The Art and Science of Depiction

Linear Perspective

Fredo Durand
MIT- Lab for Computer Science
Assignments for Monday 30.

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

Plan of the next sessions

- Drawing and projection
- Denotation
- Tone & color
Plan

• Intro to perspective
• History of Renaissance perspective
  – Early attempts
  – Bruneleschi
  – Alberti
  – De la Francesca
  – Leonardo
  – Dürer
• Gadgets
• Distortion issues

Perspective

• Does linear perspective “occur” in nature
  – E.g. we “experience” foreshortening
• Perspective or perspectives?
Pictorial depth cues

- Occlusion
- Size
- Position relative to the horizon
- Convergence of parallels, linear perspective
- Shading, shadow
- Texture gradient
- Aerial perspective

Introduction to Perspective

- Importance of the single viewpoint
**Linear Perspective**

- Image as a window
- *St Jerome In His Study*
  Antonello da Messina 1475

**Some accompanying concepts**

- Viewpoint
- Foreshortening
- Vanishing point

- Very linked to architectural spaces
Primary/secondary geometry

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

Plan

- Intro to perspective
- History of Renaissance perspective
  - Early attempts
  - Bruneleschi
  - Alberti
  - De la Francesca
  - Leonardo
  - Dürer
- Gadgets
- Distortion issues
Early attempts

• St John the Baptist Retiring to the Desert
  Giovanni di Paolo 1454

• Giotto, 1297-1299
Early attempts

- Lorenzetti 1337-1340
**Giotto’s rules**

- Lines and planes above eye level incline downwards when they move away
- Below eye level upwards when they move away
- Lines to the left incline inwards to the right

---

**Giotto**

- Confirmation of the Rule of St Francis 1325
Giotto

- Confirmation of the Rule of St Francis 1325

Early attempts

- Pietro Lorenzetti, *Birth of the Virgin* 1342
Plan

• Intro to perspective
• History of Renaissance perspective
  – Early attempts
  – Bruneleschi
  – Alberti
  – De la Francesca
  – Leonardo
  – Dürer
• Gadgets
• Distortion issues

Bruneleschi’s experiments, 1413

• Existing buildings
• Measurement, surveying
• Single viewpoint
• First scientific mimesis
Bruneleschi’s experiment, 1413

Perspective

Bruneleschi’s second experiment

• Cut out
• Note that this is 2-point perspective

Perspective
**Limitations**

- Existing buildings
- Requires measurement

---

**Masaccio, The Trinity, 1427**

- The oldest perspective painting
- Probably measurement
- Maybe helped by Bruneleschi
Masaccio, The Trinity, 1427

- The oldest perspective painting
- Santa Maria Novella (Florence)
Plan

- Intro to perspective
- History of Renaissance perspective
  - Early attempts
  - Brunelleschi
  - Alberti
  - De la Francesca
  - Leonardo
  - Dürer
- Gadgets
- Distortion issues

Leon Battista Alberti, On Painting

- 1435
- Intersections of pyramids with image surface
- Proportional triangles
- Use side view for foreshortening
- Check with diagonal
- Use pavement as reference
- Center = prince of rays
Leon Battista Alberti, On Painting

- Paolo Uccello, *The Selling of the Host*, 1468

Legitimate construction

- Carlo Criveli, *Annunciation* 1486
Plan

• Intro to perspective
• History of Renaissance perspective
  – Early attempts
  – Bruneleschi
  – Alberti
  – De la Francesca
  – Leonardo
  – Dürer
• Gadgets
• Distortion issues

Piero de la Francesca

• De Prospectiva Pingendi, 1474
  (On the perspective of painting)
• Ratios of distance and size
• Use plan and elevation view
**Piero de la Francesca**

- Use plan and elevation view

---

**Piero de la Francesca**

- *De Prospectiva Pingendi*, 1474 (On the perspective of painting)
- Ratios of distance and size
- Use plan and elevation view
- Deformation of square
  - Angle of view less than 90°
Piero de la Francesca

- *Flagellation of Christ*, 1460

Piero de la Francesca

- Invention of the true cross, 1452-59
- “Wrong perspective on the left”
**Piero de la Francesca**

- Invention of the true cross 1452-59
- “wrong perspective on the left

**Plan**

- Intro to perspective
- History of Renaissance perspective
  - Early attempts
  - Bruneleschi
  - Alberti
  - De la Francesca
  - Leonardo
  - Dürer
- Gadgets
- Distortion issues
Leonardo & perspective

- Techniques of artists’ perspective in theory and practice
- Geometry of visual rays
- Devices and instruments
- Optics and the eye
- Curiosities of vision (e.g. anamorphosis)
- Apparent contradictions

Leonardo

- Last Supper, 1497
Leonardo

- *Last Supper, 1497*

Leonardo & contradictions

- *Wide angle vision*
Leonardo & contradictions

• Wide angle vision

• Lateral recession
Plan

• Intro to perspective
• History of Renaissance perspective
  – Early attempts
  – Bruneleschi
  – Alberti
  – De la Francesca
  – Leonardo
  – Dürer
• Gadgets
• Distortion issues

Dürer

• Traveled to Italy
• Mainly influenced by de la Francesca

*Instruction in Measurement with Compass and Ruler in Lines, Planes and Solid Bodies, 1525*
Dürer

- *St Jerome in his Study* 1514
- Very off-center
- Note the verticals

Dürer

- The artist’s glass
Dürer

• The draftsman's net

Dürer

• Jacob de Keyser's invention
**Dürer**

- Dürer’s device

---

**Conclusions about Renaissance**

- Different techniques, refinement
- Measurement
- Mainly central perspective
- No notion of infinity, no vanishing point
- Spiritual notion of mathematical harmony
After Renaissance

- 17th
  - Vanishing point
  - Abstraction
  - Desargues, Descartes
- Flourished until 19th
- 20th century
  - Come-back for computer graphics and computer vision

After Renaissance

- Thomas Malton
  *A Complete Treatise on Perspective*, 1779
Plan

- Intro to perspective
- History of Renaissance perspective
  - Early attempts
  - Bruneleschi
  - Alberti
  - De la Francesca
  - Leonardo
  - Dürer
- Gadgets
- Distortion issues

Gadgets

- Camera obscura
**Vermeer 1660**

- Camera obscura

**Gadgets**

- Baldassare Lanci’s universal instrument for surveying and perspective 1557
Gadgets

- Camera Lucida
- E.g. Talbot

Perspective grids
Plan

- Intro to perspective
- History of Renaissance perspective
  - Early attempts
  - Bruneleschi
  - Alberti
  - De la Francesca
  - Leonardo
  - Dürer
- Gadgets
- Distortion issues

Leonardo & contradictions

- Wide angle vision
Leonardo & contradictions

- Wide angle vision

- Lateral recession
**Perspective distortion**

- The sphere is projected as an ellipse