The Art and Science of Depiction

Drawing systems

Fredo Durand
MIT- Lab for Computer Science
OH NO! EVERYTHING HAS SUDDENLY TURNED NEO-CUBIST!

THE TRADITIONAL SINGLE VIEWPOINT HAS BEEN ABANDONED; PERSPECTIVE HAS BEEN FRACTURED.

IT ALL STARTED WHEN CALVIN ENGAGED HIS DAD IN A MINOR DEBATE! SOON CALVIN COULD SEE BOTH SIDES OF THE ISSUE! THEN POOR CALVIN BEGAN TO SEE BOTH SIDES OF EVERYTHING!

THE MULTIPLE VIEWS PROVIDE TOO MUCH INFORMATION! IT'S IMPOSSIBLE TO MOVE! CALVIN QUICKLY TRIES TO ELIMINATE ALL BUT ONE PERSPECTIVE!

IT WORKS! THE WORLD FALLS INTO A RECOGNIZABLE ORDER!

YOU'RE STILL WRONG, DAD.

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.
Generic vs. accidental viewpoint

- Accidental alignment of trash and sea

Photo
Peter Turner
Generic vs. accidental viewpoint
Canonical view

- Rate views
Canonical view

- Rate views
- Features must be salient
- General view
- Front view
- ¾ up view
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
11.9
14.3
9.7
13.6
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

![Diagram of classification of projection systems based on primary geometry.](image)

**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.
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
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)
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
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 3\textsuperscript{rd} direction
Oblique

- Henry Lapp, 19th century
Oblique

- Lady Wenji’s Return to China, 12th century
Oblique
Oblique

- *Phoenix and Achilles,*
  350-340 BC
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 $45^\circ$ 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
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
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
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
Divergent perspective

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

Child’s view

Class of drawing & average age

<table>
<thead>
<tr>
<th>Class</th>
<th>Average Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.4</td>
</tr>
<tr>
<td>2</td>
<td>9.7</td>
</tr>
<tr>
<td>3</td>
<td>11.9</td>
</tr>
<tr>
<td>4</td>
<td>13.6</td>
</tr>
<tr>
<td>5</td>
<td>14.3</td>
</tr>
<tr>
<td>6</td>
<td>13.7</td>
</tr>
</tbody>
</table>