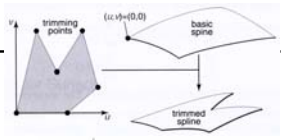
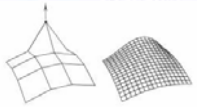
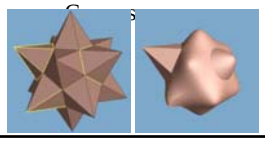
Subdivision Surfaces II

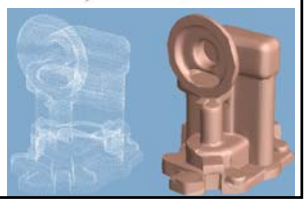
Last Time?

- Spline Surfaces
  - complex topology is challenging, requires trimming curves
- Surface Reconstruction from Points
- Loop Subdivision



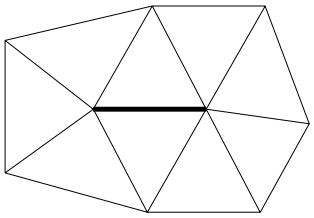






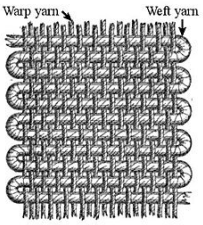
Misc. Mesh/Surface Vocabulary

- *Valence (a.k.a. degree)*: the number of edges incident to the vertex.



Misc. Mesh/Surface Vocabulary

- *Warp & weft:* Yarns used in weaving. Because the weft does not have to be stretched in the way that the warp is, it can generally be less strong.



http://en.wikipedia.org/wiki/Weft

Reading for Today

- DeRose, Kass, & Truong, "Subdivision Surfaces in Character Animation", SIGGRAPH 1998

Figure 5: Geri's hand as a piecewise smooth Catmull-Clark surface. Infinitely sharp creases are used between the skin and the finger nails.

Subdivision Surfaces in Character Animation

- Catmull Clark Subdivision Rules
- Semi-sharp vs. Infinitely-sharp creases
- Mass-Spring Cloth *(next time)*
- Hierarchical Mesh for Collision
- Texturing Subdivision Surfaces

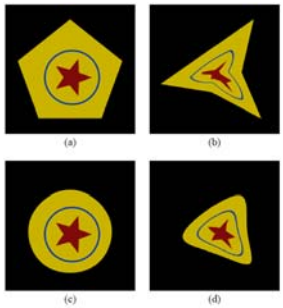
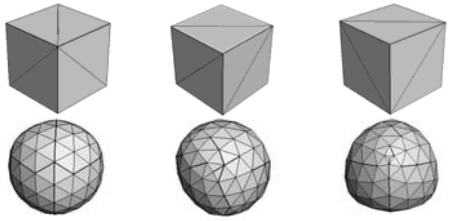


Figure 11: (a) A texture mapped regular pentagon comprised of 5 triangles; (b) the pentagonal model with its vertices moved; (c) A subdivision surface whose control mesh is the same 5 triangles in (a), and where boundary edges are marked as creases; (d) the subdivision surface with its vertices positioned as in (b).

Catmull-Clark in Pixar Production

- Based on quadrilaterals
  - Like NURBS, specifically cubic bsplines
  - Implicit adjacency in subdivided microgeometry
  - Better than triangles for symmetric objects

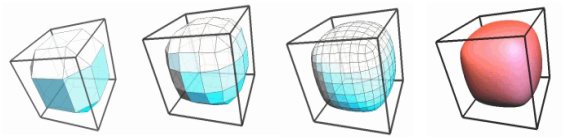


Questions?

Interpolating Subdivision

- Chaikin:

- Doo-Sabin:



of the centroids of each edge/face

Interpolating Subdivision

- *Interpolation* vs. *Approximation* of control points
- Reduce the "extraneous bumps & wiggles"
- Handle arbitrary topological type

Figure 4: Interpolating a coarsely polygonized torus. Upper left: original mesh. Upper right: Shirman-Séquin interpolation[14]. Lower left: Interpolating Catmull-Clark surface. Lower right: Faired interpolating Catmull-Clark surface.

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

Efficient, Fair Interpolation of Catmull-Clark Surfaces

- Solve for a new control mesh (generally "bigger") such that when Catmull-Clark subdivision is applied it interpolates the original mesh
- Fairing to minimize the membrane & thin-plate energies
- Subdivide initial resolution twice so that all constrained vertex positions are independent

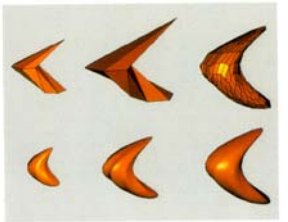
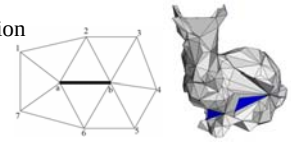


Figure 5: Top row: Original mesh, Interpolating mesh, Faired interpolating mesh. Bottom row: Corresponding Catmull-Clark surfaces. Interpolation introduces wiggles which are removed by fairing.

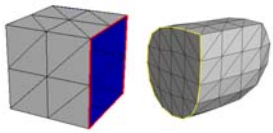
Questions?

Other…

- Assigned readings & discussion
- Anonymous homework discussion

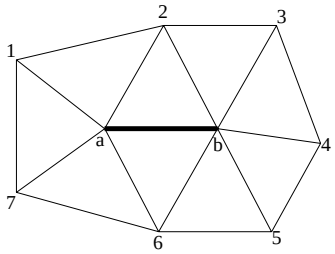


- Homework 1: Simplification & Subdivision Questions/Comments?
- Makefile & OpenGL/glut compiler/platform issues
  - `drand48/srand48` vs. `rand/srand`
  - `#include <Assert.h>` vs. `#include <cassert>`



Questions on Homework?

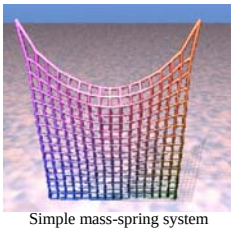
- What's an illegal edge collapse?



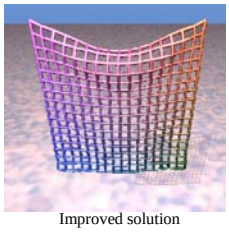
- To be legal, the ring of vertex neighbors *must be unique* (have no duplicates)!

Reading for Friday (2/1)

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



Simple mass-spring system



Improved solution

- Post a comment or question on the LMS discussion by 10am on Tuesday 1/29