

The Art and Science of Depiction
Denotation system

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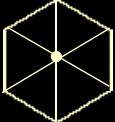
Invention of linear perspective

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

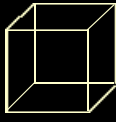
Denotation system 2

Accidental/generic

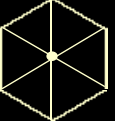
- From the objective geometric point of view



Accidental viewpoint




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



Denotation system 3

Prototypes

- Solso



Denotation system 4

Maximum size

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

Denotation system 5

Maximum size

- Kosslyn
- Imagine a horse in the distance
- Imagine it moves continuously towards you
- When does it “overflows” your visual field?
- 20° for strict overflow
- 40-60 ° for lax overflow

Denotation system 6

Maximum size

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

Denotation system

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Denotation system

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



Denotation system

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Denotation system

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



Denotation system

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Denotation system

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



Denotation system

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A fourth denotation system

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



Denotation system

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Introduction to denotation systems

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



Denotation system

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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

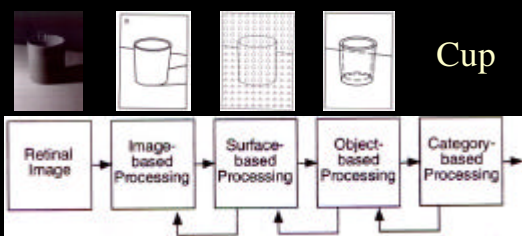
Denotation system

- Scene
- Scene primitive
- Picture primitive
- Marks

- Dimensions
- Extendedness
- Mapping

Stages of vision

- Bottom-up and top-bottom



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)



Denotation system

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Marks vs. primitive

- Seurat, La Grande Jatte (detail)



Denotation system

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Marks vs. primitive

- Paul Siemsen
Picasso



Denotation system

Marks vs. primitive



Denotation system

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Marks vs. primitive

- Giuseppe Arcimboldo
Summer, 1563

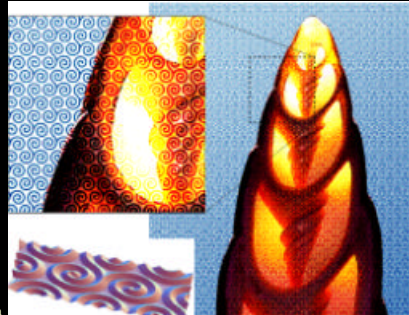


Denotation system

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Marks vs. primitive

- Victor Ostromoukhov, Artistic halftoning



Denotation system

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Marks vs. primitive

- Chuck Close *Stanley* 1980-81

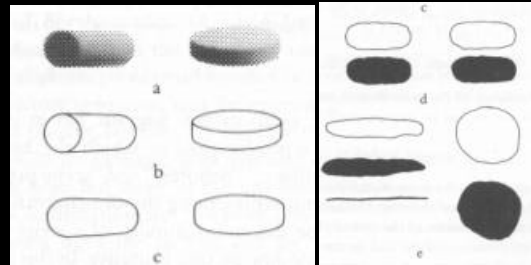


Denotation system

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Denotation

- Example of a cylinder and a disc

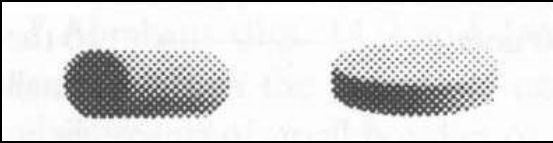


Denotation system

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Denotation: optical

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

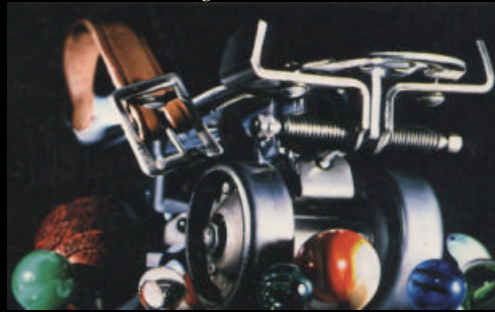


Denotation system

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Denotation: optical

- Charles Bell *Chicago* 1980



Denotation system

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Denotation: line drawing

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



Denotation system

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Denotation: outline drawing

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

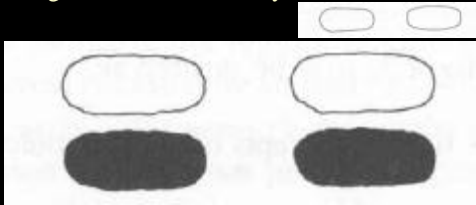


Denotation system

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Denotation: silhouette

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



Denotation system

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Silhouette vs. outline



Denotation system

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Silhouette vs. outline



Denotation system

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Silhouette vs. outline



Denotation system

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Silhouette vs. outline



Denotation system

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Silhouette vs. outline



Denotation system

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Silhouette vs. outline

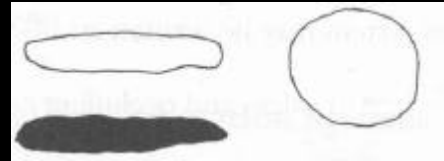


Denotation system

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Denotation: volume

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



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Denotation: volume

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

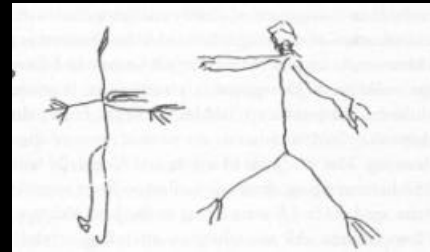


Denotation system

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Denotation: volume

- 1 (line) $\Rightarrow 3_{100}$ (extended volume)

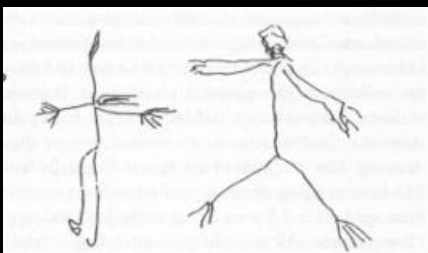


Denotation system

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Denotation: volume

- 1 (line) $\Rightarrow 3_{100}$ (extended volume)
- Related to the *structural skeleton*



Denotation system

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Denotation: volume

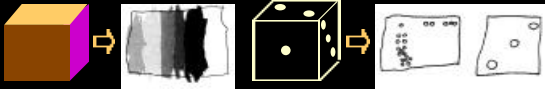


Denotation system

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3D and 2D attributes

- Show colored or numbered dice to children (6-7)
- They 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 system

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Denotation: volume

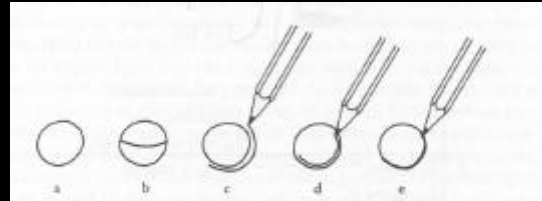
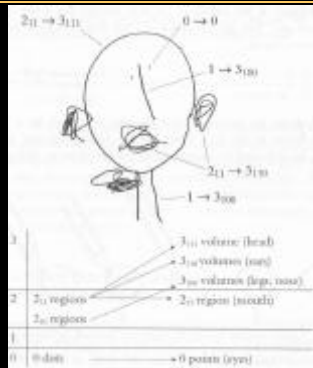


FIG. 4.4. A child's attempts to draw the mold mark on a ball. (a) The child's drawing of the ball. (b) An adult drawing, including the mold mark. (c) "I can't draw it here because it's not outside the ball." (d) "I can't draw it here because it's not inside the ball." (e) "And I can't draw it here because it won't show up. So I can't do it." From Willan (1983), courtesy of Cambridge University Press.

Denotation system

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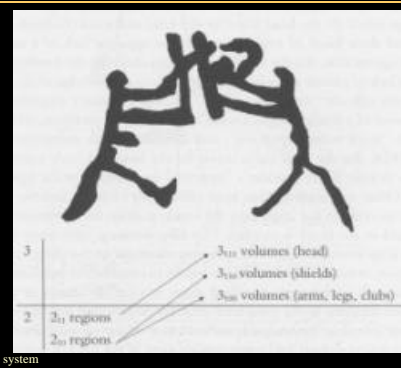
Denotation analysis



Denotation system

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Denotation analysis

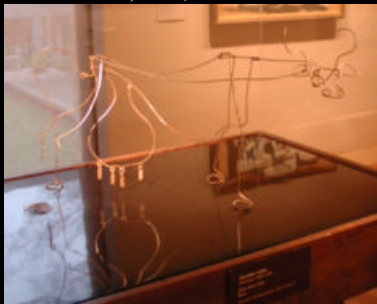


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Denotation: special case

- Alexander Calder, *Cow*, 1926



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Lineal/pictorial

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

Denotation system

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Lineal/pictorial

- E.g. Michelangelo vs. Rembrandt



Denotation system

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Plan

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

Denotation system

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Line drawing polyhedral objects

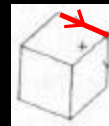
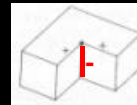
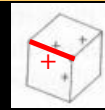
- [Clowes 71, Huffman 71, Waltz 75]
- Computer vision
- Analyze line drawing
- Label regions, analyze occlusions
- Classify edges and vertices of the line drawing

Denotation system

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Labeling edges

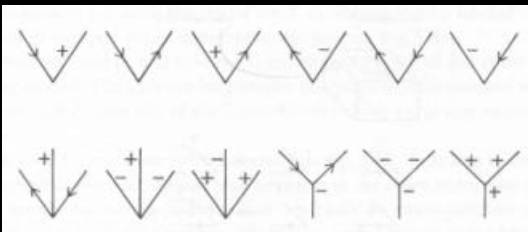
- Convex +
- Concave -
- Occluding ->
(object on the right)



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Labeling corners



Denotation system

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Labeling corners

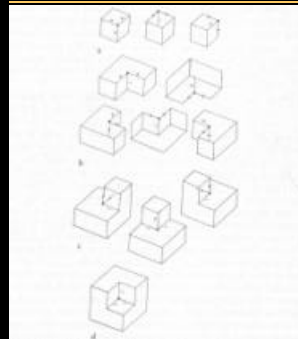
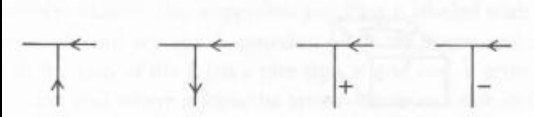


Fig. 3.3. Complete listing of possible patterns of corners in drawings of rectangular objects. From Huffman (1971), courtesy of Edinburgh University Press.

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Labeling junctions

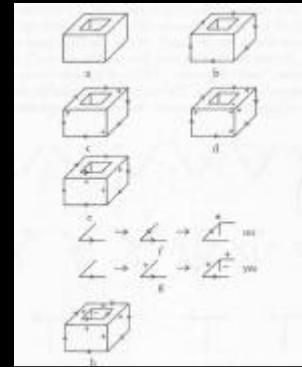
- The arrow is always in the same direction (because of occlusion)



Denotation system

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Labeling



Denotation system

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Ambiguous/impossible

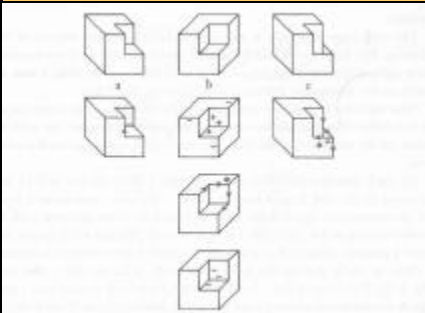


Fig. 5.6. Labelings for (a) unambiguous, (b) ambiguous, and (c) impossible drawings of rectangular objects. The "impossible" labeling is marked with an asterisk.

Denotation system

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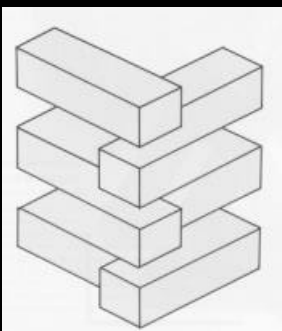
Ambiguous/impossible



Denotation system

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Ambiguous/impossible

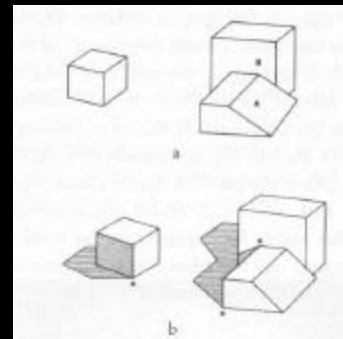


Denotation system

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Extension to shadowed scenes

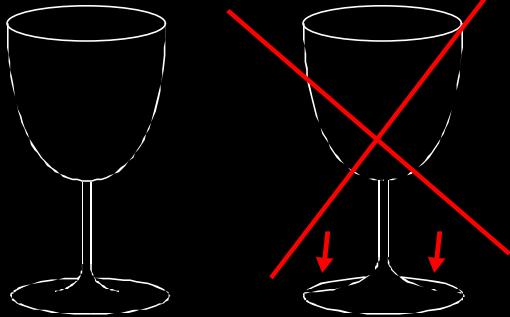
- Waltz 1975



Denotation system

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Line drawing of smooth objects

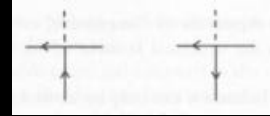


Denotation system

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Line drawing of smooth objects

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



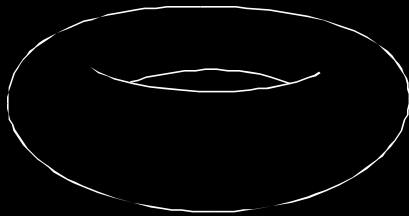
- End-junction (a.k.a. cusp)



Denotation system

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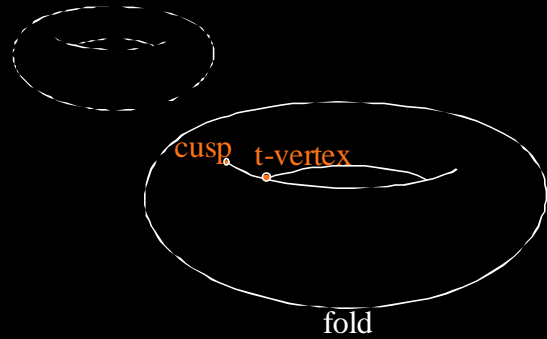
Line drawing of a torus



Denotation system

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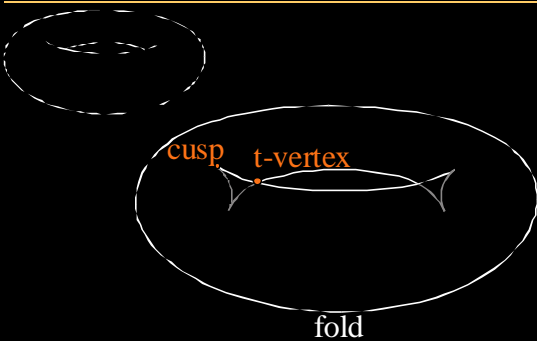
Line drawing of a torus



Denotation system

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Line drawing of a torus



Denotation system

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Drawing of smooth objects

- Walt Disney sketch for Mickey's Parrot 1938



Denotation system

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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"



Denotation system

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Ambiguous/impossible

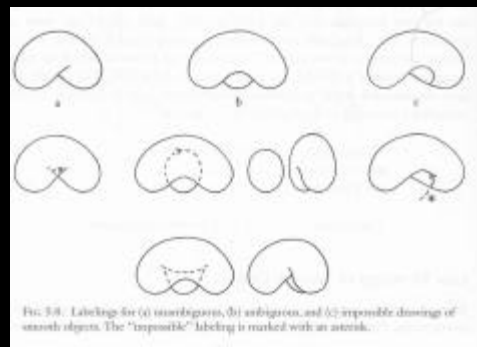


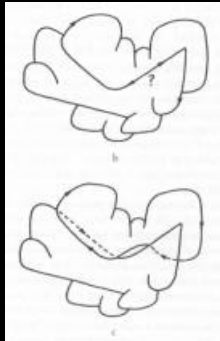
FIG. 5.8. Labelings for (a) unambiguous, (b) ambiguous, and (c) impossible drawings of smooth objects. The "impossible" labeling is marked with an asterisk.

Denotation system

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Ambiguous/impossible

- Klee
- *Little Baroque Basket* 1939



Denotation system

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Ambiguous/impossible

- Pratt Institute
- Gresh Mc Ginn



Denotation system

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Ambiguous/impossible

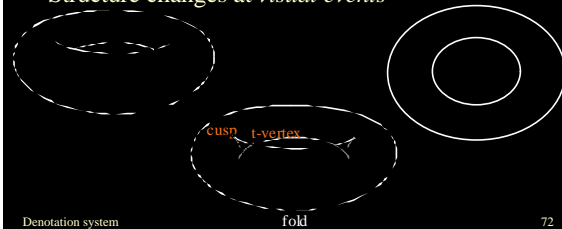
- Pratt Institute
- Gresh Mc Ginn

Denotation system

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Just for fun

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



Denotation system

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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?)

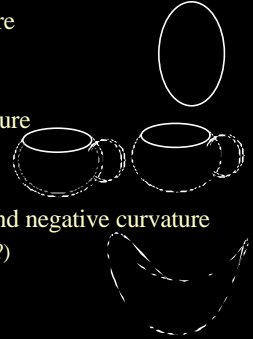


Denotation system

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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



Denotation system

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Drawing of smooth objects

- Klee, *Naked on the Bed*, 1939

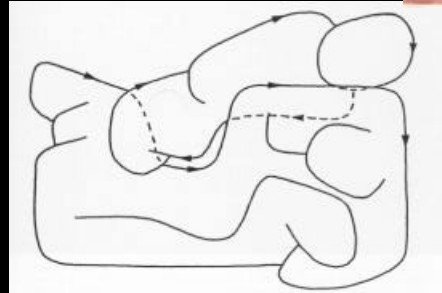


Denotation system

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Drawing of smooth objects

- Klee, *Naked on the Bed*, 1939



Denotation system

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Drawing of smooth objects

- Picasso, *Portrait of Stravinsky*



Denotation system

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Drawing of smooth objects

- Katsuka Shunsho, Japanese, 1782



Denotation system

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A second look

- Cup
- Table



Denotation system

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Plan

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

Denotation system

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Picture primitive

- Points
- Lines
- Regions

Denotation system

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Scene primitive

- View independent vs. view dependent
- 3D
- 2D
- 1D
- 0D

Denotation system

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3D and 2D scene primitives

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

Denotation system

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1D scene primitives


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

Denotation system

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1D scene primitives

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



Denotation system 85

1D scene primitives

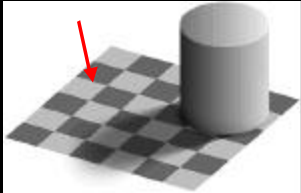
- View independent
 - Very thin objects (string, etc.)
 - Edge
 - Reflectance edge
 - Shadow edge
 - Transparency edge
 - Surface contours
- View dependent
 - Occluding contour
 - Silhouette



Denotation system 86

1D scene primitives

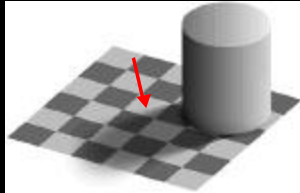
- View independent
 - Very thin objects (string, etc.)
 - Edge
 - Reflectance edge
 - Shadow edge
 - Transparency edge
 - Surface contours
- View dependent
 - Occluding contour
 - Silhouette



Denotation system 87

1D scene primitives

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



Denotation system 88

1D scene primitives

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



Denotation system 89

Transparency

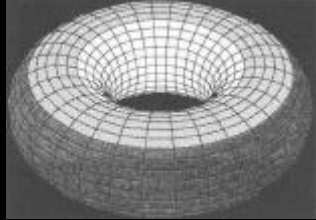
- Lissitzky



Denotation system 90

1D scene primitives

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



Denotation system

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Surface contours



Denotation system

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Surface contours



Denotation system

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Surface contours



Denotation system

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1D scene primitives

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



Denotation system

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Edge detection



Denotation system

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Edge detection

- Contour film



Denotation system

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Edge detection

- Matisse, *Loulou*



Denotation system

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Edge detection

- Matisse, *Loulou*



Denotation system

Disappears rather quickly, doesn't it.

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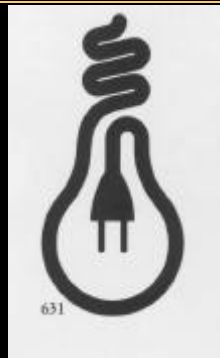
0D scene primitives

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

Denotation system

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A complex example



Denotation system

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A complex example

- Tom Purvis 1935



Denotation system

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A complex example

- E Mc Knight Kauffer 1947



Denotation system

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A complex example

- Ingres

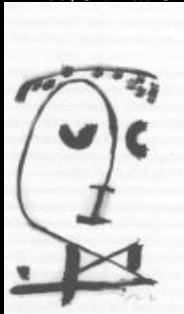


Denotation system

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A complex example

- Klee, *Oh But Oh!*, 1937

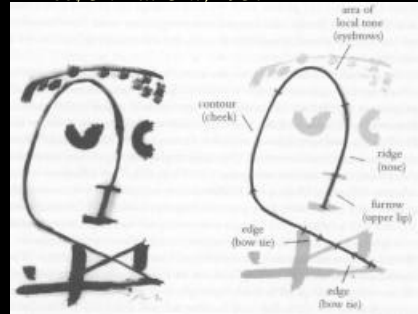


Denotation system

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A complex example

- Klee, *Oh But Oh!*, 1937



Denotation system

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Backlighting

- Line drawing...



Denotation system

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Complex system

- Henry Wolf *Nude*



Denotation system

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Drawing

- Dürer,
Head of a Man



Denotation system

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Drawing

- Raphael



Denotation system

110

Drawing

- Georges Seurat
Sous la Lampe 1882-83

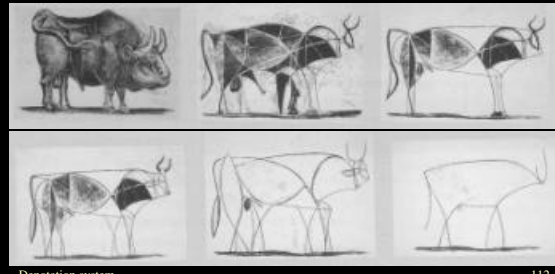


Denotation system

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Simplification

- Picasso
The Bull 1945



Denotation system

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