The Art and Science of Depiction

Denotation system

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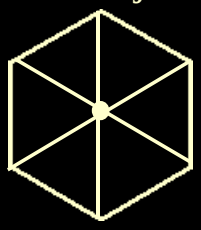
Invention of linear perspective

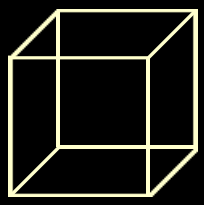
- Why so late?
  - Different goal
  - Different background
  - Advent of measurement
  - Mathematic analytical skills
  - Single viewpoint assumption

Accidental/generic

- From the objective geometric point of view

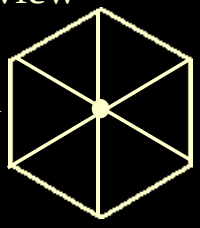


Accidental viewpoint



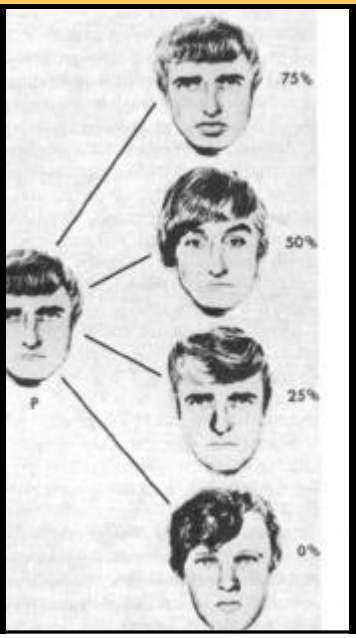
generic viewpoint

- From the subjective analysis point of view
  - Assume viewpoint is generic
  - Thus, the alignment cannot be accidental



Prototypes

- Solso



Maximum size

- Kosslyn
- Imagine a horse in the distance
- Imagine it moves continuously towards you
- When does it “overflows” your visual field?

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- 20º for strict overflow
- 40-60 º for lax overflow

Maximum size

- Kosslyn
- Imagine a horse in the distance
- Imagine it moves continuously towards you
- When does it “overflows” your visual field?
- 20º for strict overflow (equivalent 100mm)
- 40-60 º for lax overflow (30-50mm)

Denotation system

- Silhouette:
  - 2D (regions)
  - Picasso, *Rite of Spring*
- Line Drawing
  - 1D (lines)
- Optical
  - 0D (points)

Denotation system

- Silhouette:
  - 2D (regions)
- Line Drawing
  - 1D (lines)
  - Picasso, *Portrait of Stravinsky*
- Optical
  - 0D (points)

Denotation system

- Silhouette:
  - 2D (regions)
- Line Drawing
  - 1D (lines)
- Optical
  - 0D (points)
  - Picasso, *Paul as Arlequin*

A fourth denotation system

- Sculpture
  - 3D (volume)
    Picasso, *Head of a Woman (Fernande)*, 1909
- Silhouette:
  - 2D (regions)
- Line Drawing
  - 1D (lines)
- Optical
  - 0D (points)

Introduction to denotation systems

- Difference between drawing and paintings
- The multiple role of e.g. lines
- What denotes what in the picture?

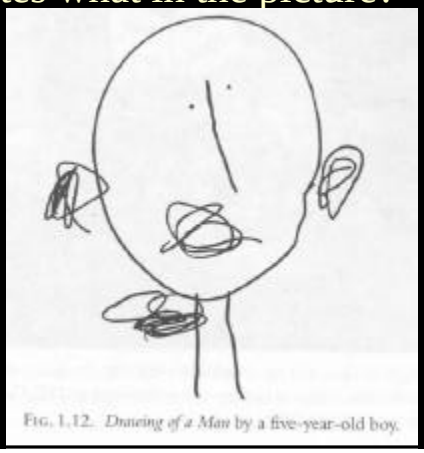


FIG. 1.12. *Drawing of a Man* by a five-year-old boy.

Plan

- Introducing denotation systems
- Line drawing
- A catalogue of primitives

Denotation system

- Scene
- Scene primitive
- Picture primitive
- Marks

Denotation system

- Scene
  - Objects, parts
- Scene primitive
  - Volumes, surfaces, lines and points of the scene.
- Picture primitive
  - Regions, lines and point in the picture
- Marks
  - Physical marks on the canvas

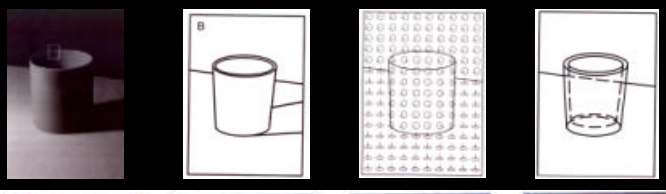
Denotation system

- Scene
- Scene primitive
- Picture primitive
- Marks

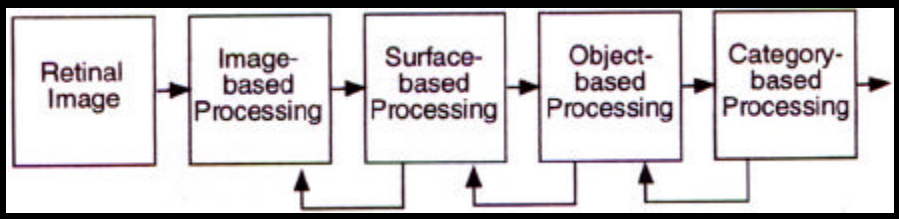
- Dimensions
- Extendedness
- Mapping

Stages of vision

- Bottom-up and top-bottom



Cup



Marks vs. primitive

- The mark is only the physical realization of the primitive
- They can have different dimensionality

Marks vs. primitive

- Mosaic
- Primitives = lines
- Marks = points (or small regions)

Marks vs. primitive

- Seurat, La Grande Jatte (detail)

Marks vs. primitive

- Paul Siemsen
  Picasso

Denotation system

Marks vs. primitive

Denotation system

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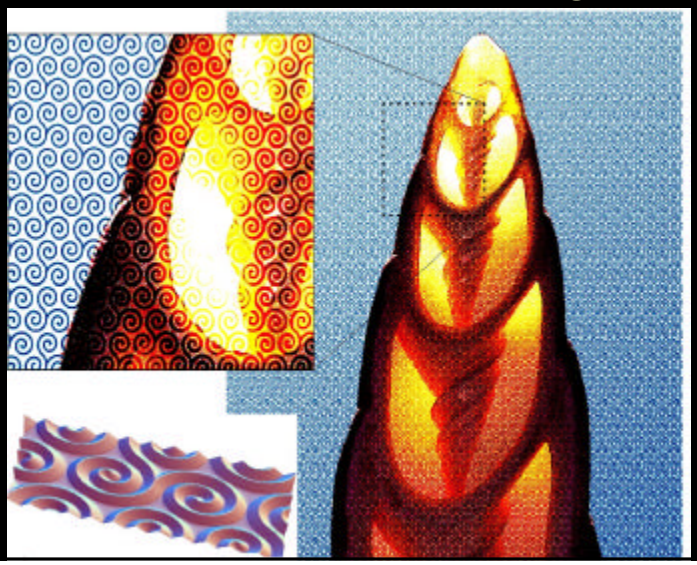
Marks vs. primitive

- Giuseppe Arcimboldo
  Summer, 1563

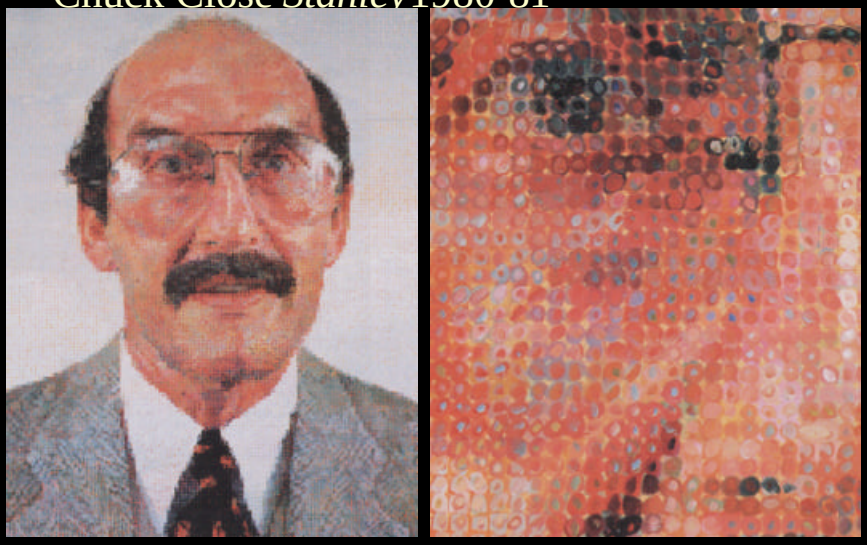
Marks vs. primitive

- Victor Ostromoukhov, Artistic halftoning



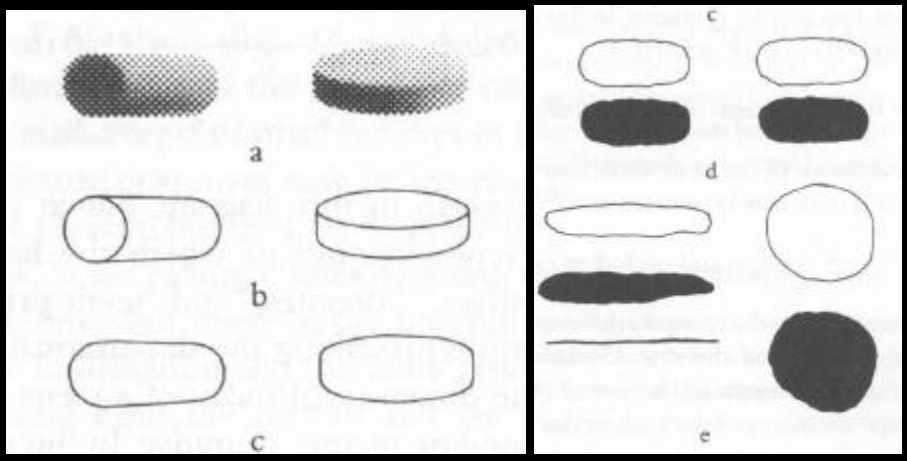
Marks vs. primitive

- Chuck Close *Stanley*1980-81



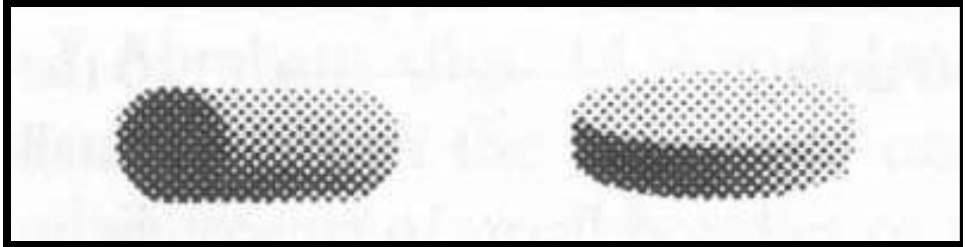
Denotation

- Example of a cylinder and a disc



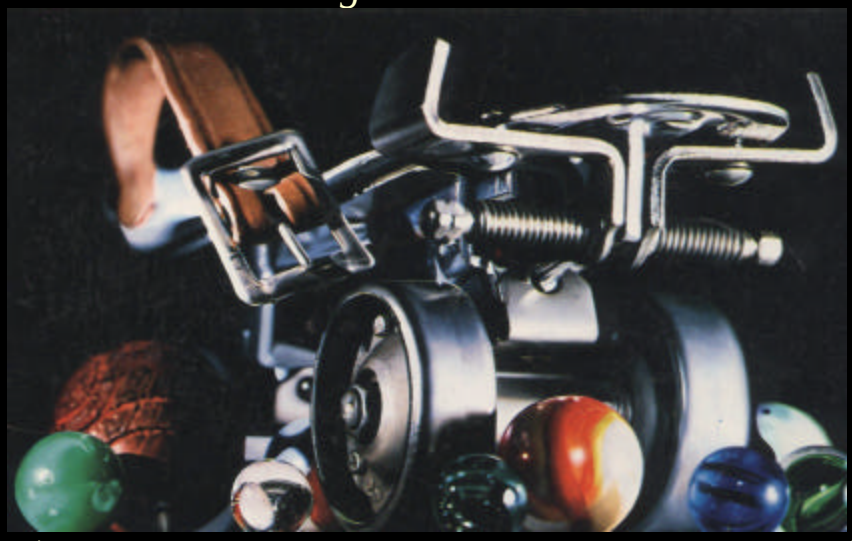
Denotation: optical

- Example of a cylinder and a disc
- Picture point denote scene point
- 0 (dot) => 0 (visible point)



Denotation: optical

- Charles Bell *Chicago* 1980

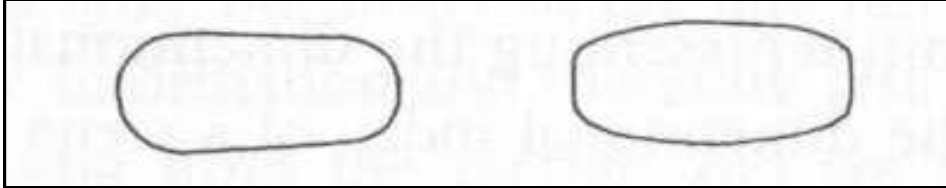


Denotation: line drawing

- Example of a cylinder and a disc
- Picture line denotes scene line
- 1 (line) => 1 (scene occluding contour and edge)

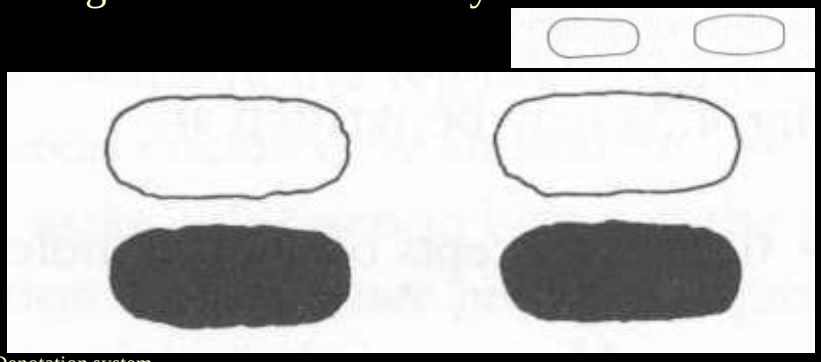
Denotation: outline drawing

- Example of a cylinder and a disc
- Picture line denotes scene line
- 1 (line) => 1 (scene occluding contour)
- No internal edge



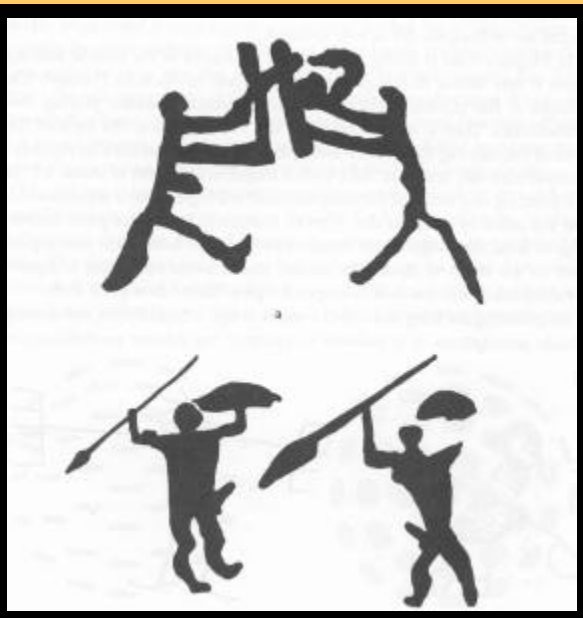
Denotation: silhouette

- Example of a cylinder and a disc
- Picture region denotes scene visible region
- 2_{10} (region) => 2_{10} (visible region)
- Edge becomes more fuzzy and less salient



Silhouette vs. outline

Silhouette vs. outline



Silhouette vs. outline

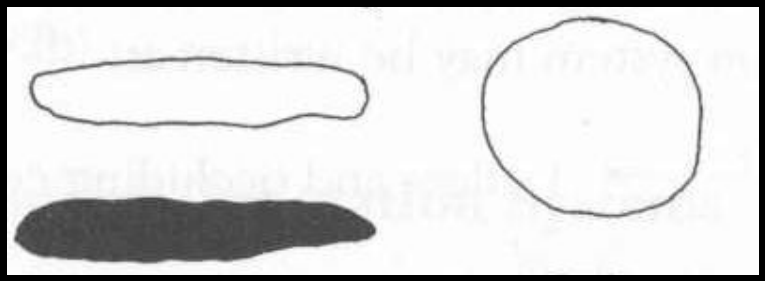
Silhouette vs. outline

Silhouette vs. outline

Silhouette vs. outline

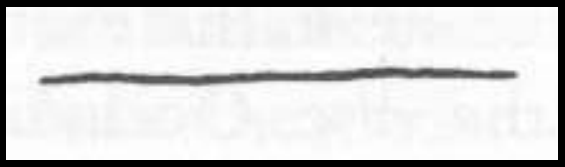
Denotation: volume

- Example of a cylinder and a disc
- Picture region denotes scene volume
- 2_{10} (extended region) => 3_{100} (extended volume)
- 2_{11} (circular region) => 3_{110} (disc)



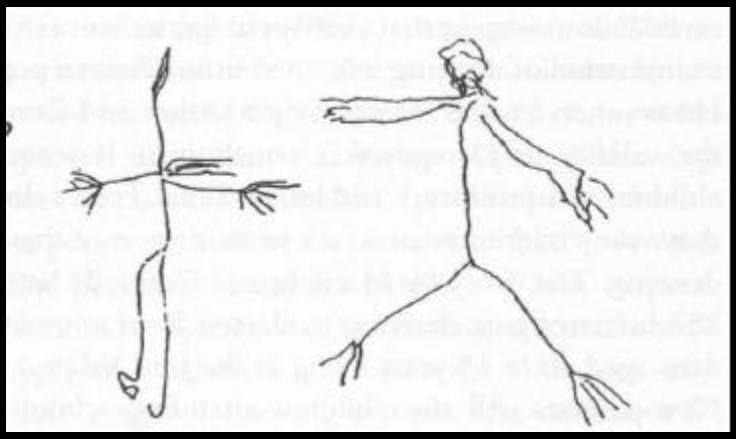
Denotation: volume

- Example of a cylinder and a disc
- Picture region denotes scene volume
- 1 (line) => 3_{100} (extended volume)



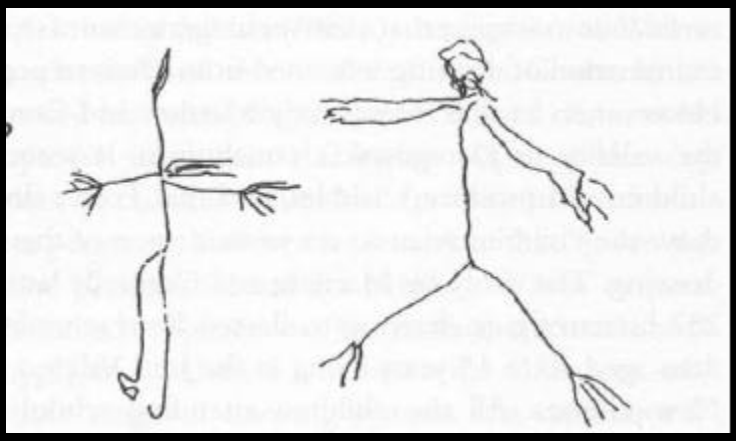
Denotation: volume

- 1 (line) => 3_{100} (extended volume)



Denotation: volume

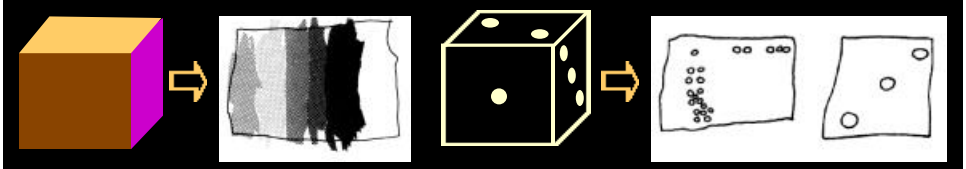
- 1 (line) => 3_{100} (extended volume)
- Related to the *structural skeleton*



Denotation: volume

3D and 2D attributes

- Show colored or numbered dice to children (6-7)
- The still draw a rectangle
- But different colors or many points
- The rectangle stands for the whole dice
- The notion of 3D object with corners is translated as a 2D object with corners



Denotation: volume

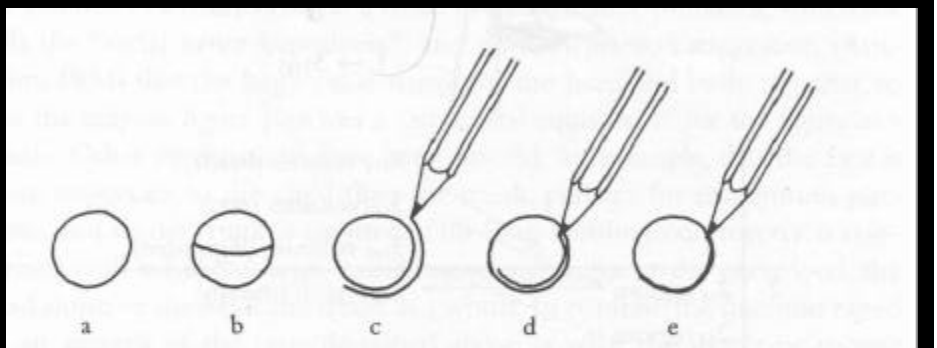
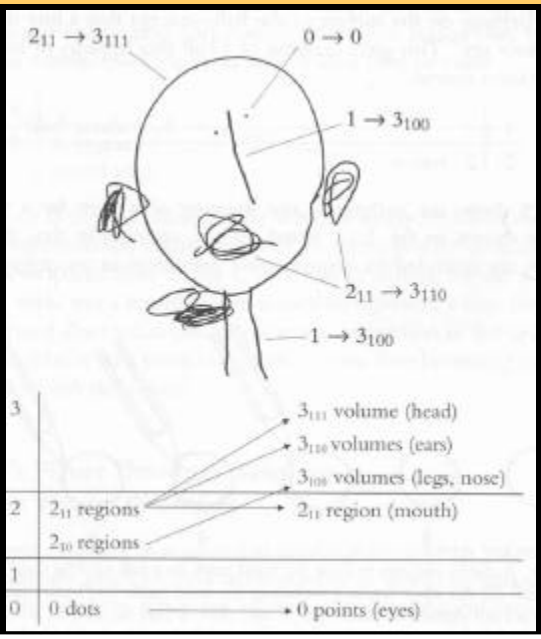
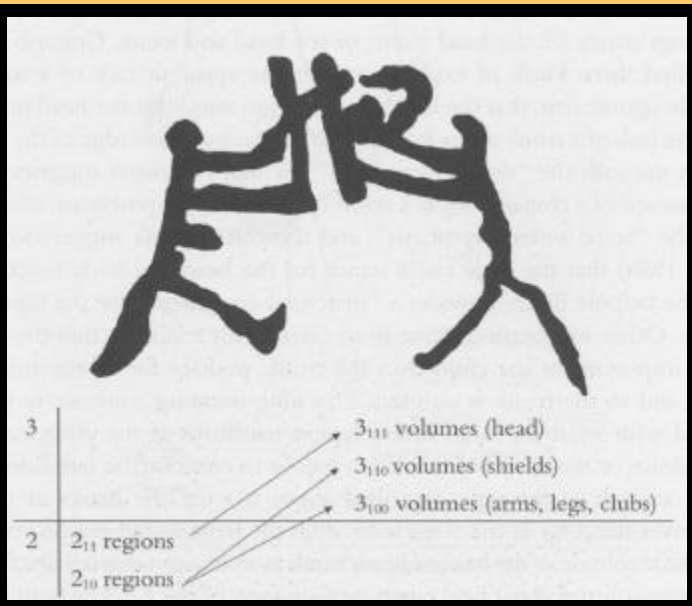


FIG. 4.4. A child's attempts to draw the mold mark on a ball. (a) The child's drawing of the ball. (b) An adult drawing, including the mold mark. (c) "I can't draw it here because it's not outside the ball." (d) "I can't draw it here because it's not inside the ball." (e) "And I can't draw it here because it won't show up. So I can't do it." From Willats (1985), courtesy of Cambridge University Press.

Denotation analysis

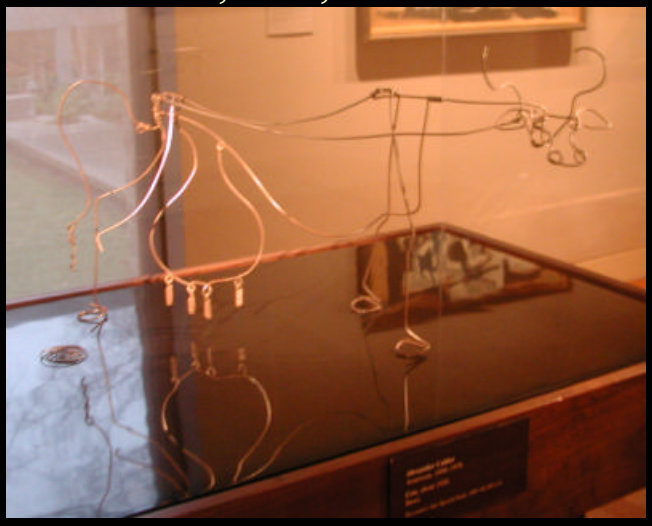


Denotation analysis



Denotation: special case

- Alexander Calder, *Cow*, 1926



Lineal/pictorial

- Heinrich Wölfflin, 1916
- Renaissance vs. Baroque
- The line and drawing vs. the brush stroke

Lineal/pictorial

- E.g. Michelangelo vs. Rembrandt

Plan

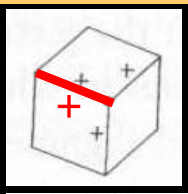
- Introducing denotation systems
- Line drawing
- A catalogue of primitives

Line drawing polyhedral objects

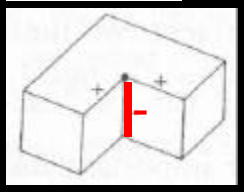
- [Clowes 71, Huffman 71, Waltz 75]
- Computer vision
- Analyze line drawing
- Label regions, analyze occlusions
- Classify edges and vertices of the line drawing

Labeling edges

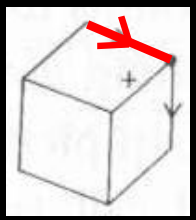
- Convex +



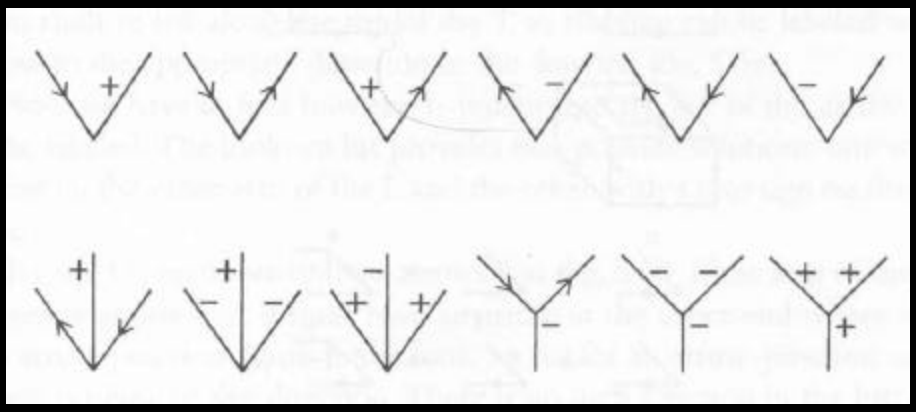
- Concave -



- Occluding -> (object on the right)



Labeling corners



Denotation system

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Labeling corners

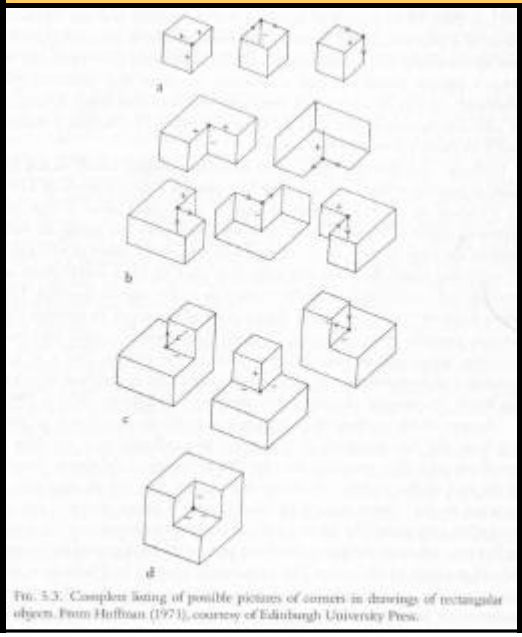

FIG. 5.3. Complete listing of possible pictures of corners in drawings of rectangular objects. From Huffman (1971), courtesy of Edinburgh University Press.

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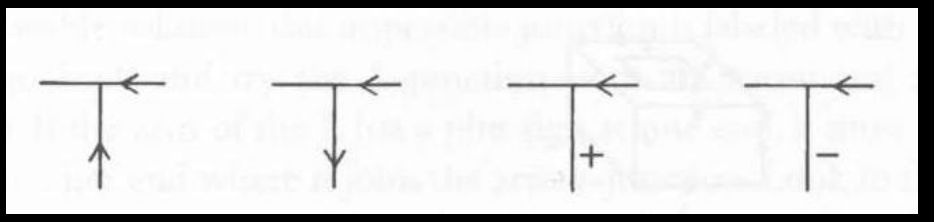
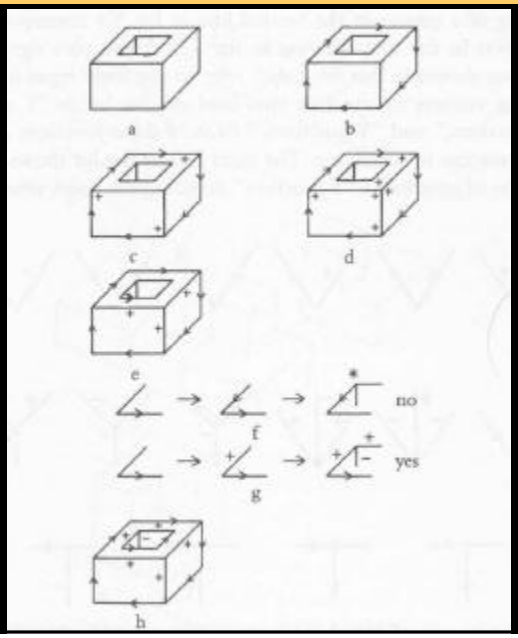
Labeling junctions

- The arrow is always in the same direction (because of occlusion)



Labeling



Ambiguous/impossible

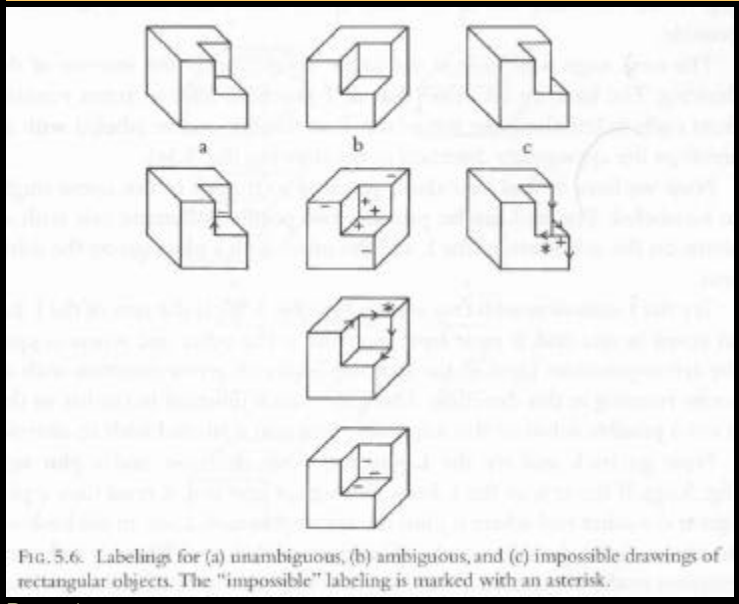
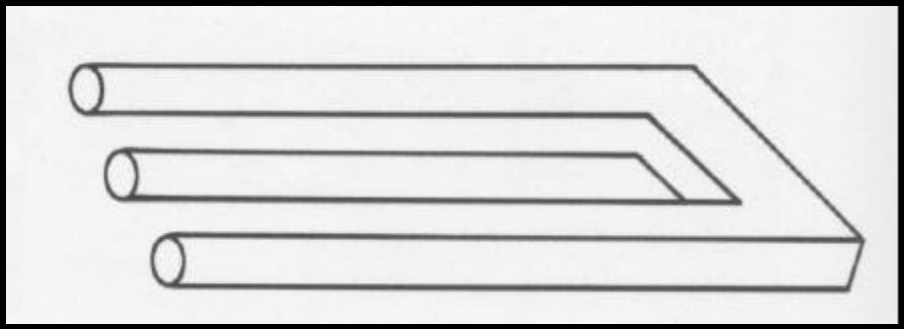
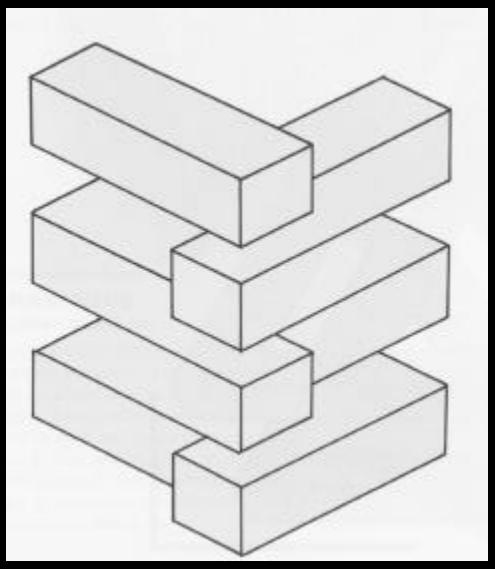


FIG. 5.6. Labelings for (a) unambiguous, (b) ambiguous, and (c) impossible drawings of rectangular objects. The "impossible" labeling is marked with an asterisk.

Ambiguous/impossible

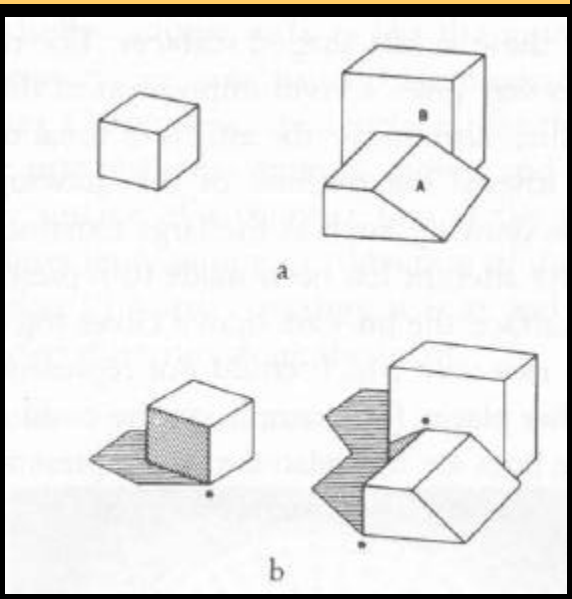


Ambiguous/impossible

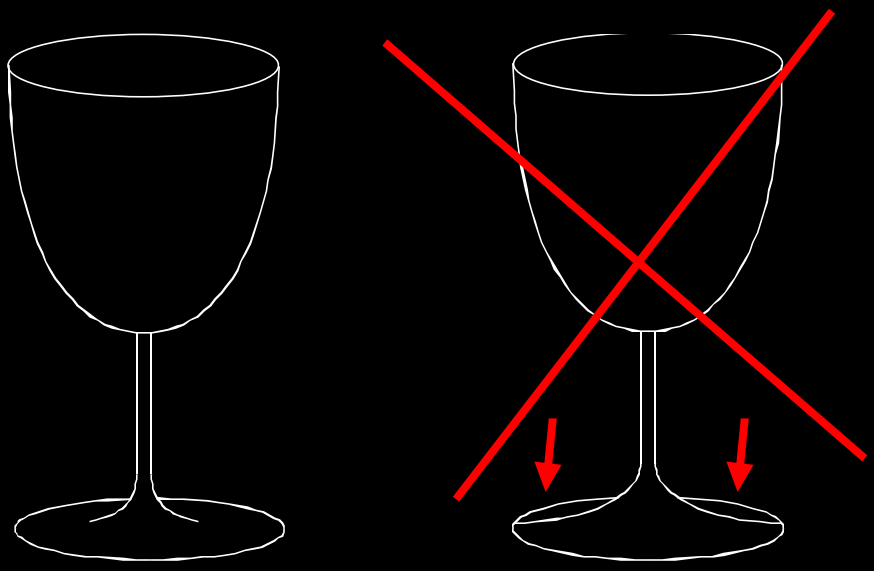


Extension to shadowed scenes

- Waltz 1975

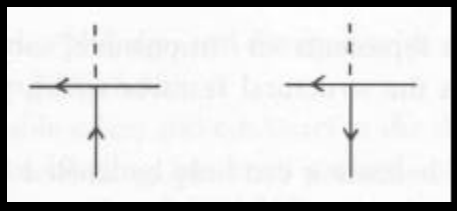


Line drawing of smooth objects



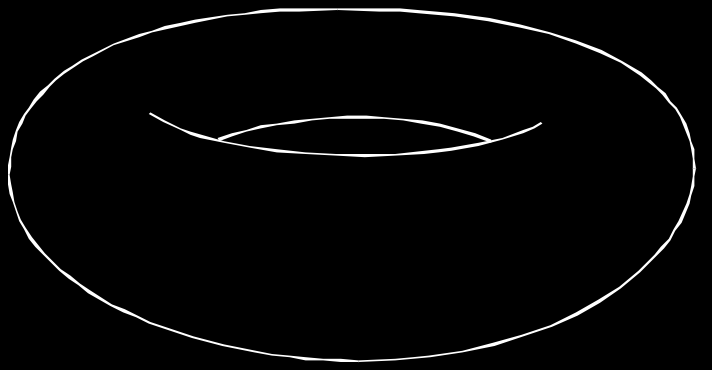
Line drawing of smooth objects

- Only one kind of edge
  - occluding contour
- Two types of vertices
  - T-junction (a.k.a. T-vertex)

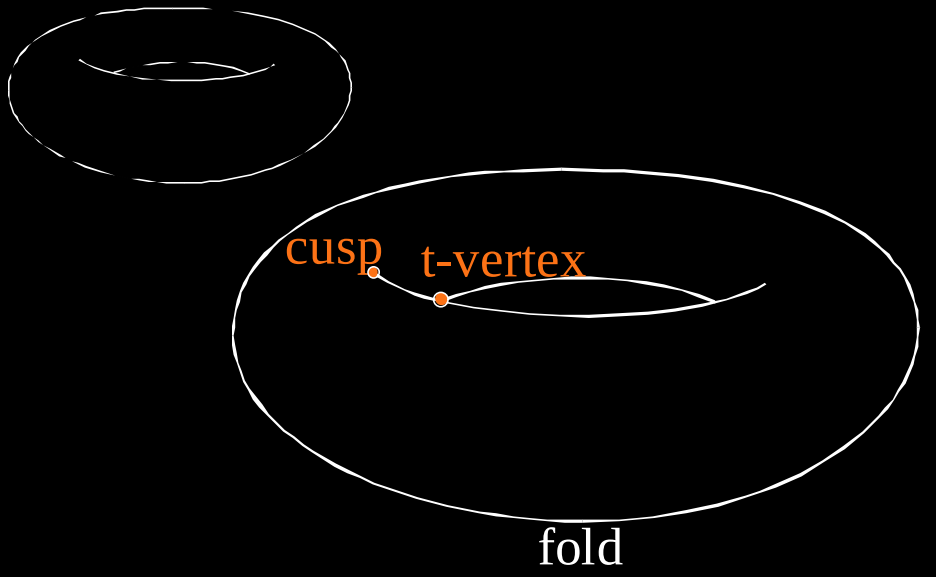


  - End-junction (a.k.a. cusp)

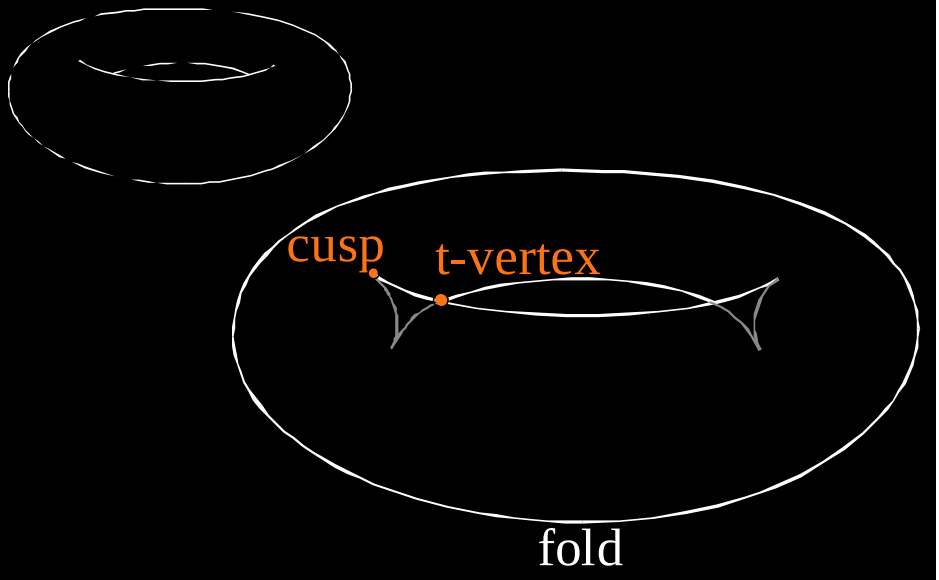
Line drawing of a torus



Line drawing of a torus



Line drawing of a torus

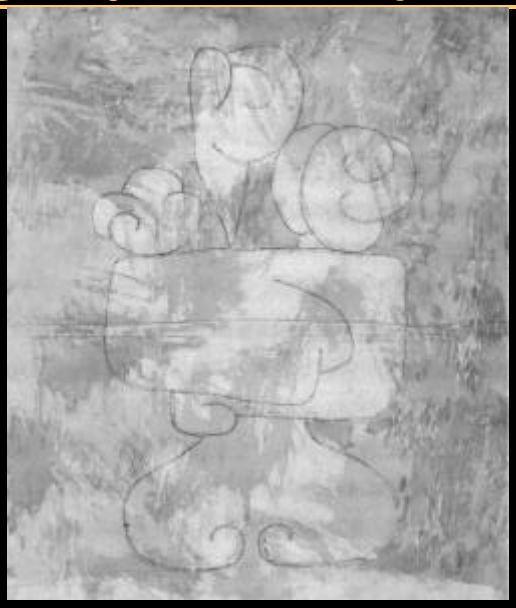


Drawing of smooth objects

- Walt Disney *sketch for Mickey's Parrot* 1938

Drawing of imaginary smooth object

- Paul Klee
- "As the figure grows little by little before our eyes an association of ideas may easily tempt us into objective interpretation. For with a bit of imagination every complex structure lends itself to a comparison with familiar forms in nature"



Ambiguous/impossible

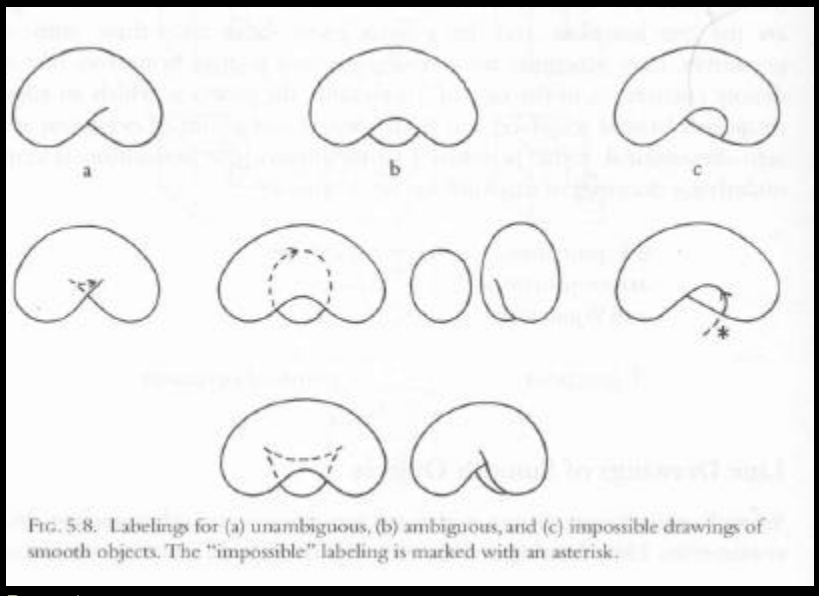
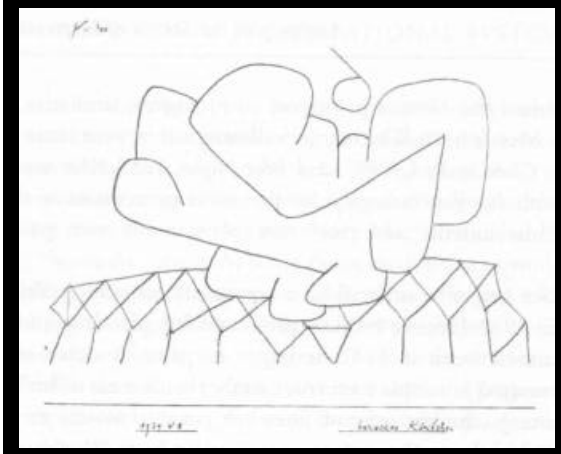
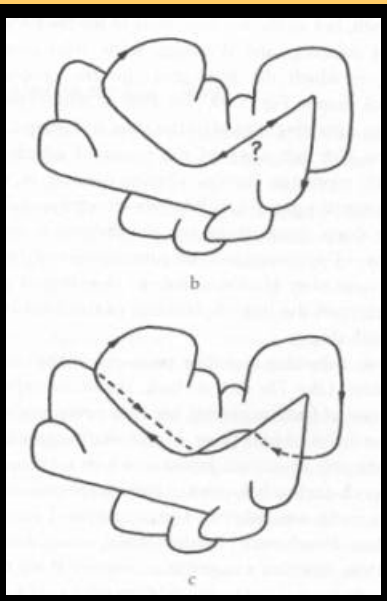


FIG. 5.8. Labelings for (a) unambiguous, (b) ambiguous, and (c) impossible drawings of smooth objects. The "impossible" labeling is marked with an asterisk.

Ambiguous/impossible

- Klee
  Little Baroque Basket 1939





Ambiguous/impossible

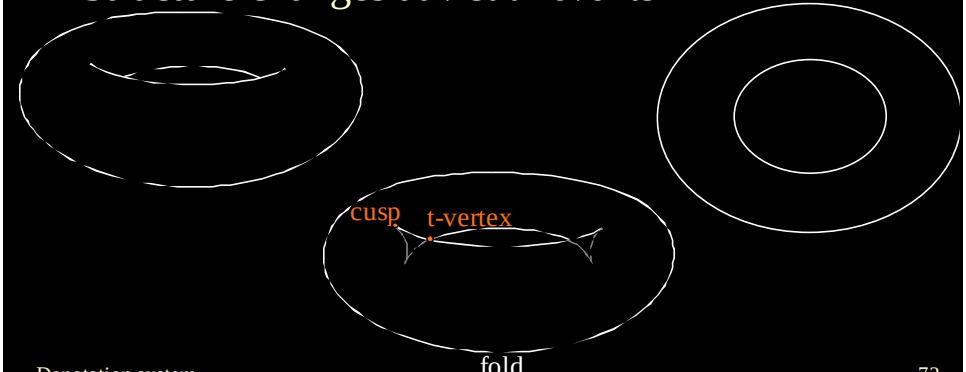
- Pratt Institute
  Gresh Mc Ginn

Ambiguous/impossible

- Pratt Institute
  Gresh Mc Ginn

Just for fun

- Theory of singularity
- Evolution of the drawing when the viewpoint moves
- Structure changes at *visual events*

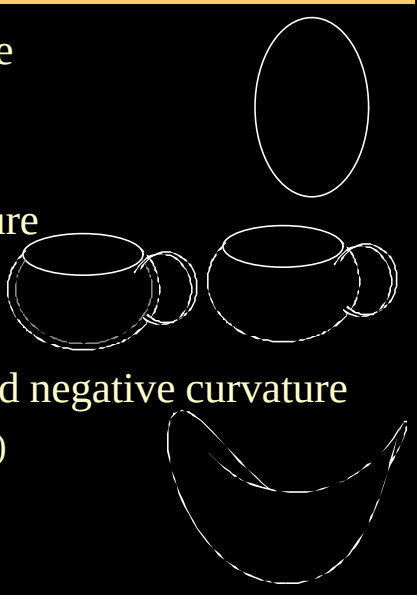


Convex/concave/saddle

- Convex: positive curvature
  - Egg
- Concave: negative curvature
  - Interior of cup
- Saddle: mix of positive and negative curvature
  - Saddle (surprising, isn't it?)

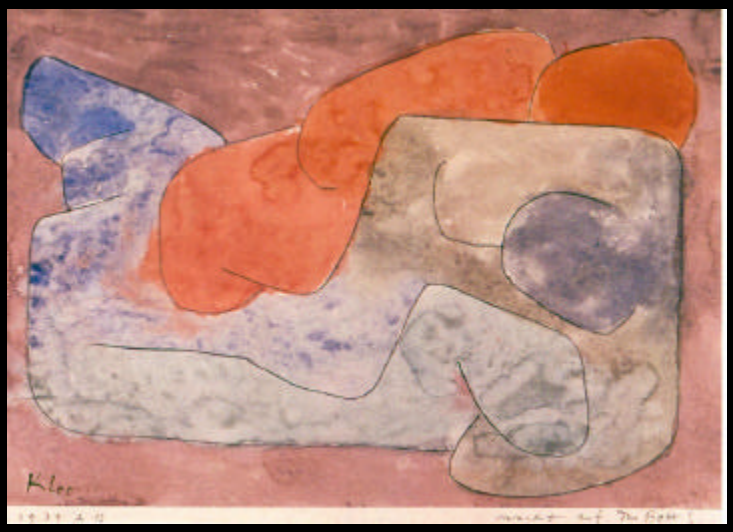
Convex/concave/saddle

- Convex: positive curvature
  - Egg
  - Convex contour
- Concave: negative curvature
  - Interior of cup
  - Hidden contour
- Saddle: mix of positive and negative curvature
  - Saddle (surprising, isn't it?)
  - Concave contour



Drawing of smooth objects

- Klee, *Naked on the Bed*, 1939



Drawing of smooth objects

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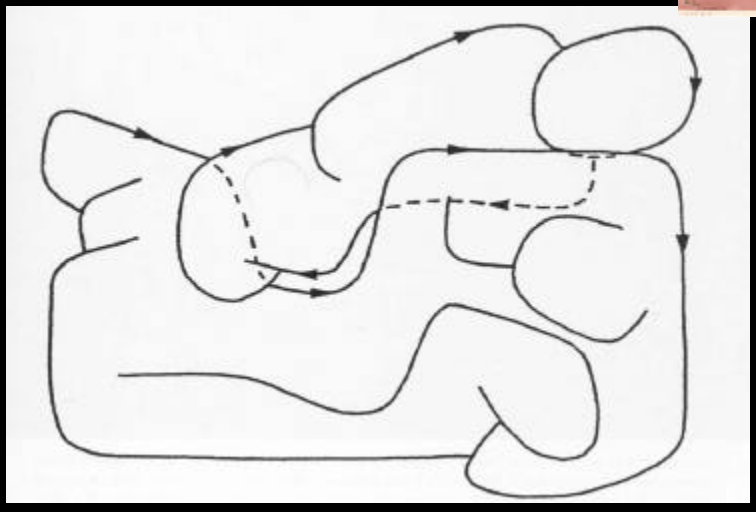

Drawing of smooth objects

- Picasso, *Portrait of Stravinsky*

Drawing of smooth objects

- Katsuka Shunsho, Japanese, 1782

A second look

- Cup
- Table

Plan

- Introducing denotation systems
- Line drawing
- A catalogue of primitives

Picture primitive

- Points
- Lines
- Regions

Scene primitive

- View independent vs. view dependent

- 3D
- 2D
- 1D
- 0D

3D and 2D scene primitives

- 3D
  - Volume
  - Extendedness (sphere, disc, lump)
- 2D
  - Surface

1D scene primitives

- View independent
  - Very thin objects (string, etc.)
  - Edge
  - Reflectance edge
  - Shadow edge
  - Transparency edge
  - Surface contours
- View dependent
  - Occluding contour
  - Silhouette

1D scene primitives

- View independent
  - Very thin objects (string, etc.)
  - Edge
  - Reflectance edge
  - Shadow edge
  - Transparency edge
  - Surface contours
- View dependent
  - Occluding contour
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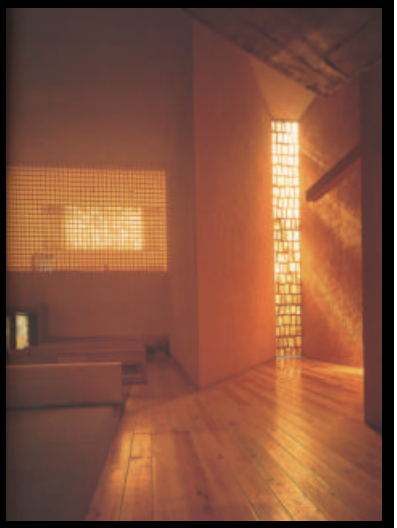

1D scene primitives

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  - Edge
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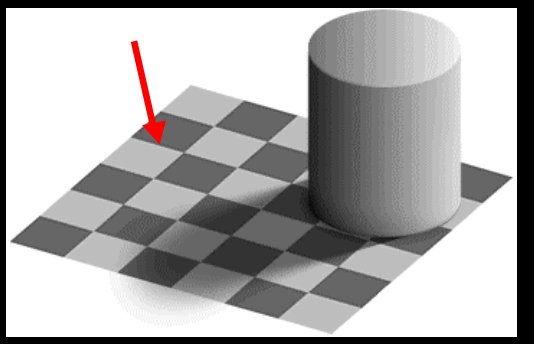

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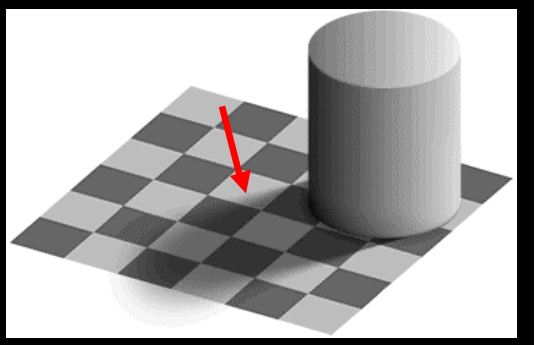

1D scene primitives

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Transparency

- Lissitzky

1D scene primitives

- View independent
  - Very thin objects (string, etc.)
  - Edge
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  - Shadow edge
  - Transparency edge
  - Surface contours
- View dependent
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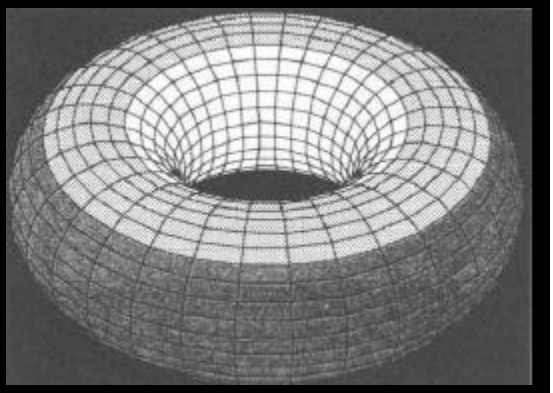


Surface contours

Surface contours

Denotation system 93

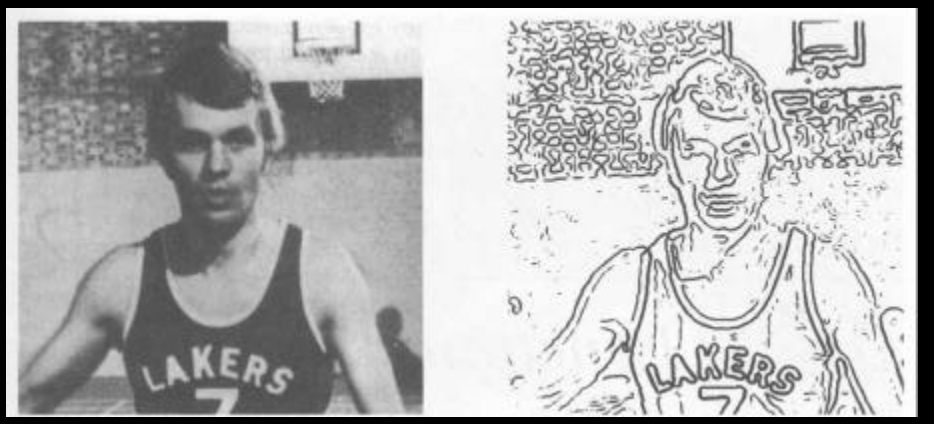
Surface contours

Denotation system 94

1D scene primitives

- View independent
  - Very thin objects (string, etc.)
  - Edge
  - Reflectance edge
  - Shadow edge
  - Transparency edge
  - Surface contours
- View dependent
  - Occluding contour
  - Silhouette

Edge detection



Edge detection

- Contour film

Edge detection

- Matisse, *Loulou*

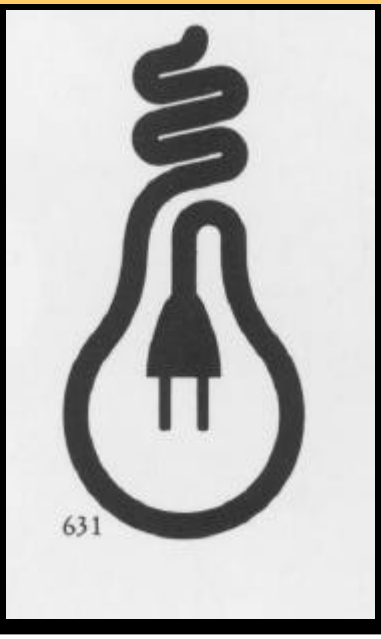
Edge detection

- Matisse, *Loulou*

0D scene primitives

- Generic visible point
- View independent
  - Corner
  - X-junction for shadow
- View dependent
  - T-junction
  - Cusp
  - X-junction for transparency

A complex example



A complex example

- Tom Purvis 1935

A complex example

- E Mc Knight Kauffer 1947

A complex example

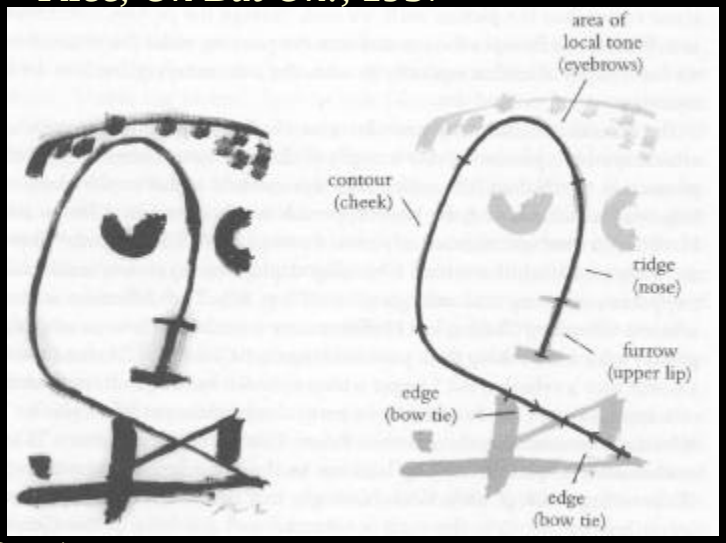
- Ingres

A complex example

- Klee, *Oh But Oh!*, 1937

A complex example

- Klee, *Oh But Oh!*, 1937



Backlighting

- Line drawing…

Complex system

- Henry Wolf
  Nude

Drawing

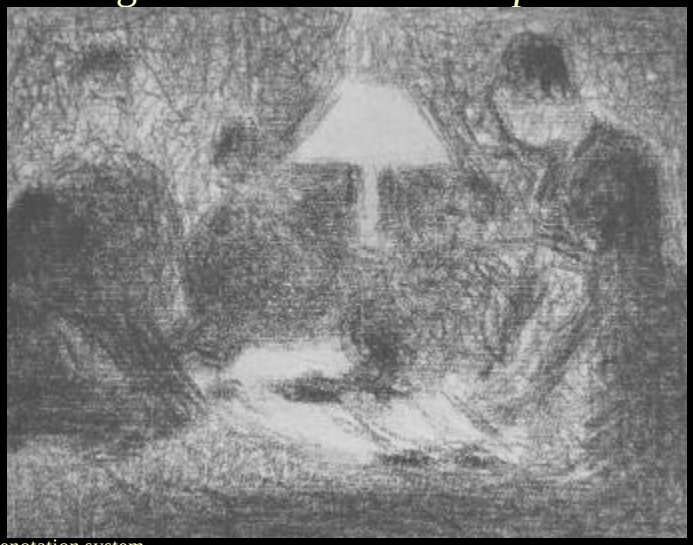
- Dürer,
  Head of a Man

Drawing

- Raphael

Drawing

- Georges Seurat *Sous la Lampe* 1882-83



Simplification

- Picasso *The Bull* 1945