

# Beveling the Reality

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## Implementation:

### Functions Fully Implemented:

- eraseEdge: removes an edge from the mesh.
- eraseVertex: removes a vertex and the edges touching it from the mesh.
- collapseEdge: replaces an edge with a vertex.
- collapseFace: replaces a face on a mesh with a single vertex.
- splitPolygon (triangulation): turns any non-triangle face into several triangles without changing the structure of the mesh.
- bevelVertex: replaces a vertex with a face.
- bevelVertexComputeNewPositions: controls the size/extents of a face created with bevelVertex.
- bevelEdge: replaces an edge with a face.
- bevelEdgeComputeNewPositions: controls the extents of the face created with bevelEdge.
- bevelFace: creates a smaller sub-face inside of a face.
- bevelFaceComputeNewPositions: Allows the face created by bevelFace to be extruded or inset based on mouse input.
- Spline Interpolation (Hermite and Catmull-Rom): interpolates changes of an object according to hermite and/or catmull rom splines.

### Functions Attempted/Partially Implemented:

- resample (isotropic remeshing): supposed to edit the mesh's edges and vertices in such a way that evens it out; splitting too long edges, flipping edges to get vertices' degree as close to 6 as possible, and moving the vertices closer to the average of the neighbors' positions. Edge collapse to remove edges too short does not work properly on meshes with a large number of triangles.
- downsample (simplification)

Assets Created (videos, models, etc.):

- Matthew's video: Showcase video demonstrating the functionality of each operation.
- Lucy's video: Model creation process video
- Lucy's model

## Process:

We put a lot of time into this project, but ran into difficulties for a couple of reasons. Initially, we had planned to do animation, but were told that we needed to do more, and decided on doing the bevel operations. We immediately put a lot of time into the bevel operations and finished them. As finals week started to hit, we got started on animation but saw the task was much larger than expected and received notice that animation was now considered a standalone project. Seeing that we probably wouldn't have time to finish animation and not wanting to take a risk, we switched projects and left animation unfinished, deciding instead to implement the rest of the local and global mesh operations from the extra credit of assignment 2 alongside the bevels. We were successful with most of them (erase vertex/edge, collapse edge/face, triangulate) but couldn't manage to get downsample or resample to fully work. Since the expectations for our project changed during the process, this is what we ended up with:

1. The three bevel operations
2. Almost all of the other mesh operations
3. A dog head made with our mesh operations
4. Some small parts of animation

Despite the hiccups along the way, we are ultimately satisfied with our project, and we think the model that we were able to build with it turned out nicely.

## Outstanding Bugs:

A list of the bugs we weren't able to fix, as well as some issues we found in the starter code.

### Our code:

- Downsample does resolve on some models, but it doesn't on others.
- Downsample's optimal point calculations using quadrics doesn't seem to work. Midpoints were used as a rough approximation.
- Resample doesn't work due to edgeflip behavior (see below).

- Spline interpolation has a slight sharp angle at each knot. It's noticeable if the change in direction is drastic.

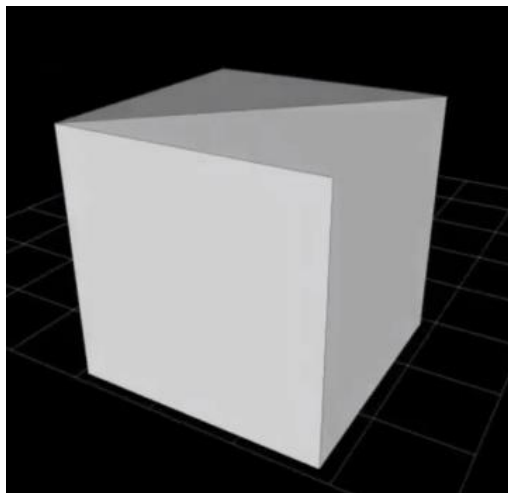
### Starter code/instructions:

- Face normals aren't precise, instead of (0, 0, 1) for a perfectly flat face we get something like (0.00002, 0.00002, .99996). This rounding error can accumulate when scrubbing facebevel back and forth (which you normally wouldn't do).
- Matrix determinant sometimes doesn't work correctly. Tests showed it sometimes returned 0 for a symmetric matrix, which would indicate the matrix is not invertible, but symmetric matrices are guaranteed to be invertible. May also be due to rounding error, but it messes up cost calculations for downsample.
- Isotropic remeshing relies on an edge case for edgeflip which we were not asked to implement. Not an issue with the code, per se, but it might be better to either ask students to address this edge case in implementing edgeflip or to not have a behavior which depends on it.

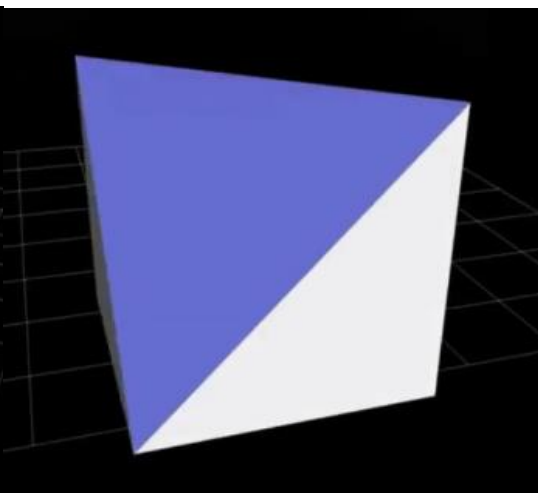
### Screenshots

Screenshots from Matthew's feature demo video are listed in this section. The full video is available at this link: <https://www.youtube.com/watch?v=76twVC89dxE&feature=youtu.be>

Edge Erase

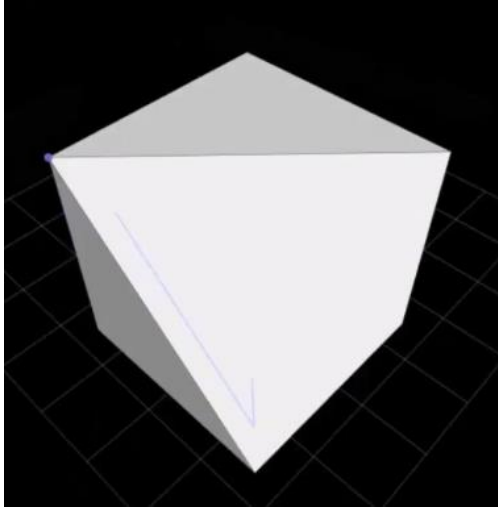


Vertex Erase

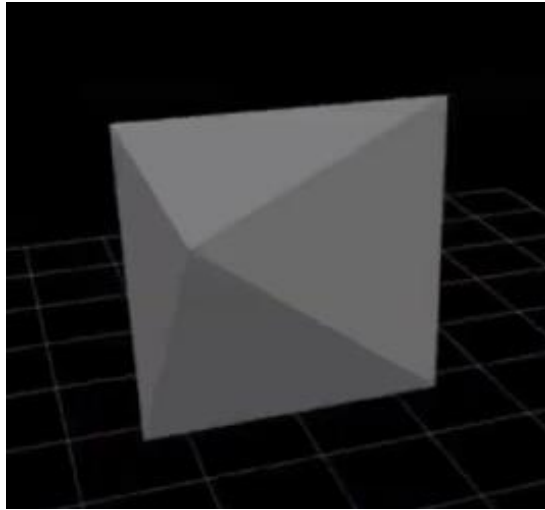


Edge Collapse

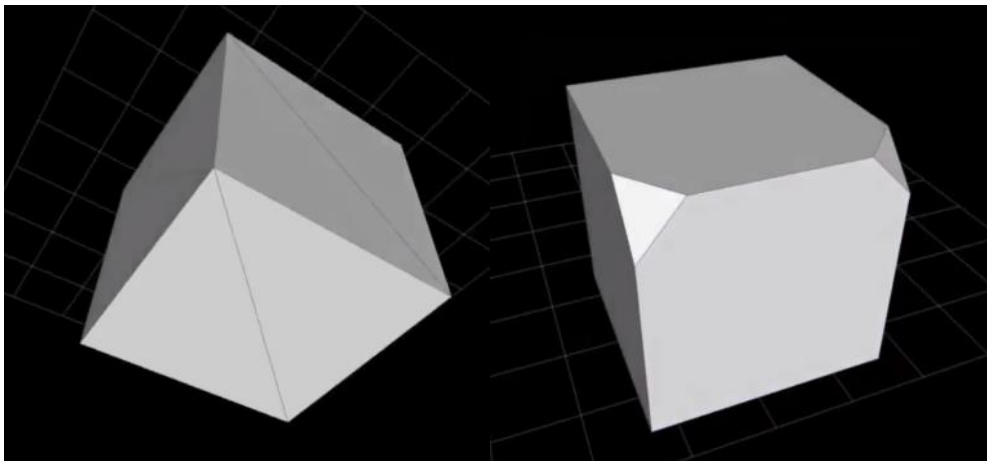
Face Collapse



Triangulate  
Bevel

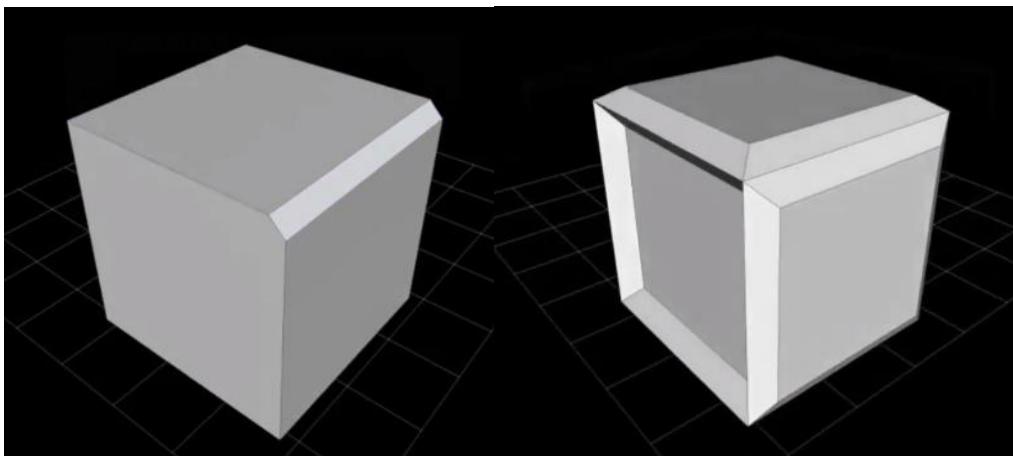


Vertex



Edge Bevel

Face Bevel



Model Steps

