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

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**Accidental/generic**

- From the objective geometric point of view

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

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**Prototypes**

- Solso

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**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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  - 20° for strict overflow
  - 40-60 ° 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?
- 20° for strict overflow (equivalent 100mm)
- 40-60° for lax overflow (30-50mm)

Denotation system

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

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  - 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?
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)

Marks vs. primitive

- Seurat, La Grande Jatte (detail)

Marks vs. primitive

- Paul Siemsen Picasso

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) $\Rightarrow$ $0$ (visible point)

**Denotation: line drawing**
- Example of a cylinder and a disc
- Picture line denotes scene line
- $1$ (line) $\Rightarrow$ $1$ (scene occluding contour and edge)

**Denotation: outline drawing**
- Example of a cylinder and a disc
- Picture line denotes scene line
- $1$ (line) $\Rightarrow$ $1$ (scene occluding contour)
- No internal edge
**Denotation: silhouette**

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

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**Silhouette vs. outline**

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**Silhouette vs. outline**

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**Silhouette vs. outline**

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**Silhouette vs. outline**

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**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)

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**Denotation: volume**

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

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**Denotation: volume**

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

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**Denotation: volume**

- AN OBITUARY 225-325 225-325 225-325 225-325 225-325
- Two years later, in the
- *The Times*, his obituary
- Aged 84, 225-325 225-325 225-325 225-325
**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**

![Denotation: volume](image)

**Denotation analysis**

![Denotation analysis](image)

**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**
**Labeling junctions**

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

![Diagram](image1)

**Labeling**

![Diagram](image2)

**Ambiguous/impossible**

![Diagram](image3)

**Ambiguous/impossible**

![Diagram](image4)

**Ambiguous/impossible**

![Diagram](image5)

**Extension to shadowed scenes**

- Waltz 1975

![Diagram](image6)
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

- cusp
- t-vertex

Line drawing of a torus

- 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

- 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?)

Drawing of smooth objects

- Klee, *Naked on the Bed*, 1939

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
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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

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Denotation system

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Denotation system

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Denotation system

Transparency

- Lissitzky

Denotation system
1D scene primitives

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Surface contours

Edge detection
**Edge detection**
- Contour film

**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**
- Tom Purvis 1935
Denotation system

A complex example

• E Mc Knight Kauffer 1947

Keep it under your STETSON

Denotation system

A complex example

• Ingres

Denotation system

A complex example

• Klee, Oh But Oh!, 1937

Denotation system

A complex example

• Klee, Oh But Oh!, 1937

Denotation system

Backlighting

• Line drawing…

Denotation system

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