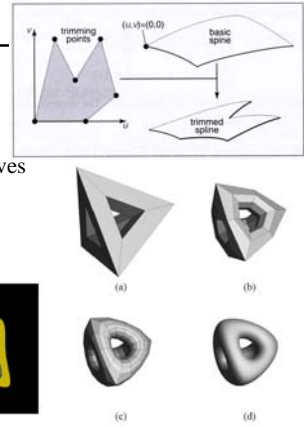# Subdivision Surfaces II

Last Time?

- Spline Surfaces
  - complex topology is challenging, requires trimming curves
- Subdivision Surfaces
  - Catmull Clark
  - Texture Interpolation

Readings for Today

Hoppe et al., "Piecewise Smooth Surface Reconstruction" 1994

"Efficient, fair interpolation using Catmull-Clark surfaces",
Halstead, Kass & DeRose, SIGGRAPH 1993

Misc. Mesh/Surface Vocabulary

- *Genus:* The maximum number of disjoint simple closed curves which can be cut from an orientable surface of genus g without disconnecting it is g.
- *Homeomorphic/Topological equivalence*: a continuous stretching and bending of the object into a new shape

Misc. Mesh/Surface Vocabulary

- *Dihedral Angle*:
  - the angle between the planes of two triangular faces
  - "looking down the edge" between two faces, the angle between the faces.

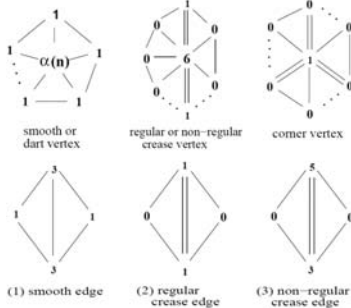## Piecewise Smooth Surface Reconstruction

- Input: scanned mesh points
  - Estimate topological type (genus)
  - Mesh optimization (a.k.a. simplification)
  - Smooth surface optimization
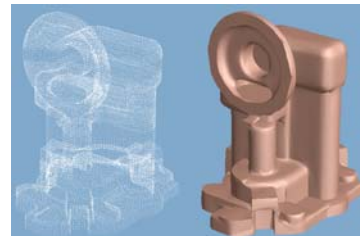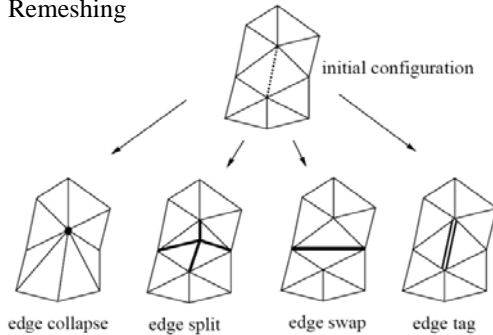
Piecewise Smooth Surface Reconstruction

- Adding creases to Loop Subdivision
  - Vertex & edge masks
  - Limit masks
    - Position
    - Tangent

smooth or dart vertex   regular or non-regular crease vertex   corner vertex

(1) smooth edge   (2) regular crease edge   (3) non-regular crease edge

Piecewise Smooth Surface Reconstruction

- Remeshing

initial configuration

edge collapse   edge split   edge swap   edge tag

Piecewise Smooth Surface Reconstruction

- Crease subdivision masks *decouple* behavior of surface on either side of crease
- Crease rules cannot model a cone
- Optimization can be done locally
  - subdivision control points have only local influence
- Results
  - Noise?
  - Applicability?
  - Limitations?
  - Running Time

Efficient, Fair Interpolation of Catmull-Clark Surfaces

- *Interpolation* vs. *Approximation* of control points
- Reduce the "extraneous bumps & wiggles"
- Handle arbitrary topological type
- Subdivision Matrix: S_n
  $V_n^{i+1} = S_n V_n^i$ (apply 1 round of subdivision to a vertex)
  $V_n^{i+1} = S_n^i V_n^1$ (apply *i* rounds of subdivision)
- Limitations(?) of Implementation
  - Uses only positional constraints
  - Subdivides twice so that all constrained vertex positions are independent
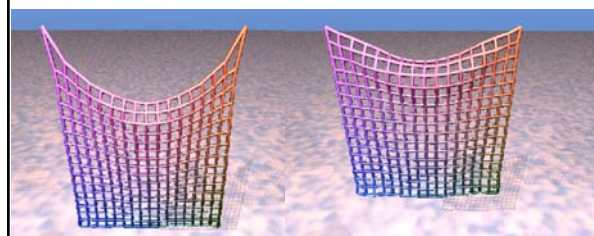
Questions on Homework?

- What's an illegal edge collapse?
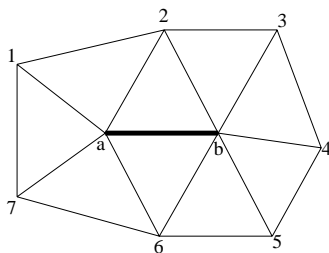
- To be legal, the ring of vertex neighbors *must be unique* (have no duplicates)!

Reading for Tuesday (2/6)

- "Deformation Constraints in a Mass-Spring Model to Describe Rigid Cloth Behavior", Provot, 1995.

Simple mass-spring system   Improved solution