A System for Sculpting 3D Data

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Concept

• Problem: Create 3D models in computer
• Solutions:
  – Digitize real object and input its points
  – Synthesize objects in the computer
  – Combination of these methods
Past Work

• Ohio State U Computer Graphics Research Group
• GRAphics Symbiosis System – 2D graphics language for non-programmers
• WHATSISFACE – non-artists and non-programmers can draw a realistic facial image
• ANIMA II – language for non-programmers to specify 3D motions for color animation
Approach

• Sculptor’s studio-like environment
• User creates 3D objects as if from clay
• Sculptor’s natural way of thinking
  – No numeric coordinates or math operations
  – Direct operations on objects
Processor

- PDP-11/45
- 96K words memory
- 88M disk space

- 16 bit words
- Fixed point arithmetic

How?
- < 2600 edges
- All custom assembler code
- Tolerate some overflow/precision loss errors
User Interaction

• 4096 X 4096 display
• Cursor position
• Joystick
• 16 function buttons
• Sonic pen
• 10 dials
Sculpting Sequence

- User selects a primitive polyhedron...

- ...or creates a primitive one by extrusion and intersection of 1 or 2 orthogonal views
Sculpting Sequence

• Basic manipulation like scaling, moving, and rotating via dials
• Warping – grab and stretch part of an object
• Bending – reshape an object by reshaping a corresponding control line, such as when generating motion scenes to be interpolated by an animation tool
Sculpting Sequence

- User can use created objects as tools for intersection
- Wireframe only, full interactive rendering too expensive
- Can revert to an earlier sculpting sequence saved on stack if user is dissatisfied with current sculpture
Intersection/Union

• Join two solids by addition
• Cut one object with another by subtraction
• Classic computational geometry
• All about data structure (many interlinked lists)
• Generalization advanced over previous
• Intersection and union are functionally the same operation (4 resulting polyhedra)
Intersection/Union
Warping

• User moves a vertex of an object
• Vertices adjacent to the control vertex also move, but by a weighted amount
• Weight falls off as a function of edge traversal count away from control vertex
• Rate of weight fall off controlled by dial
• Effect is to stretch part of an object
Warping
Bending

• Alter the shape of an existing object by altering a corresponding control line
• Control line is series of possibly connected 2D line segments
• User draws control line
• System maps control line to object vertices
• User adjusts control line shape
• System moves object vertices to match
Diagram 3. Mapping of Surface Point to Skeletal Edge.
Hidden Line Processing

• Predecessor to hidden face culling
• Loutrel’s algorithm (path of edges technique)
• Limit <900 edges for interactive speed
Paint

• Each face can be assigned a color
• 3 bits per color
• No visual feedback
• Can filter display by face color
• Face colored is carried through intersection
Conclusions and Future Work

• Achieves intended goals of interactive 3D object creation
• Does not address complex 3D visualization issues
• Does not emulate look and feel of real sculpting tools and materials, just puts a friendly face on geometric “sculpting”
• Future work: Get a 32 bit machine