Surface Drawing

Steven Schkolne
Peter Schröder

Also Hiroshi Ishii
and Michael Pruett*

Presented by Geoffrey Oxholm
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Making 3D Models

- Requires significant planning
- Counterintuitive primitives
  - Spheres
- Reduction in creativity
  - Modify / tweak given models
- Expectation ≠ Result
- Requires technical thinking
  - Difficult for artists
3D Interfaces


• Lines and basic primitives
Volume Sculpting


• Subtractive vs. additive
Sketch 3D
SKETCH

Zeleznik et al. “SKETCH: An interface for sketching 3D scenes.” SIGGRAPH 96

Efficient use of 2D Interface
Modeling in 2D - The Pencil

Simple

Intuitive

Perceptual
Perceptual Thinking

• “The cognitive operations called thinking are not the privilege of mental processes above and beyond perception, but the essential ingredients of perception itself.” – Arnheim

• In other words, perception forms thinking!
Ideal Interactive Modeling

1. Invisible mathematical structure
2. Direct primitives
3. Full dimension
4. Smallest toolset
5. Direct creation
6. Sensory completeness
Surface Drawing

• Extend traditional 2D drawing to the 3D world

Surface Drawing:
A method for creating shape in which surfaces are created by moving a locally two-dimensional object through three-dimensional space.
Creating Surfaces
Creating Surfaces
Creating Surfaces

Sketches done in less than one minute by novices
Creating Surfaces
Incremental Cookie Cutter Algorithm

• As the hand moves, a mesh is made

• Points are projected on a 2D plane and the Delaunay triangulation is found.
Incremental Cookie Cutter Algorithm

• When the hand moves back over:
  - Find neighboring patches
  - Project onto 2 dimensions
  - Re-triangulate
  - Project back to 3D
Incremental Cookie Cutter Algorithm

1. Find Neighborhood $s^i \in N(x)$ such that

$$\| x_p - s^i_p \| < d_{\text{max}} \text{ and } x_d \cdot s^i_p > \cos(\theta_{\text{max}})$$

2. Find surface region
   - Triangles that may change
   - And signed boundary edges

3. Ensure non-degenerate projections
   - No triangles should flip

4. Cut
   - Remove surface region
Incremental Cookie Cutter Algorithm

5. Project
   • Onto 2D tangent plane of new point

6. Triangulate (Delaunay Triangulation)
   • Remove extra triangles

7. Un-Project
   • Keep edges as we move back to 3D
Tools

• Hand (glove)
  • Makes surfaces

• Eraser
  • Sphere
  • Deletes all points inside

• Stick
  • Rotate
  • Translate
Using The Hand Tools

Surface

Eraser

Details
Results

1. Invisible mathematical structure
2. Direct primitives
3. Full dimension
4. Smallest toolset
5. Direct creation
6. Sensory completeness
Subsequent Work
Tongs

- Squeeze gently to grab a local feature
- Squeeze hard to grab the whole thing
Drawing a flower
Subsequent Work
Subsequent Work

- Multi-tool - Menu
  - “Light Saber”
    - Cut bonds
  - Dot
    - Single Strand
  - Line
    - Double Helix

- “Ray Gun”
  - Create bonds
Thank you.

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