: viewing circles obliquely, *British Jnl. of Psych., 1997*]

Sketching Dogma

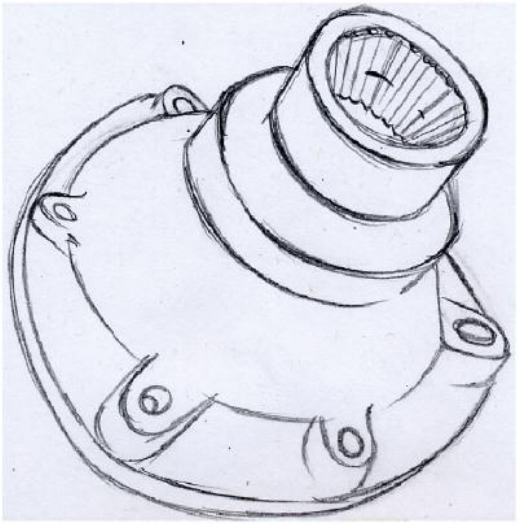
"Sketching is for rough prototype drawings, where precision is not important"

"Only design *intent* is important in "conceptual design"

"Even though we can't draw very well, *real* artists and designers can…"

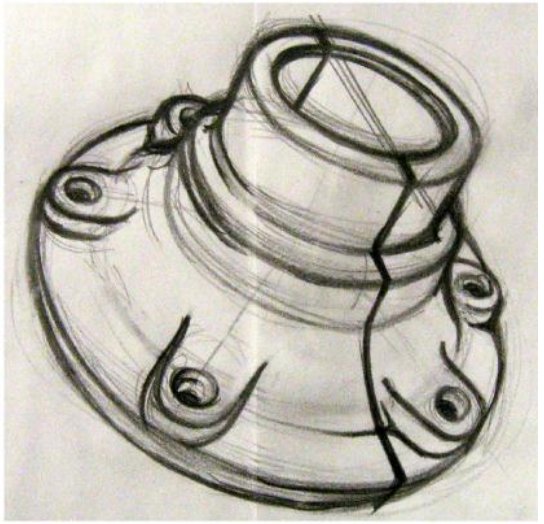
Experts!

'Artist'



[Cole et al 08]

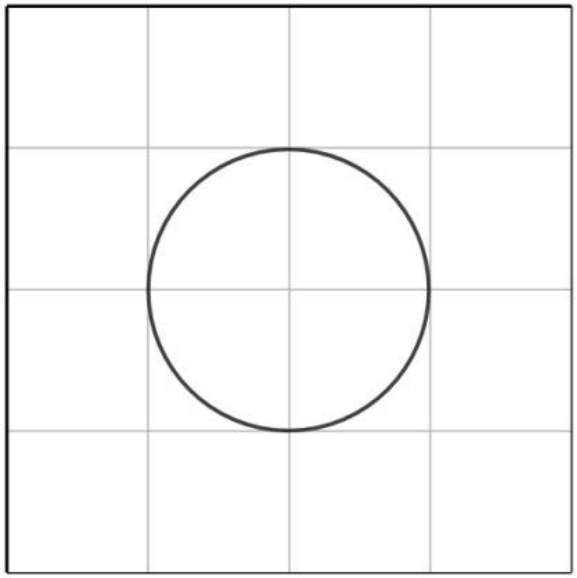
Expert 3D Depicter

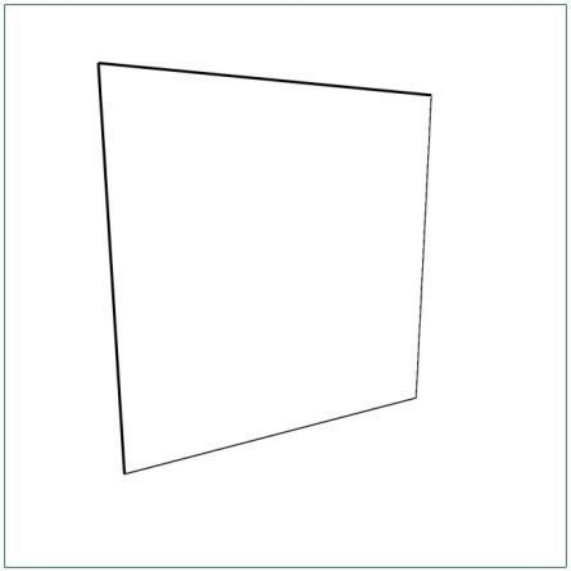


Our Experiment

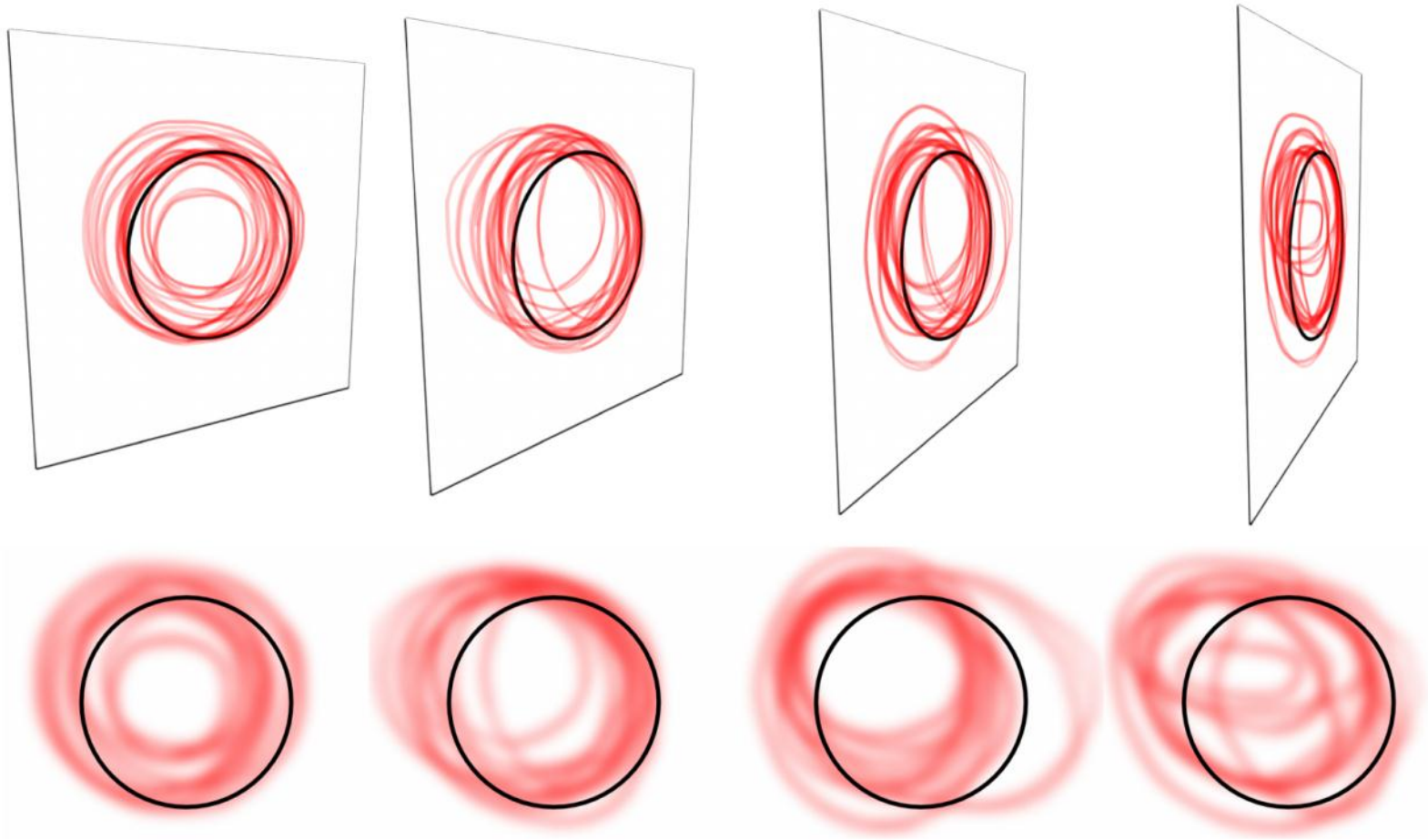
[**Schmidt, Khan, Kurtenbach, Singh,** On expert performance in 3D curve drawing tasks. *SBIM 2009*]
http://www.dgp.toronto.edu/~rms/data/CurveDrawing

Expert Drawing I: Circle-on-Plane

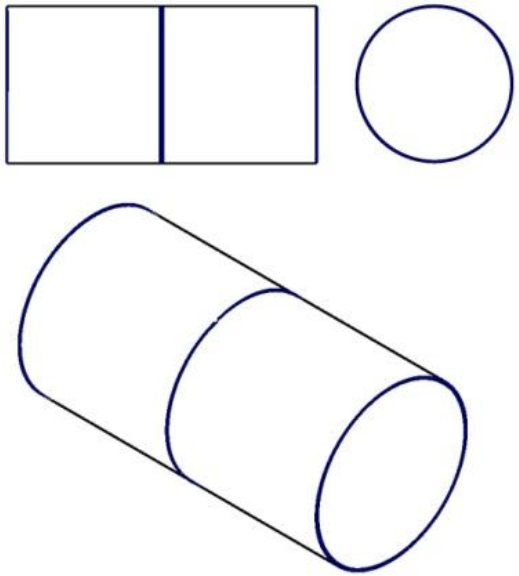


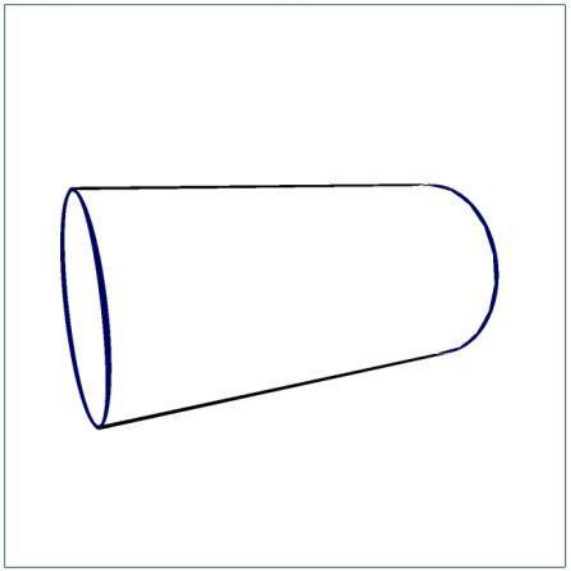


Expert Drawing I: Circle-on-Plane



Expert Drawing II: Line-on-Cylinder





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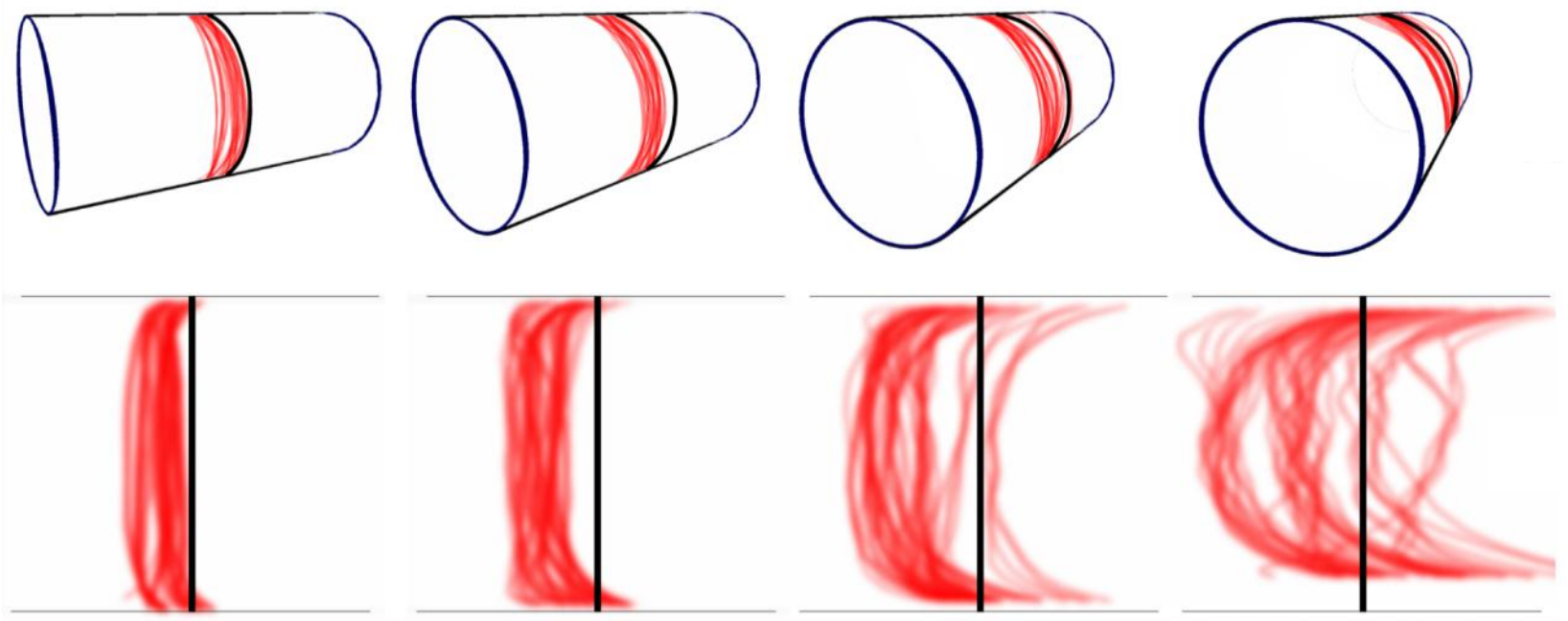
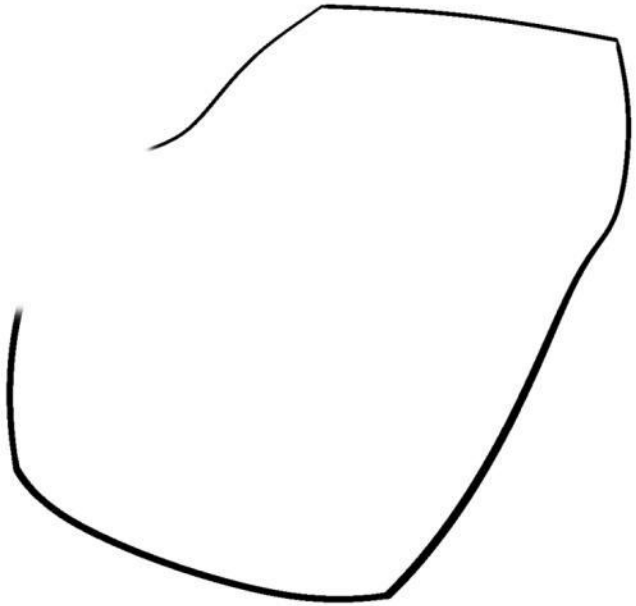
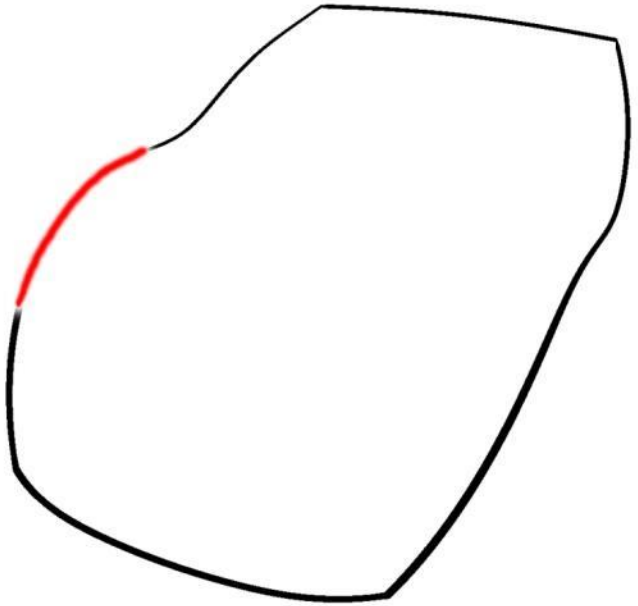


Expert Drawing III: Silhouette Curves

Please fill in the missing curve section





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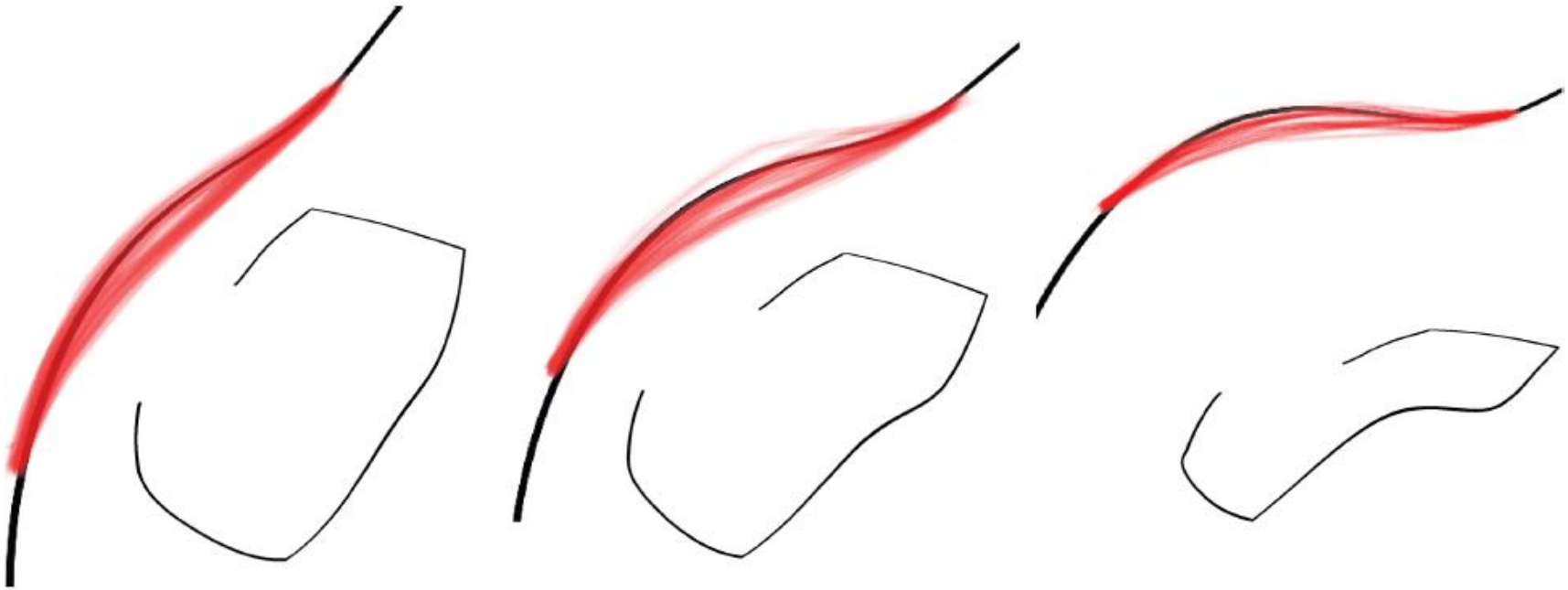
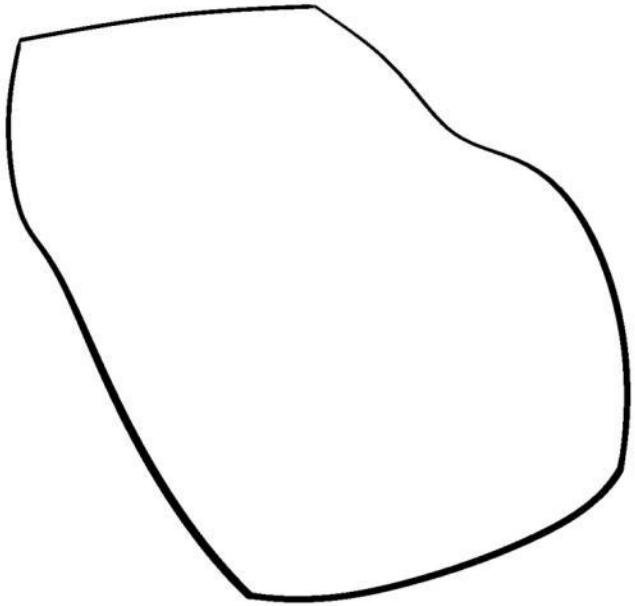
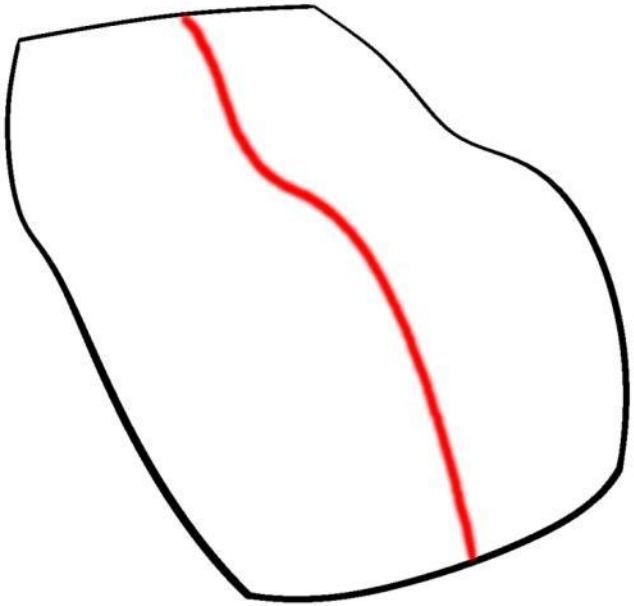
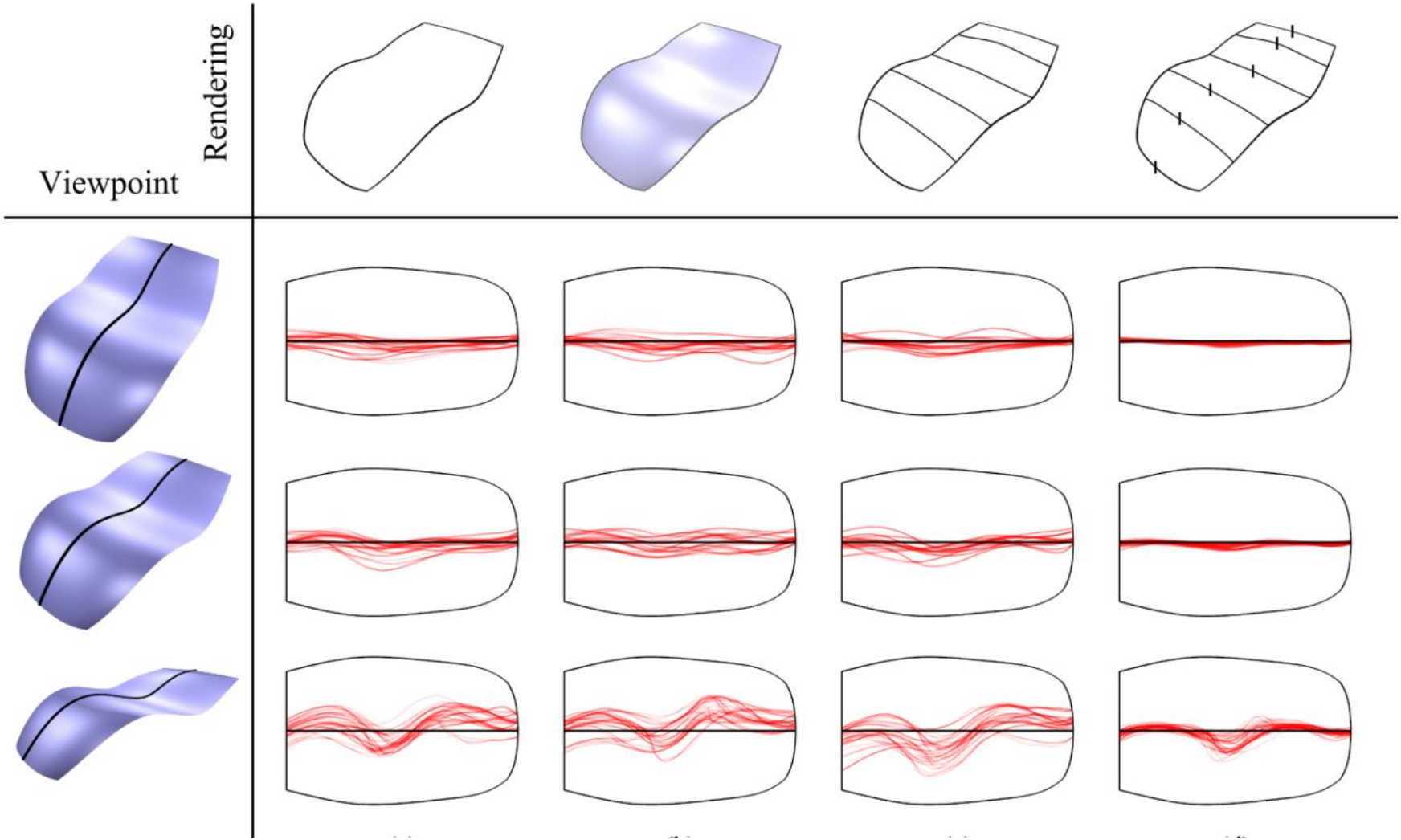


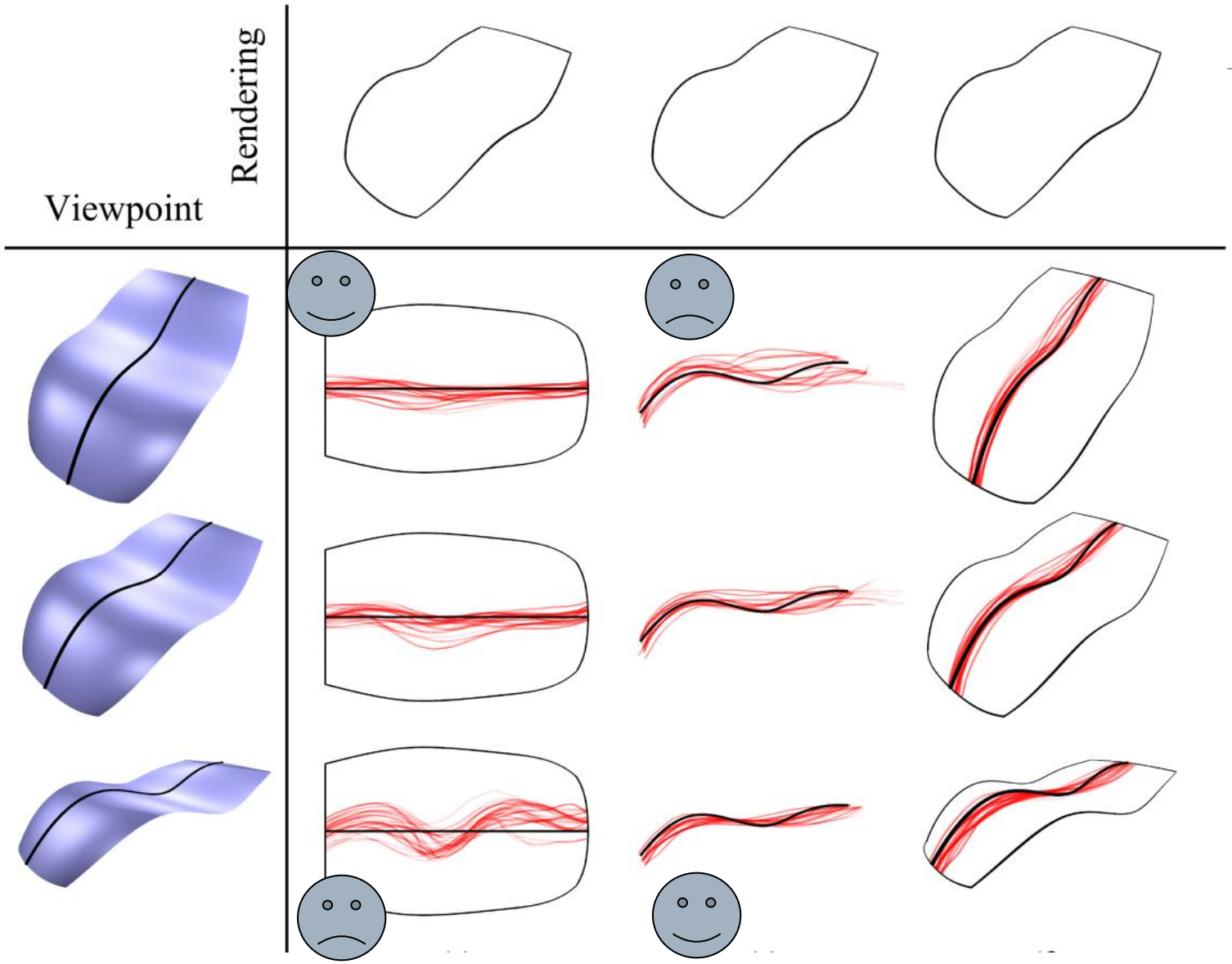
Expert Drawing IV: Curve-on-Surface

Please draw the center-line along the surface






Rendering
Viewpoint

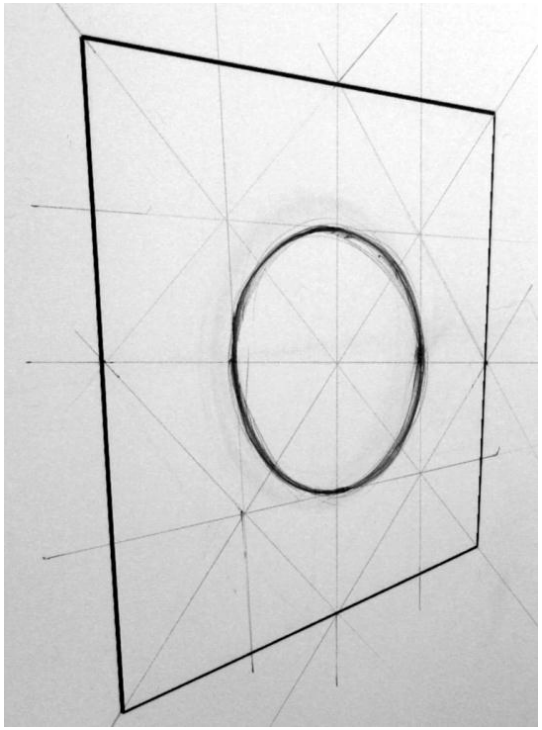

Rendering
Viewpoint

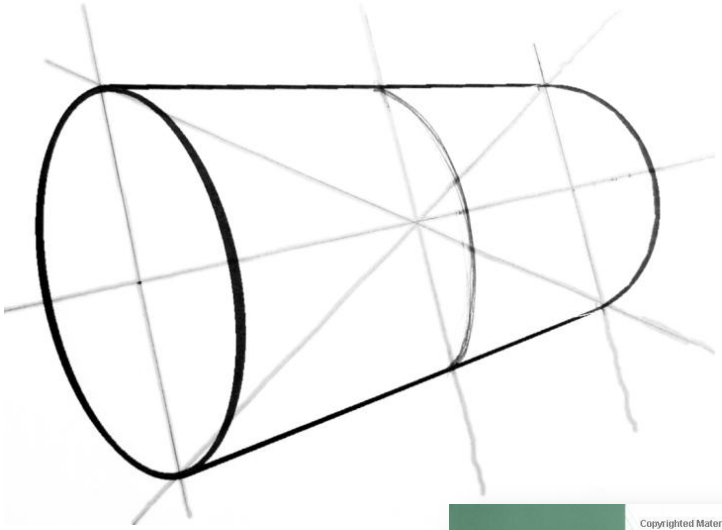
Implications for 3D Sketching

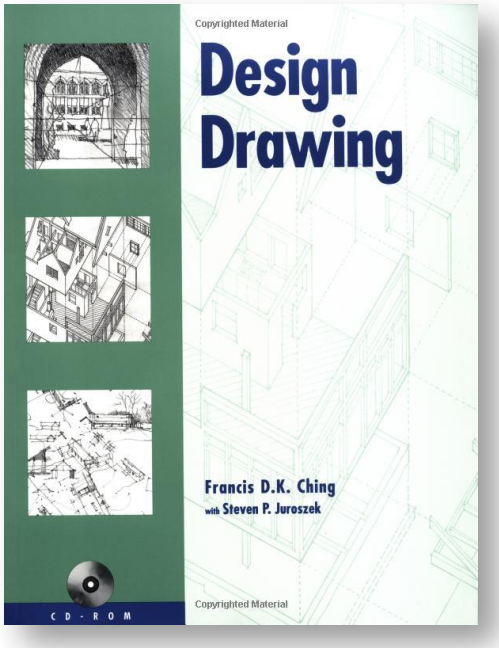
- Artists and Designers can't draw either!
- Averaging Oversketches [Baudel, Bae et al 08,09, …]
  - Reduces mechanical error
  - Converges on biased position
- Viewpoint selection
  - no free lunch, 45° ➡ largest bias
- Drawing on surfaces is just as hard

Humans have an audio IN and OUT,
a **biased** video IN but no explicit video OUT!
^

Experts and drawing systems

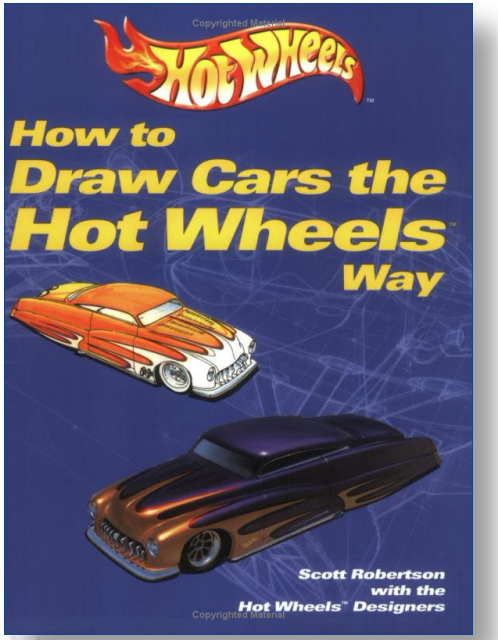


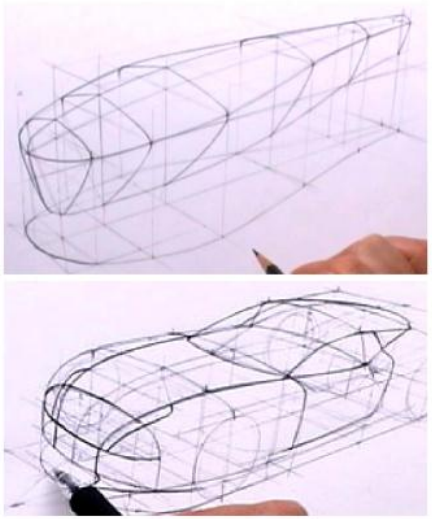


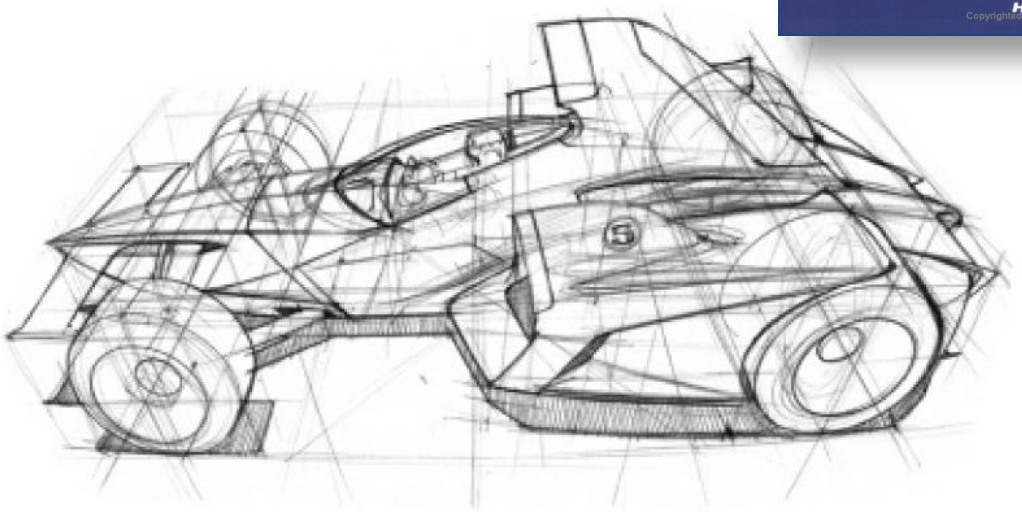


Analytic Drawing

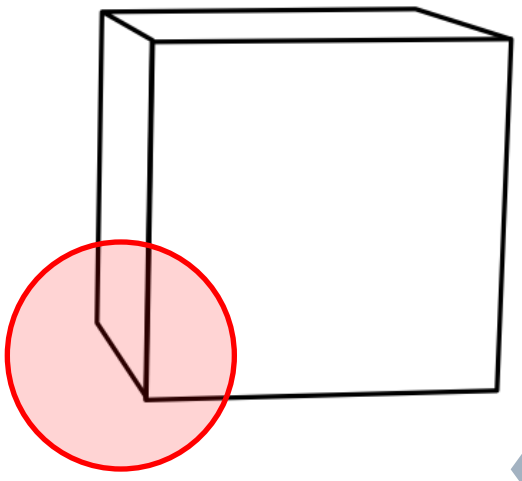
1. Pick a drawing system
   - 2-point perspective, isometric,…
   - Rules for how to interpret lines
2. Construct a 3D scaffold
3. Draw curves within the scaffold

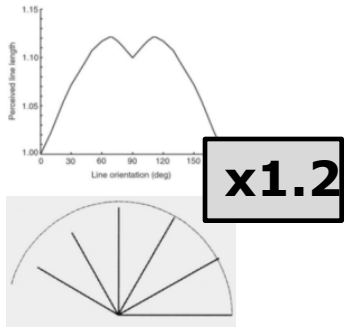




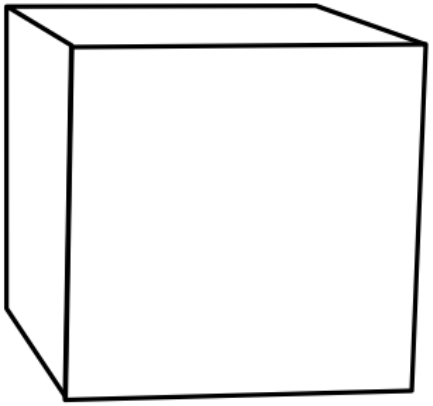


Modeling Perceptual Bias



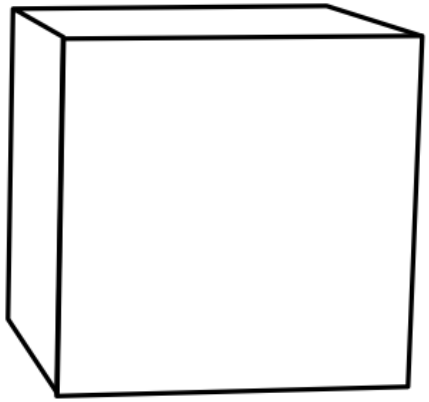


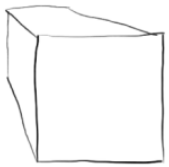
x1.2



inference

rendering





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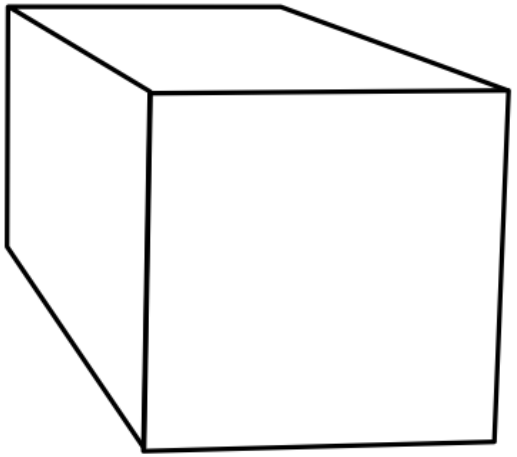


Bayesian Ideal Observer Theory

- P(*scene* | *image*) ~ P(*image* | *scene*) P(*scene*)

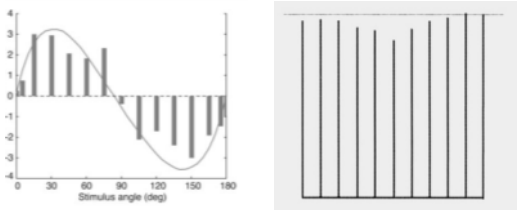
- Perceptual systems evolve to fit "natural" distributions

- Collect natural distributions
- Predict biases

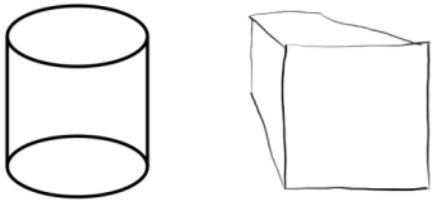
Take-aways

- Mechanical Error / Error of Intent
- Error of intent caused by perceptual bias (?)
- Multiple layers of perceptual bias

Low-Level "Projective"



High-Level "object/semantic"



- Solutions will affect inference *and* rendering!