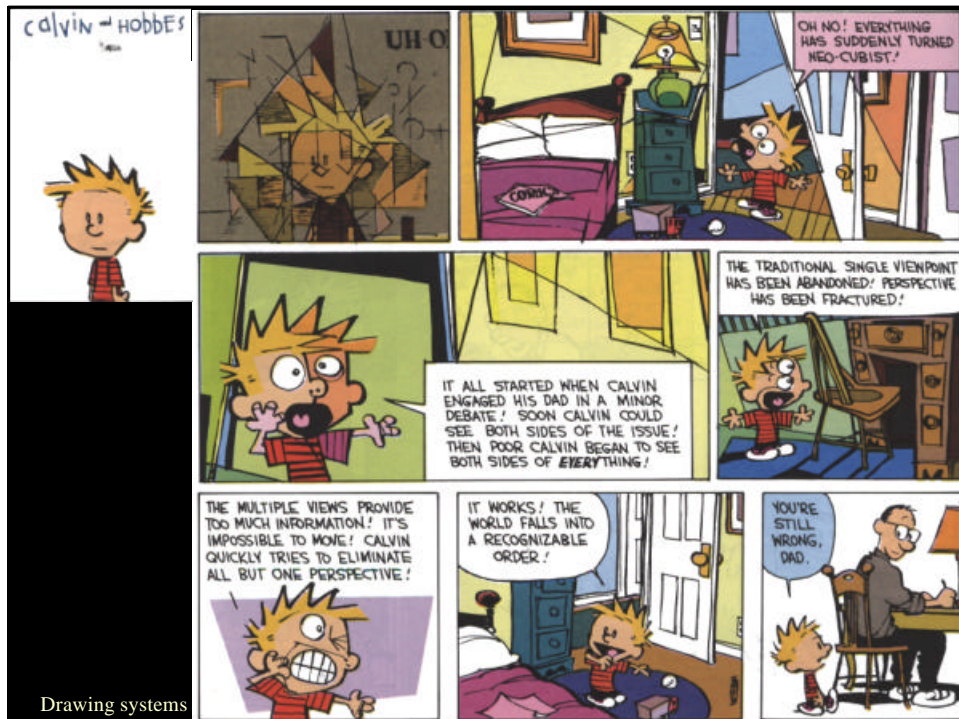*The Art and Science of Depiction*

Drawing systems

Fredo Durand

MIT- Lab for Computer Science

Drawing systems

Assignments for Monday 30.

- Solso *Cognition and the Visual Arts*
  - Chapter 8 & 9
- Final project
  - Firm subject

Plan

- Drawing and projection
  - Linear perspective & the Renaissance
  - Drawing systems
    - Catalogue of "all" drawing systems
    - Advantage/disadvantages
  - Distortion and constraints
- Denotation
- Tone & color

Issues

- Place of the spectator
- Intrinsic/extrinsic (essential/accidental)
- Unified space
- Shape representation
- Error/distortion/choice

- Child development
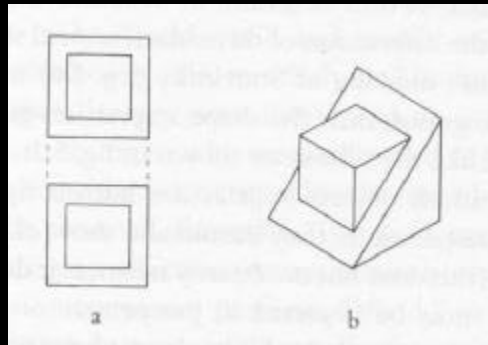- No cultural judgment!

Context

- Importance of the notion of front/top/side
- Presence of lines and planes or not
- Orthogonals
  - Lines orthogonal to the picture plane
  - I.e. lines that converge in the center of the image in central perspective
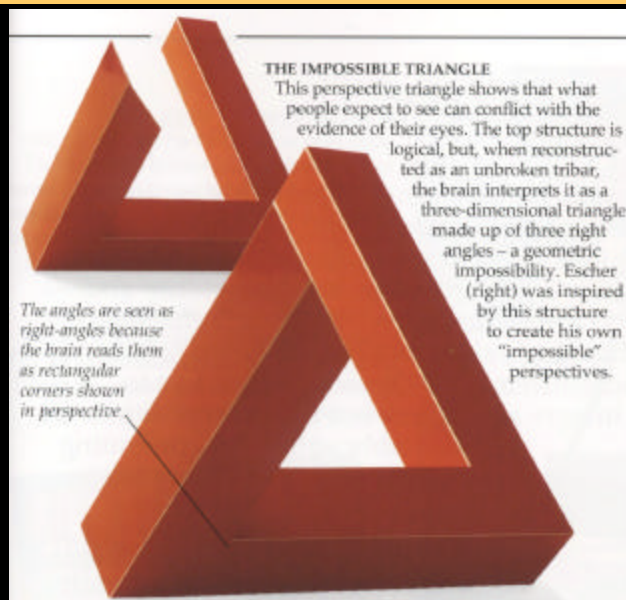- Picture plane/curved picture

Efficient shape representation

- True shape
- 3D layout
- Canonical view
- General/accidental view

Generic vs. accidental viewpoint

THE IMPOSSIBLE TRIANGLE
This perspective triangle shows that what people expect to see can conflict with the evidence of their eyes. The top structure is logical, but, when reconstructed as an unbroken tribar, the brain interprets it as a three-dimensional triangle made up of three right angles – a geometric impossibility. Escher (right) was inspired by this structure to create his own "impossible" perspectives.

The angles are seen as right-angles because the brain reads them as rectangular corners shown in perspective

Generic vs. accidental viewpoint

- Accidental alignment of trash and sea

Photo
Peter Turner

Generic vs. accidental viewpoint

Canonical view

- Rate views

BEST (1.60)

BEST (1.60) · SIDE (1.84) · FRONT-SIDE (2.12) · FRONT-SIDE-TOP (2.80) · SIDE-TOP (3.48) · FRONT (3.72) · BACK-SIDE (4.12) · BACK-SIDE-TOP (4.29) · FRONT-TOP (4.80) · BACK-TOP (5.56) · BACK (5.58) · TOP (6.36)
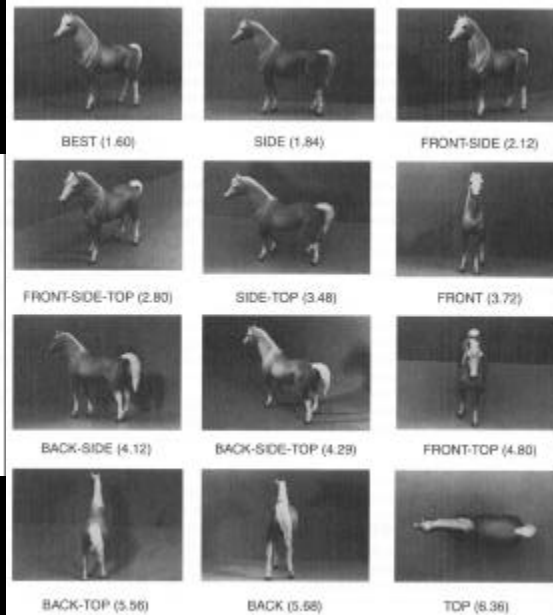
Canonical view

- Rate views
- Features must be salient
- General view
- Front view
- ¾ up view

HORSE · PIANO · TEAPOT · CAR · CHAIR · CAMERA · CLOCK · TELEPHONE · HOUSE · PENCIL SHARPENER · SHOE · IRON

Invariants

- Invariants
  - Alignments
  - Angles
  - Shape
  - Symmetry
- Property mapping
- Each system here assumes a unified space. Can be mixed up though

3D and 2D attributes

- Show a dice to children (~6-7)
- They usually draw a rectangle
- The rectangle can stand for one face
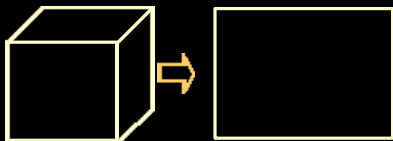
3D and 2D attributes

- Show colored or numbered dice to children (6-7)
- The still draw a rectangle
- But different colors or many points
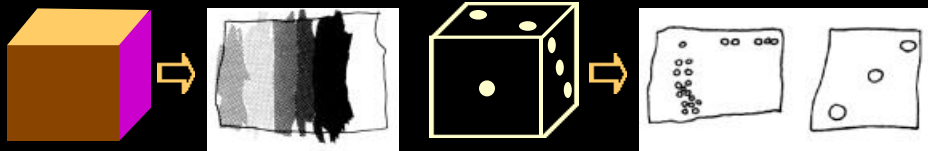
3D and 2D attributes

- 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
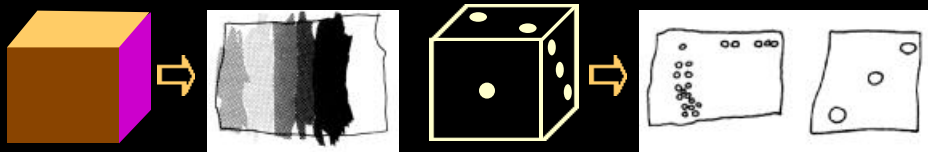
Evolution of children's drawings

- Asked to draw a table

Child's view

Class of drawing & average age

7.4   9.7

11.9   13.6
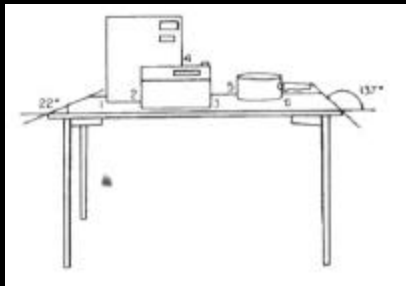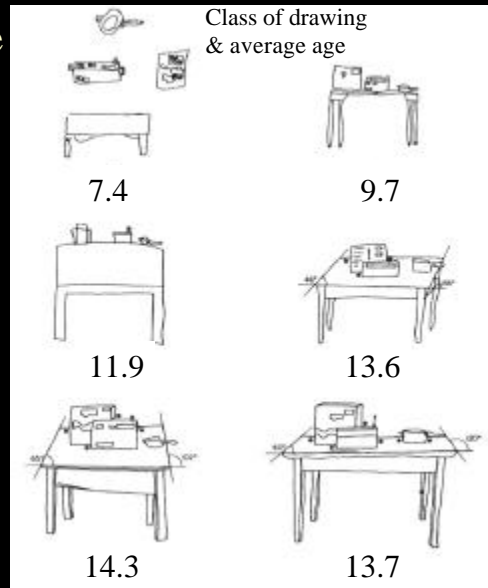
14.3   13.7

Primary/secondary geometry

- Primary geometry
  - Description in 3D object-space
- Secondary geometry
  - Description in 2D image-space
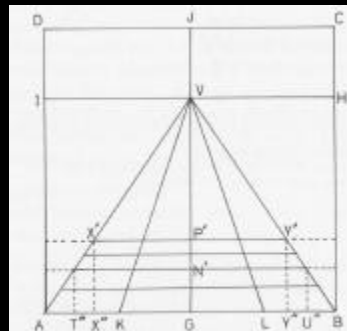
Primary/secondary geometry

- Primary geometry
  - Description in 3D object-space
- Secondary geometry
  - Description in 2D image-space
  - Permits the description of more drawing systems
  - Often better corresponds to the drawing approach

British standard classification

- Primary geometry
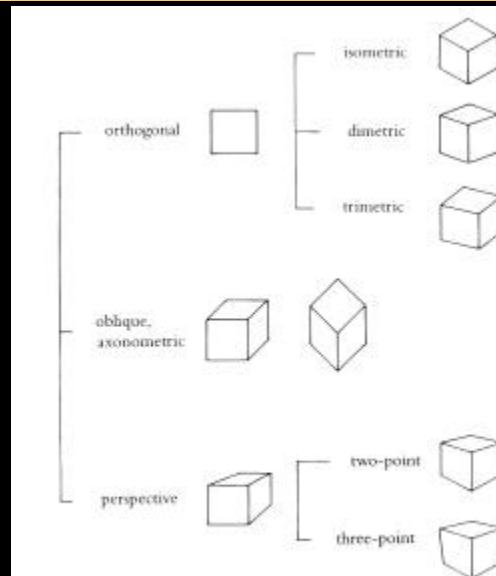
Fig. 2.1. Classification scheme for projection systems, based on primary geometry. Adapted from British Standard 1192 (1969).

Willats's classification

- Secondary geometry
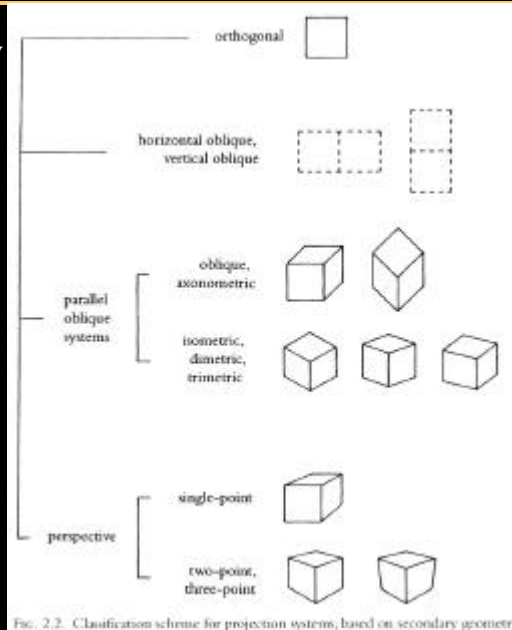
Fig. 2.2. Classification scheme for projection systems, based on secondary geometry

orthogonal

horizontal oblique, vertical oblique

parallel oblique systems — oblique, axonometric

isometric, dimetric, trimetric

perspective — single-point

two-point, three-point

Classification of drawing systems

- Linear
  - Parallel
  - Linear perspective
  - Divergent perspective
- Non Linear
  - Quasi linear
  - Curved projections
  - Topological
  - Split views, fold-out
  - Multiple viewpoints

Classification of drawing systems

- Linear
  - Parallel
    - Orthogonal
    - Fold-out oblique
      - Horizontal oblique
      - Vertical oblique
    - Orthographic
      - Isometric
      - Others
    - Non orthogonal
      - Oblique
      - Axonometric
  - Linear perspective
    - One point
    - Two points
    - Three points
  - Divergent perspective

- Non Linear
  - Quasi linear
    - Naïve perspective
    - Expressionist perspective
    - Importance-driven
    - Cell panorama
  - Curved projections
    - Panorama
    - Fish-eye
  - Topological
  - Split views, fold-out
  - Multiple viewpoints

Linear projections

- Straight lines and alignments are preserved
- Can be expressed in primary geometry
  - Ray-image intersections
  - A matrix

- Parallel

- Linear perspective

- Divergent perspective

12
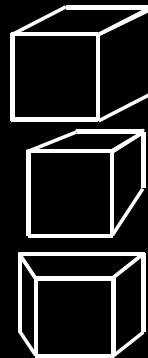
Parallel projections

- No foreshortening
- Can represent true shape
- Some are poor shape representations

- Projection direction
    - Orthogonal to image plane or not
    - Along one principal direction or not
- "Stretching" or not

Parallel projections

- Orthogonal
- Fold-out oblique
    - Horizontal oblique
    - Vertical oblique
- Non orthogonal
    - Oblique
    - Axonometric
- Orthographic
    - Isometric
    - Others

Orthogonal

- Direction
  - Perpendicular to image plane
  - Along one principal direction
- True shape for objects parallel to image plane
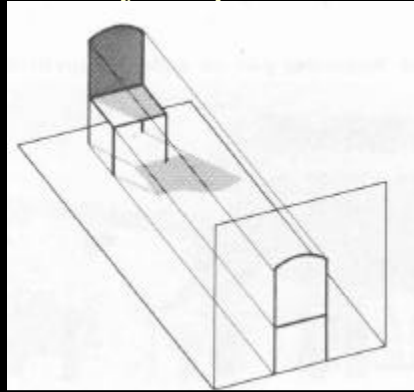
Orthogonal

- Direction
  - Perpendicular to image plane
  - Along one principal direction
- True shape for objects parallel to image plane
- Typically engineering
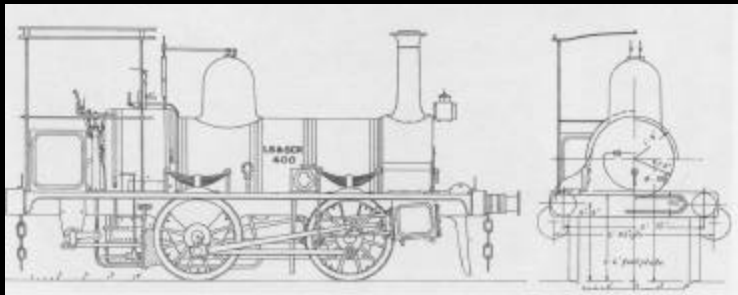
Orthogonal

- Amphora, 6th century BC

Orthogonal

- Bayeux Tapestry 1080

Orthogonal

- Telephoto

As the hijack bargaining goes on under the sweltering sun . . .

Orthogonal

- Child drawing

Parallel projections

- Orthogonal
- Fold-out oblique
  - Horizontal oblique
  - Vertical oblique
- Non orthogonal
  - Oblique
  - Axonometric
- Orthographic
  - Isometric
  - Others

Fold-out oblique

- Horizontal oblique
- Vertical oblique
- Direction
  - 45°, parallel to one principal face (top or side)

17
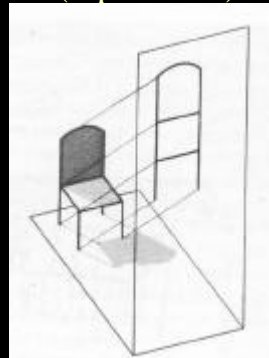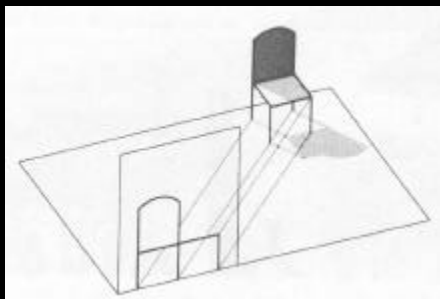
Fold-out oblique

- Horizontal oblique
- Vertical oblique
- Direction
  - 45°, parallel to one principal face (top or side)
- Can be stretched for fold-out
  - True shape for 2 directions
- Mainly interesting for secondary geometry

Horizontal oblique

- Folk art

FIG. 2.8. Paul A. Seifert, *Residence of Mr. E. R. Jones*, 1881. Watercolor, 54.6 × 69.9 cm. New York State Historical Association, Cooperstown, New York.

Horizontal oblique

- Icons

Horizontal oblique

- Child drawing
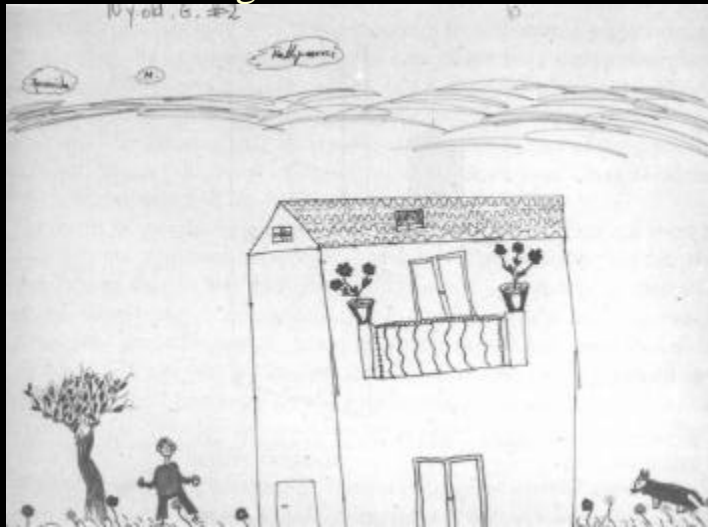
Horizontal oblique

- Cézanne Still life with a commode, 1887

Pushing the envelope
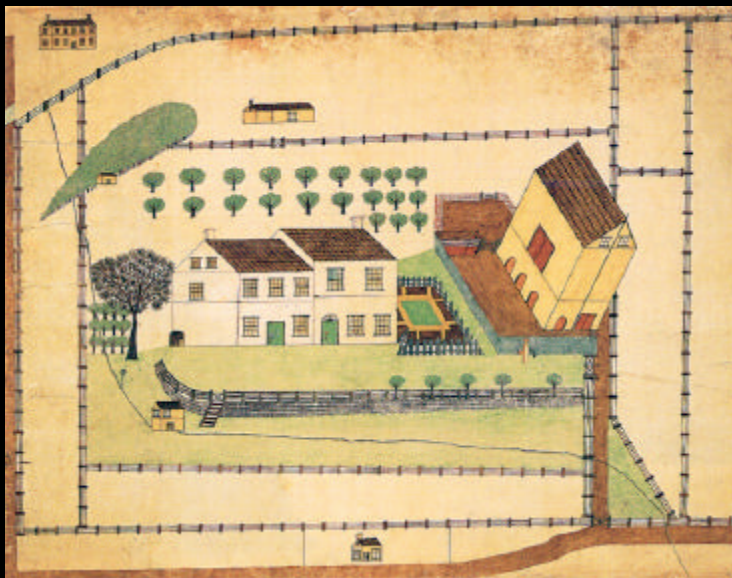
Vertical oblique

- Soriguerola, 13th

Vertical oblique

- Soriguerola, 13th
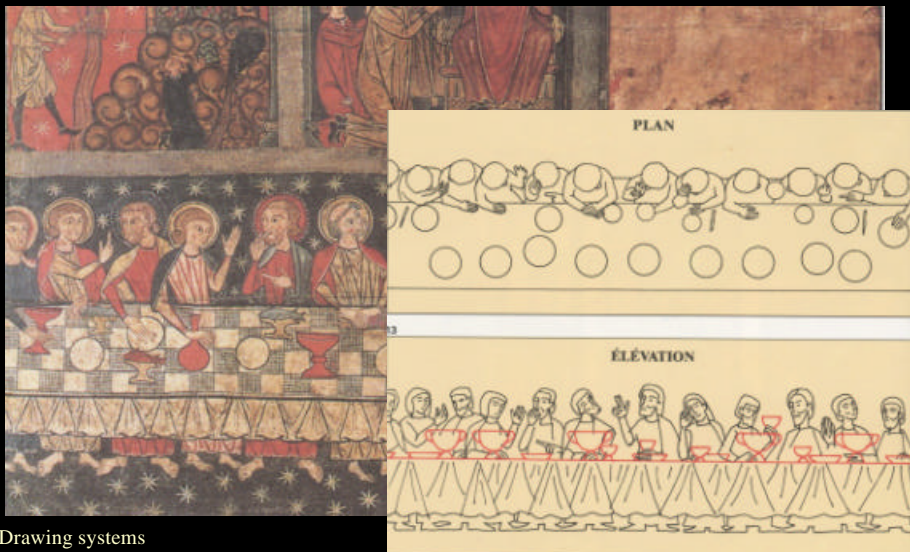
Drawing systems

Vertical oblique

- Juan Gris,
  Breakfast,
  1914

Vertical oblique

Vertical oblique

- Indian art, 1660

Vertical oblique

- Claude Rogers, *The Hornby Train*, 1951-53
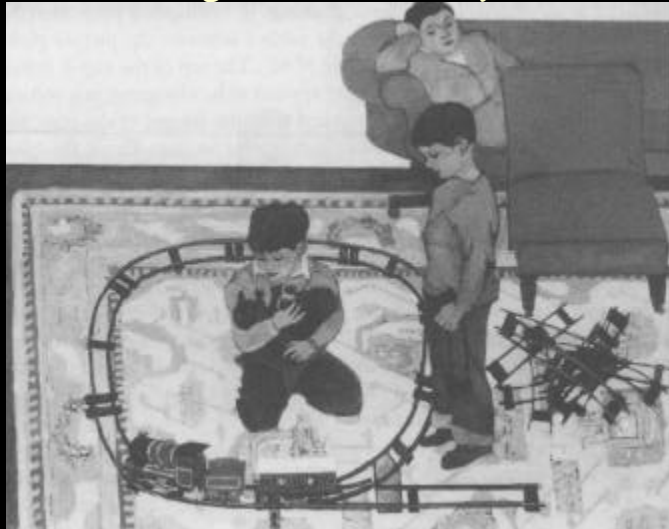
Vertical oblique

- Andre Kerstesz,
  Tulipe Melancolique

Pushing the envelope

Pushing the envelope

- Non-linear
- Locally linear

Parallel projections

- Orthogonal
- Fold-out oblique
  - Horizontal oblique
  - Vertical oblique
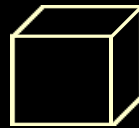- Non orthogonal
  - Oblique
  - Axonometric
- Orthographic
  - Isometric
  - Others

Non orthogonal

- Direction
  - non orthogonal to picture plane
- Oblique
  - Picture plane parallel to front
  - True shape for front face
- Axonometric
  - True shape for top face
  - True distance for up direction
  - Direction 45° of the picture plane

Oblique

- Picture plane parallel to front
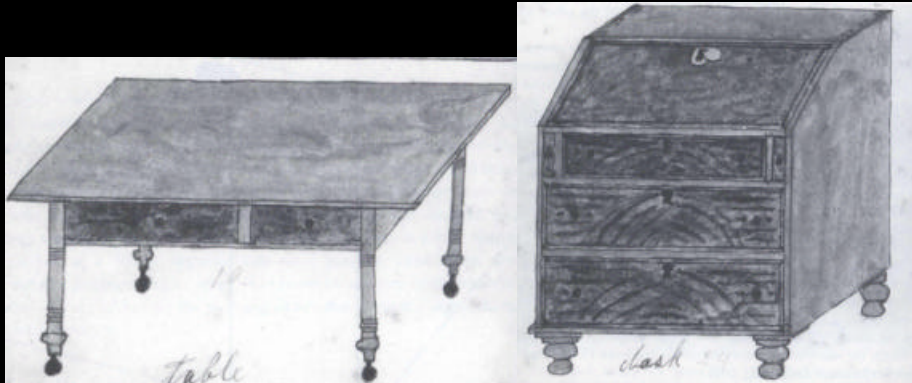- True shape for front face
- Can use true distance for 3rd direction
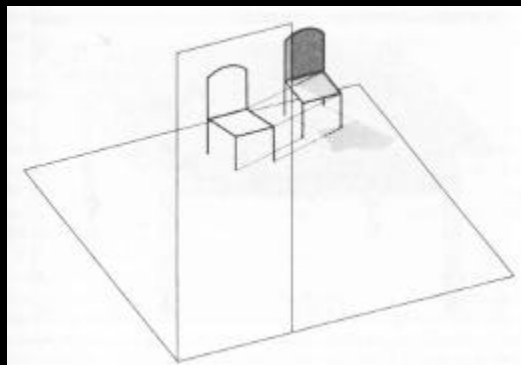
Oblique

- Henry Lapp, 19th century

Oblique

- Lady Wenji's Return to China, 12th century

Oblique

Oblique

- *Phoenix and Achilles,* 350-340 BC
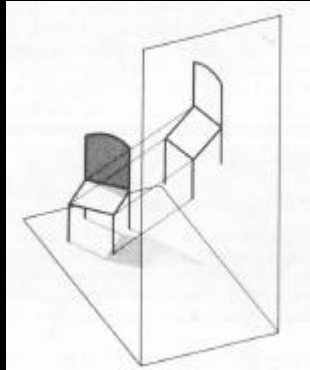
Axonometric

- Axonometric
  - True shape for top face
  - True distance for up direction
  - Direction 45° of the picture plane
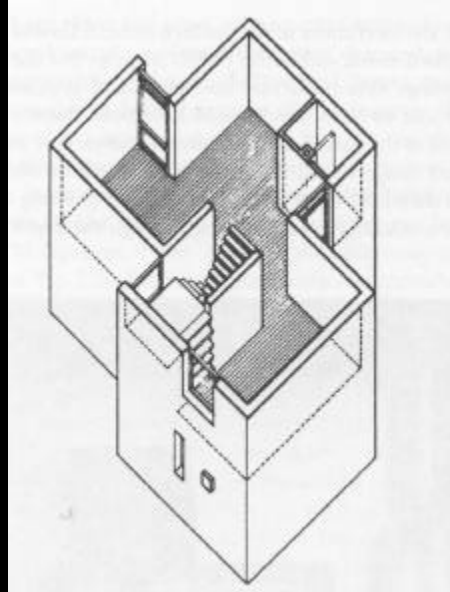
Axonometric

- Le Corbusier was a big fan

Axonometric

- James Stirling, 1953

Axonometric

- Juan Gris,
  Breakfast,
  1914

Parallel projections

- Orthogonal
- Fold-out oblique
  - Horizontal oblique
  - Vertical oblique
- Non orthogonal
  - Oblique
  - Axonometric
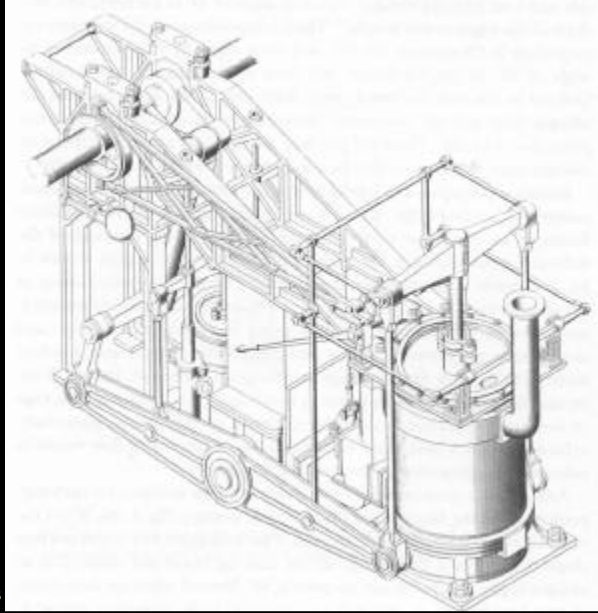- Orthographic
  - Isometric
  - Others

Orthographic

- Direction
  - Orthogonal to picture plane
  - Along no principal direction
- Isometric
  - Direction along the average of the principal directions
  - True distances along 3 directions
- Others
  - Generic orthographic

Isometric
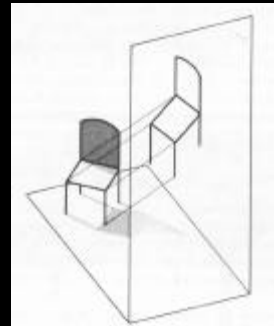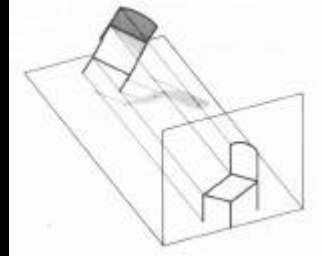
Isometric

- Brooks-Greaves
  St Paul's Cathedral
  1928

Isometric vs. Axonometric

- Isometric
  - No true shape
  - True distances in 3 directions
  - Little distortion
  - Direction average 2 principal directions

- Axonometric
  - True shape for top face
  - True distance for up direction
  - Direction 45° from picture plane

General Orthographic

- Seldom used!

Mixed parallel system
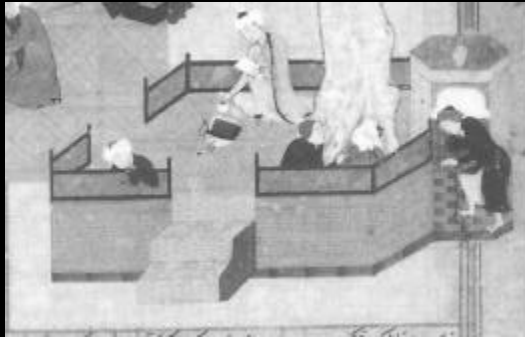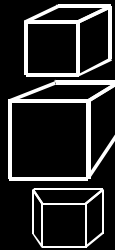
- Persian miniature, 1494
- Oblique+vertical oblique

Classification of drawing systems

- Linear
  - Parallel
  - Linear perspective
  - Divergent perspective
- Non Linear
  - Quasi linear
  - Curved projections
  - Topological
  - Split views, fold-out
  - Multiple viewpoints

Linear perspective

- Foreshortening
- The spectator is "immersed"
- Potential distortions

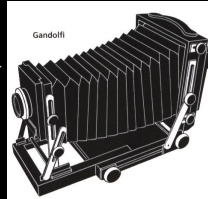- One point
- Two points
- Three points

1-point perspective

- Central focus
- Preserves horizontals and verticals

1-point perspective

- Central focus
- Preserves horizontals and verticals
- Can mean that the optical center is not the center of the image
  - View-camera
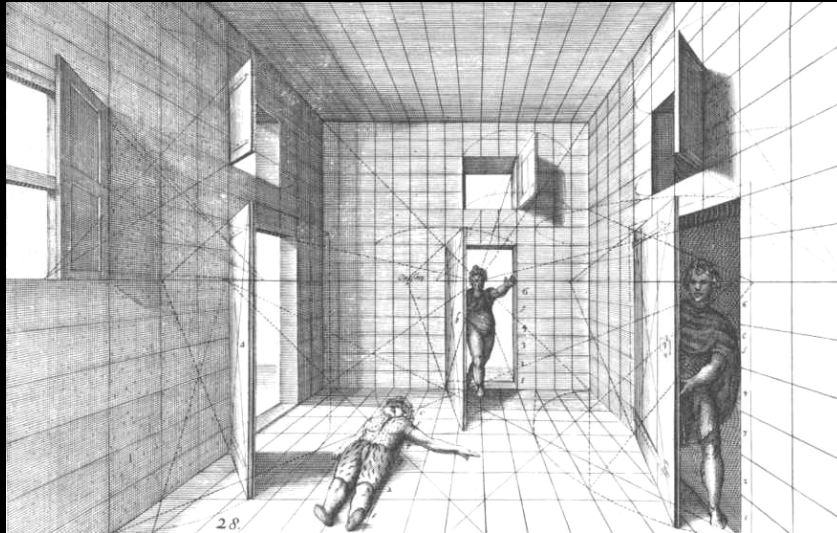

Gandolfi

1-point perspective

- Jean Vredeman de Vries,1604

1-point perspective

- Unknown artist Ideal city, 15th

1-point

- *Interior of St Bavo's church at Haarlem,* Pieter Jansz Saenredam, 1648

37
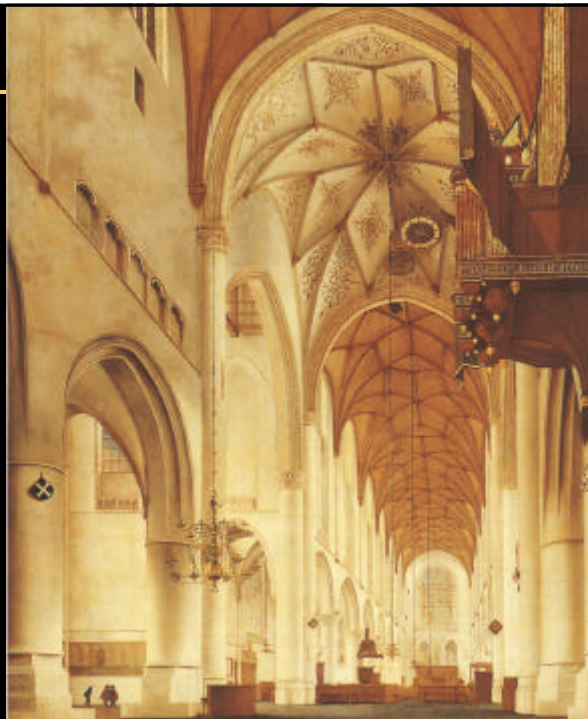
1-point perspective

The Avenue Middelharnis, Meindert Obbema 1689

1-point perspective

Western perspective in a Japanese picture

2-point perspective

2-point perspective

- Objects stand out of the picture
- Preserves verticals
- Can mean that the optical center is not the center of the image
  - Architecture lens

Old assignment

- Before: 3-point perspective

Old assignment

- After: 2-point perspective

3-point perspective

3-point perspective

- Dramatic 3D effect
- The generic case, nothing preserved
- seldom used through art history

Perspective anomaly and expression

- Giorgio de Chirico,
  *Mystery and
  Melancholy of
  a Street,*
  1914

Perspective anomaly and expression
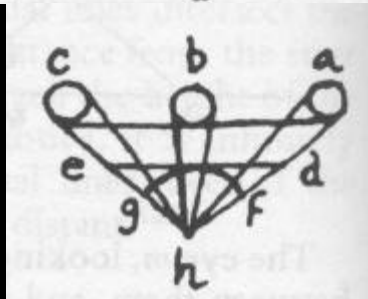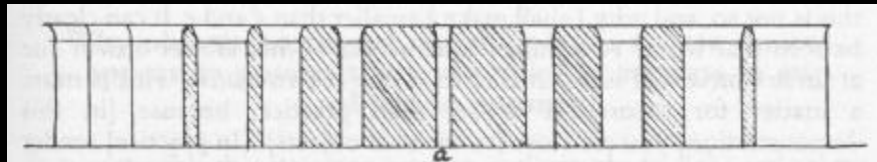
- Giorgio de Chirico
  Les Muses Inquietantes
  1925

Perspective distortion

- Wide angle projection
- Does not preserve subjective size

Perspective distortion
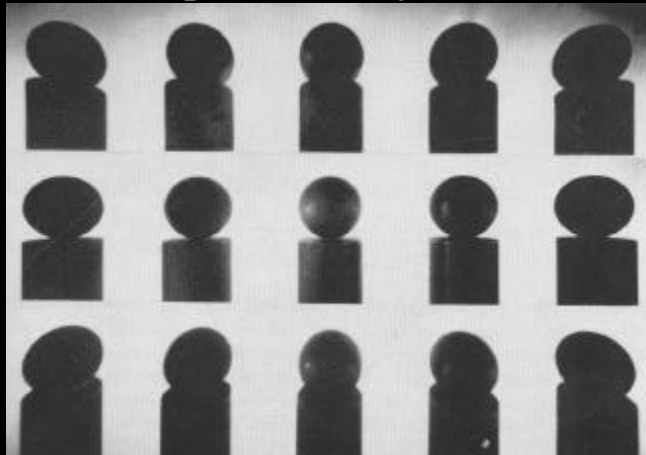
- Wide angle projection
- Does not preserve subjective size

Perspective distortion

- Wide angle projection
- Distorts shape

Perspective distortion

- Portrait: distortion with wide angle

Wide angle · Standard · Telephoto

Perspective distortion

- The sphere is projected as an ellipse
- Symmetry is not preserved
- Some perspective manuals claim that the projection of a sphere is a circle

Perspective distortion

- The sphere should be projected as an ellipse
- But a circle is used

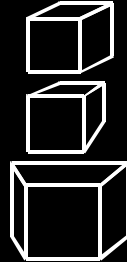# Classification of drawing systems

- Linear
  - Parallel
  - Linear perspective
  - Divergent perspective
- Non Linear
  - Quasi linear
  - Curved projections
  - Topological
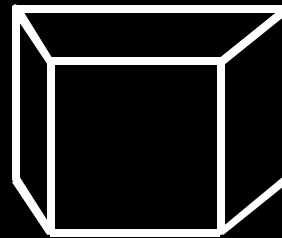 - Split views, fold-out
  - Multiple viewpoints

Divergent perspective

- A.k.a. inverted perspective
- Subject of quarrel, hard to include in a theory
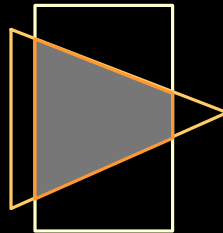
- Icons
- Asian
- Cubism
- Children

Divergent perspective: explanations

- Does not exist!
- Lack of skill
- Represents more faces
- Fear of idolatry
- Perceptual over-compensation
- Perceptual effect of field of view and size constancy

Drawing systems

Divergent perspective

- *The Four Gospels, Luke,* 1380, Byzantine

Drawing systems

Divergent perspective

- *Mark*,
  15th century,
  Byzantine

Divergent perspective

- Andrei Rublev,
  The Holy Trinity,
  1408~1425

Divergent perspective

- Hasadera Enji (Japanese)

Divergent perspective

- Georges Braque, *Still Life: The Table, 1928*

Divergent perspective

- David Hockney, *Chair*

Divergent perspective
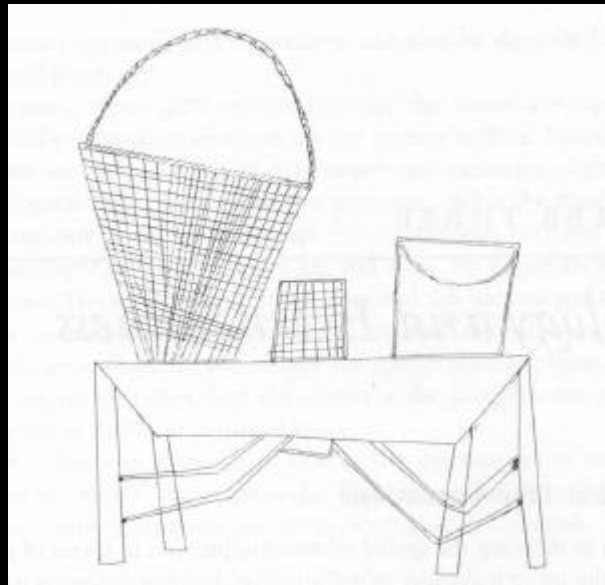
- Child drawing (Kenyan here)

Evolution of children's drawings

- Asked to draw a table

Class of drawing
& average age

7.4 9.7

11.9 13.6

14.3 13.7

Child's view