
PolyMesh manual

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Introduction

The PolyMesh plugin allows to have polygonal meshes created, edited and rendered within AoI. A "polygonal" mesh is a mesh the faces of which consist in polygons. Quad meshes are a particular kind of polygonal meshes. Thus, the PolyMesh plugin can be used to work with quad meshes.

Why polygonal meshes in AoI? AoI native mesh format is triangular meshes. Triangular meshes are not only the "lowest" kind of polygonal meshes, they also have a special property: their faces are naturally flat. Since an AoI renderer needs the surface to be rendered to be broken in elementary flat pieces (triangles again), triangular meshes just have to list their triangles to the renderer. AoI triangular meshes also have a unique and very interesting feature: they can subdivide themselves in order to provide a smooth surface. Subdivision is very flexible and is governed by extensive smoothness parameters. This way, a complex surface can be generated using a very limited number of faces. However, triangular meshes have a drawback: modeling such meshes are not very natural and indeed the so called box "modelling technique" is difficult to transpose to triangular meshes.

The PolyMesh plugin aims at providing polygonal mesh editing feature to AoI while at the same time keeping all of the powerful aspects of AoI triangular meshes. To this end (and let's be honest: for convenience as well...), polymeshes are built upon to triangular meshes. That is to say a polygonal mesh is translated in a triangular mesh prior to rendering operations.

One last word about the PolyMesh plugin genesis. Many AoI users use Wings for mesh modeling purposes. Wings is powerful, its interface is generally intuitive and I found it quite easy to come up with the intended result. So instead of trying to reinvent the wheel, the initial goal was more or less to transpose Wings to AoI, or rather to bring Wings features to AoI. At the same time, it was obvious that the polygonal mesh editor had to adopt a workflow similar to the one of the triangular mesh editor, for the sake of consistency. And of course, I introduced some features of my own in the process. So the PolyMesh plugin is a mixture of three components: original AoI mesh editing tools, and more generally "look'n'feel", Wings features and personal stuff.

Creating a PolyMesh object

Creating a new object

The plugin installs a polymesh tool in the tool palette as shown below. If this tool is selected, then clicking and dragging in a view will create a polymesh object. The object created depends on the current tool settings. These settings can be changed through double clicking on the tool icon. The mesh shape can be a cube, a single face, an octahedron, a cylinder or a flat mesh. Depending on the mesh type, it is possible to specify a UxV number of vertices.



Figure 1. PolyMesh tool icon

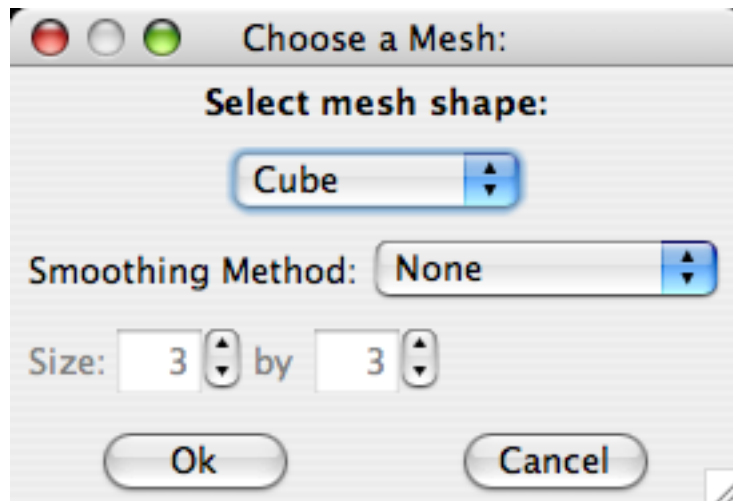


Figure 2. PolyMesh settings dialog

Converting a Spline or Triangle Mesh object to a PolyMesh object

Simply select the mesh to convert before selecting the Convert to Polymesh menu item in the Object menu. Only spline and triangular meshes can be converted to polymeshes.

PolyMesh internals

If you are really eager to start working with the PolyMesh plugin, you may want to skip this section and go to the next one, "Commands", but I advise you to read this section later on.

Polymeshes structure uses the half-edge mesh structure. There is not much to say about that, and if you want to know what an half-edge mesh structure is, you'll easily find the definition on the internet. The half edge structure is a subset of the winged-edge structure, which is used by Wings (hence the name).

What is more important to know to the user is how a polymesh is triangulated to a triangle mesh prior to rendering. Let me repeat this one more time: **polymeshes are triangulated in order to be rendered.**

Triangulation

Triangulation means that some decision must be taken on how to triangulate the mesh. For a given face, there are several possible cases which lead to different results.

1. The face is already a triangle. Not much to do, then, eh?
2. The face is a quad. Joining two opposite vertices along a diagonal does the job. However, there are **two** diagonals. Which one to choose, then? If the face is flat, then both choices yield the same result. If the face is not planar (which is generally the case), choosing one diagonal will lead to a convex shape, whereas choosing the other diagonal leads to a concave shape. Look at the distorted cube shown below. Non planar faces are broken into two triangles each. The default choice for triangulating a quad face is to end up with a convex volume, so the green diagonal is chosen.

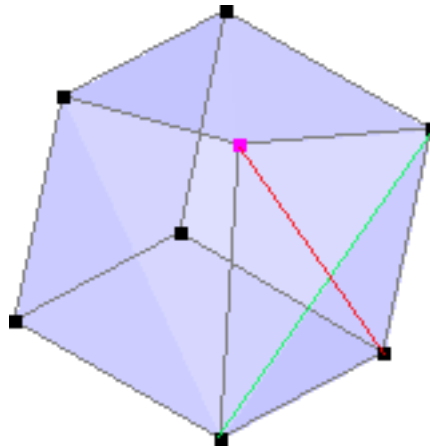


Figure 3. Quad face triangulation

3. The face consists of more than four vertices. We will first suppose that the face is convex. The simplest way of triangulating the face is to choose an arbitrary vertex and then draw edges to each other vertex, as shown on the left part (a) of the next figure. This scheme has an important drawback: it arbitrarily breaks the symmetry of the face, giving a single vertex a different role than every other vertex of the face. The other possibility is using scheme (b): edges are drawn from the face center up to every vertex of the face boundary. However, this design adds a vertex at the center of the face.

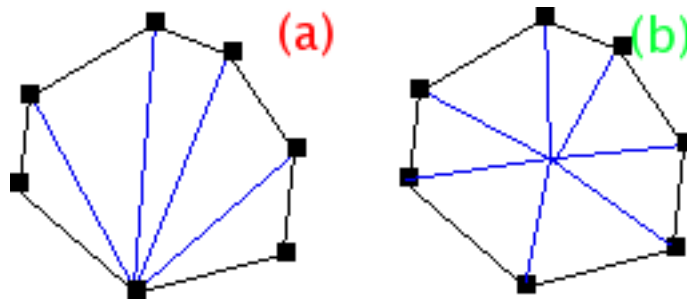


Figure 4. Convex polygonal face triangulation

4. The face consists of more than four vertices and it is not convex. All the non convex part are triangulated using the so called "ear-cutting" algorithm. All the concave parts that stick out of the face inner part are cut into triangles (see figure below). The convex center part of the face is then triangulated as explained above, be it a quad or a general convex polygonal face.

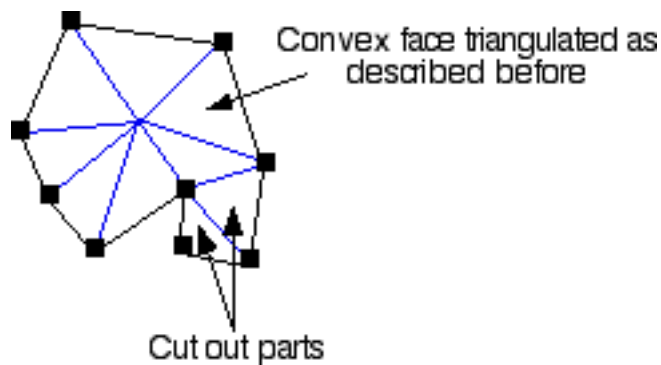


Figure 5. Concave polygonal face triangulation

Thus, any face that has more than three vertices (triangle) introduces new edges, and any concave face that has more than four vertices introduces a new vertex. New edges have a smoothness of 1.

Duck bills

Triangulation design as previously described can lead to an artifact which I call "duck bills" for lack of a better description. This happens when two adjacent polygonal faces share two triangular faces which are made of the same points but have opposite normals. Have a look at the following figure. Two adjacent polygonal faces have 7 vertices each, sharing edges which describe concave parts of each face. According to the ear cutting process for triangulating convex parts of a face, the triangle that makes up the concave part of each face is cut for both faces. As a result, these two faces share the same triangle, only its normals differs from one face to another (opposite signs). Whereas this mesh structure is legal as far as the PolyMesh is concerned, it cannot be smoothed by an underlying triangle mesh. So if you happen to edit a polymesh with smoothing on and suddenly the smoothed preview switches to unsmoothed, a good guess is that there is a duck bill somewhere.

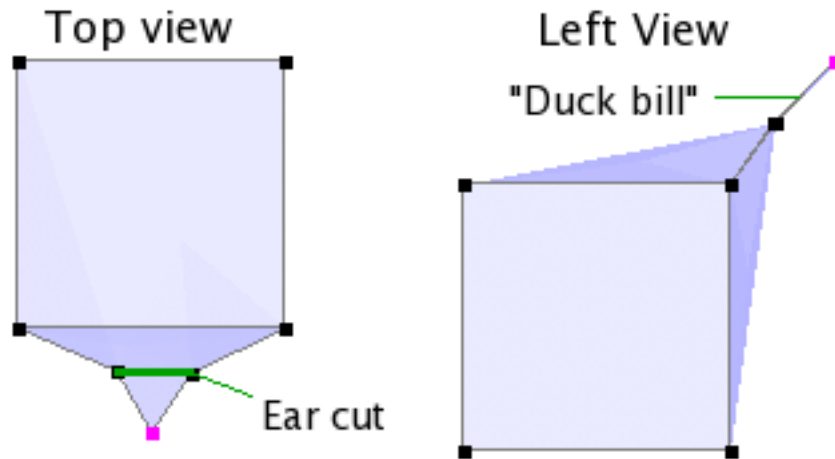


Figure 6. Duck bill

Texturing

As for texturing, texture parameters are inferred from their values at the boundary of the face. Texture parameters can be defined per face or per vertex. Unlike the triangular mesh, texture parameters cannot be defined per face-per vertex. In case texture parameters are defined per face, adding a vertex at center doesn't affect texture mapping. If texture parameters are defined per vertex, the value for the vertex added at face center corresponds to the mean value of boundary vertices.

The PolyMesh Editor Window

The polymesh editor window looks like the figure below. The tools on the left are similar to those found in the triangle mesh editor window. Menus, however, are a bit different of those found in the triangle mesh editor window. Finally, a combination of slider, values and button on the right allows to choose values for specific commands.

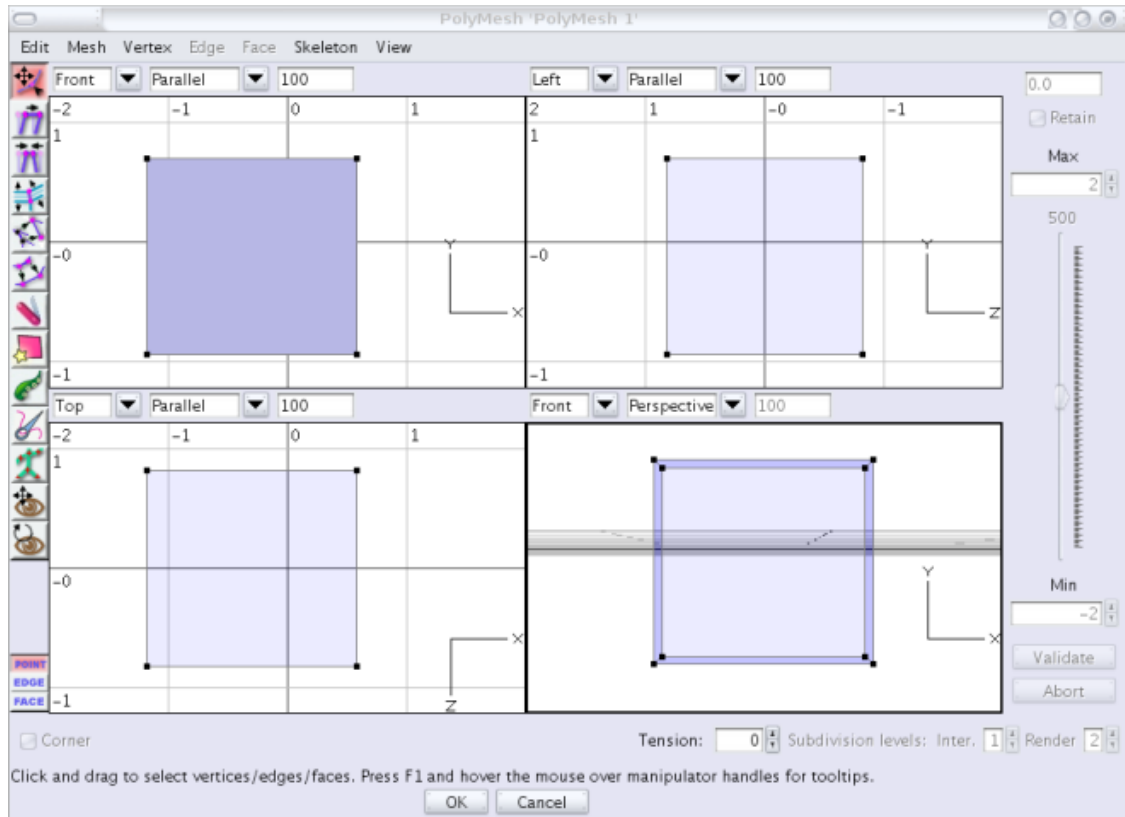


Figure 7. The Polymesh Editor Window

Tools are in fact identical to those found in the triangle mesh editor, except for additional tools (extrude, knife, sew and tentacle).

Generally speaking, tools are used for free movements whereas menu commands are used for constrained movements. Free movements are those which are set using the mouse in a view. Constrained movements are those which follow a given direction (most often the normal direction). For constrained movements, only the amplitude of the movement is to be set by the user. When the polymesh editor enters amplitude setting mode, the controls at the right of the window (slider, spinners, text fields...) are activated. Moving the slider will vary the amplitude of the movement from Min to Max. These two values can be modified using the lower and upper spinners. Alternatively, a value can be manually entered into the top value field. If the Retain checkbox is checked, then the entered value becomes the default value for subsequent operations. This feature can be useful for applying several similar operations in a row using the same amplitude, e.g. extrude faces successively 4 times with a value of 0.22. Amplitude selection is applied through selecting the Validate button. Abort aborts the current operation. *Caution:* while in amplitude selection mode, mouse interaction with mesh is still enabled. Limit interaction to operations that do not modify the mesh. If the mesh topology is modified while selecting an amplitude, an error may occur. Safeties will be implemented as the PolyMesh plugins evolves.

The Point, Edge and Face buttons at the bottom left of the window are used to change selection mode, as in the triangle mesh editor window. There are, however, keyboard shortcuts to quickly switch to a given selection mode. These shortcuts are 'p' (or 'v'), 'e' and 'f' (provided shortcuts weren't modified using AoI editable keystrokes feature).

There is another handy feature which is triggered using the S key. If you are editing a smoothed mesh,

you may notice that smoothing may cause slowdown for real time operation like extrusion, bevel, etc. This is especially true for complex meshes. Hitting the **S** key disables smoothing so that mesh display operations are much faster. This feature can also be used to know how the mesh looks like when before smoothing. Hitting the **S** key again brings back smoothed display.

In addition, the poly mesh editor provides manipulators to easily move, scale and rotate the current selection. Manipulators are discussed at the end of this section.

Finally, some important settings can be changed using several widgets at the bottom of the window. The available settings may change depending on the editing mode currently selected. Be sure to read the relevant sections to find out what these widgets are for.

Tools

Extrude tool. Using this tool in edge or face mode, you can pick the selected items and extrude them using the mouse. Newly created items positions follow the mouse location. Extrusion can be applied to individual items or selection as a whole (double-click on icon for options). This tool does not operate in point mode. In edge mode, *only boundary edges can be extruded*.

Knife tool. The knife tool allows to "cut in" new edges. Select the knife tool and click and drag across the edges to cut. A new vertex is placed at each intersection between the line drawn and the edges that border at least a face facing the screen. Release the mouse to validate the cuts. More cuts can be subsequently achieved if the Ctrl key is held on while releasing the mouse. Drag the mouse again to draw a second line. New lines can be added while the Ctrl key is held down. Releasing the mouse without having the Ctrl key pressed ends the cut. If you forget to release the Ctrl key and want to terminate the cut, simply click anywhere near the least point. If you want to also cut the edges at the back, keep the Shift key depressed while cutting edges.

If there is an initial selection, the knife tool only cuts the selected edges, ignoring the non selected ones. Here again, only "front" edges can be cut, except if the Shift key is held down. Be sure to cancel any selection if need be in between cut operations.

Limitations: an edge may only be cut once. If the same edge is crossed by several lines, only the latest cut is considered.

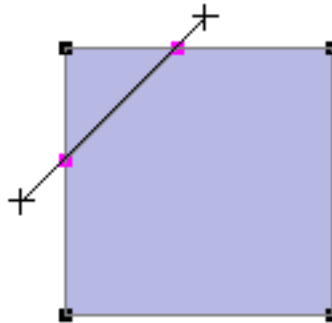


Figure 8. Using knife tool (single cut)

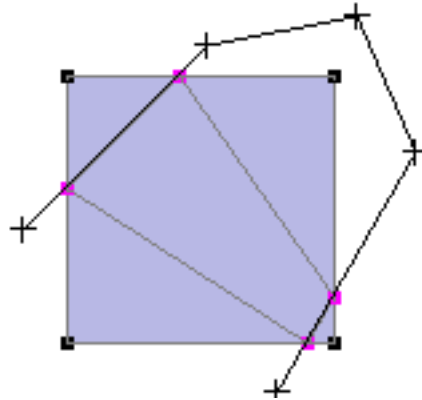


Figure 9. Using knife tool (multiple cuts)

Create Face tool. This tool allows to draw faces rather than generate them through box modelling. Face can only be added to boundaries of an existing mesh. Faces cannot be added to closed meshes. To draw a face, select the Create Face tool. Click on a boundary vertex that will share the newly created face with an existing face. Add several points in the same view. Click on an ending boundary vertex to close the face (see picture below).

It is also possible to create a disjointed face rather than to have to add faces to existing faces. You still have to begin the drawing process starting with an existing edge. This allows to locate the new face with respect to the view Z direction (the normal to the screen). Then draw the face vertices as you would normally. To end the face, however, click on the second point, the first vertex which does not belong to the existing mesh. Disjointed faces or patch of faces can be sewn together using the sew tool.

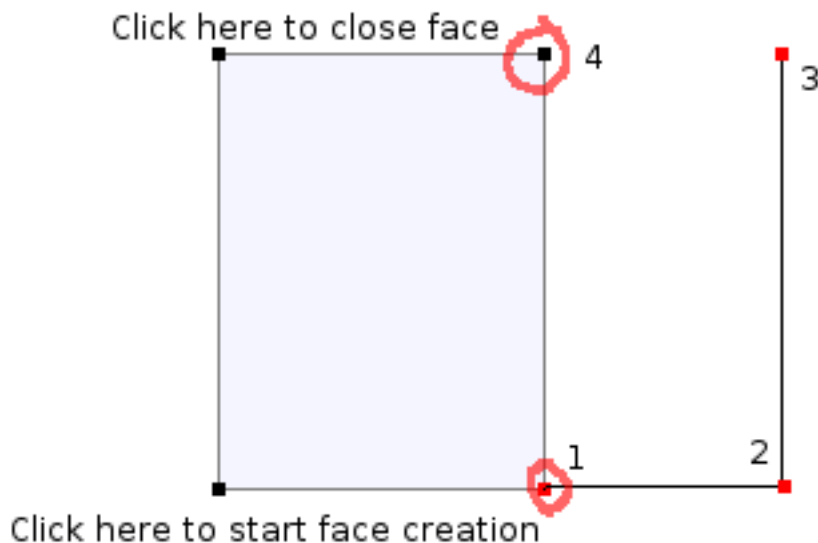


Figure 10. Using Create Face tool (attached face creation)

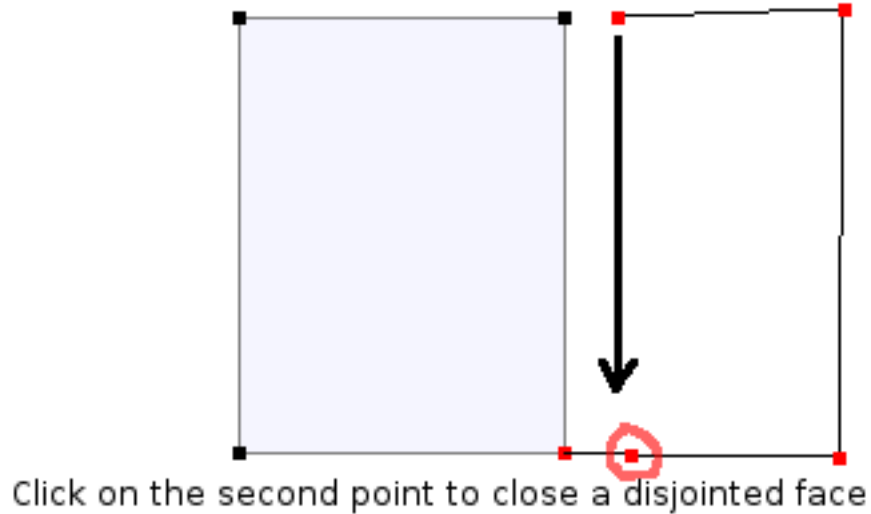


Figure 11. Using Create Face tool (disjointed face creation)

Tentacle tool. Actually, this tool is about faces extrusion along a curve path. Select faces or a group of faces before selecting the tentacle tool. Once the tentacle tool is selected, a red square will show the first point to extrude along. Click several points to define the curve to extrude along. Once you are satisfied with the result, validate your work with the **Enter** key.

The blue handles can be used to increase or decrease the scaling of a given cross-section. Beware, this setting affects further extrusion so it influences cross-sections after the one modified.

There are also some options you can use:

- If you shift-click the first point of the curve, the cross section will remain constant, as opposed to the standard behavior where the cross section decreases along the curve;
- Shift-clicking an existing control point allows to reset scaling handles, which is handy when the scale is so small the blue handles can't be dragged anymore;
- Ctrl-clicking anywhere cancels the extrusion;
- Ctrl-clicking an existing point deletes it.

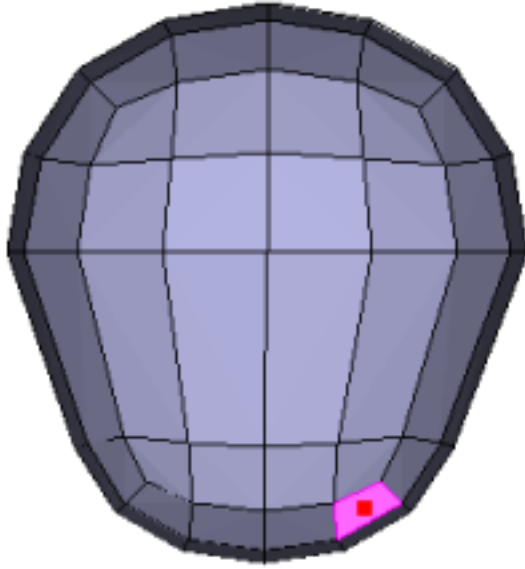


Figure 12. Tentacle tool step 1

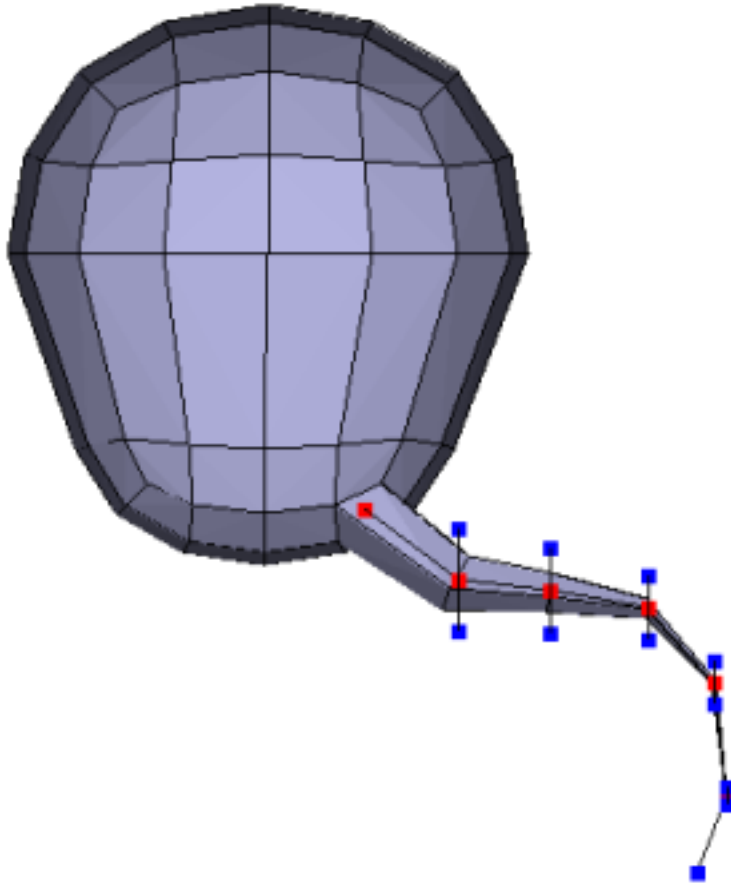


Figure 13. Tentacle tool step 2

Sew tool. This tool allows to merge edges together thus allowing to join disjointed faces. This tool works in a similar way as the knife tool does. The principle is to draw a line crossing the two edges to merge, as shown in the figure below. The edges crossed by the dragged line are merged, the vertex positions of the second edge to be crossed being kept in the process.

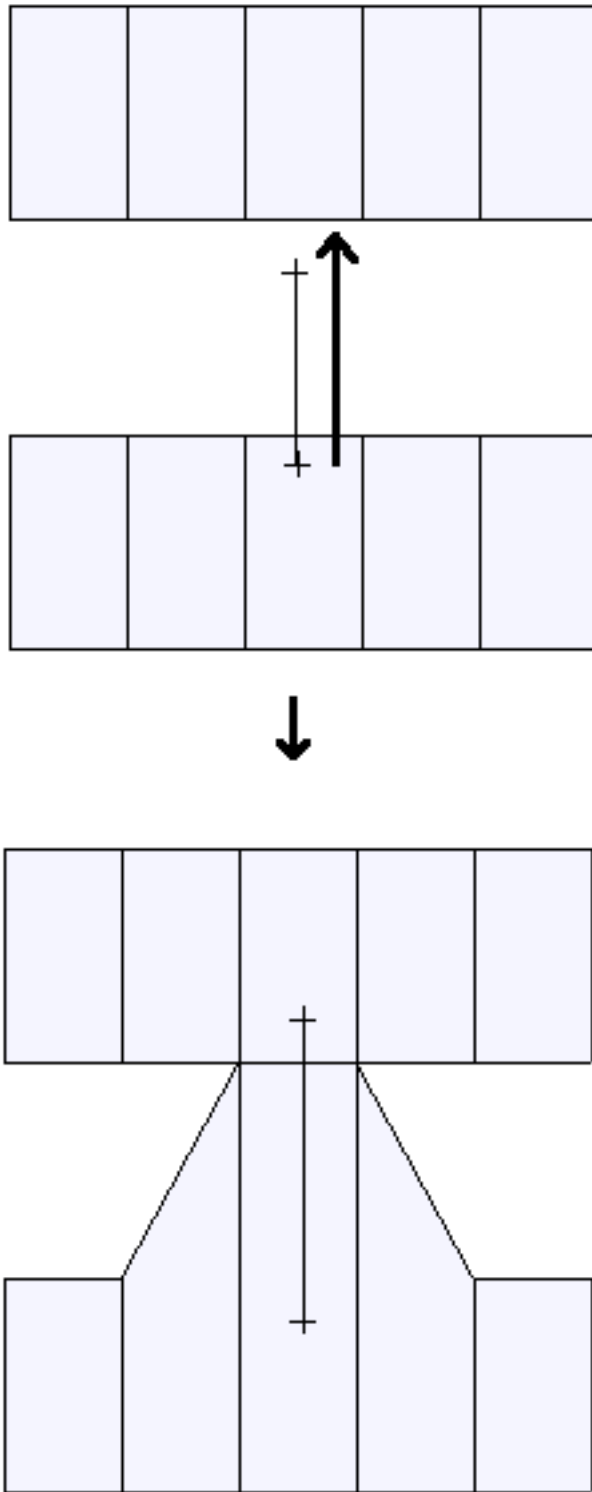


Figure 14. Using Sew tool

It is also possible to sew two disjointed selections in order to sew several edges at the same time. Selections must be disjointed for the sew tool to work. They can be complete boundary selections, in which case the boundaries must have the same number of edges. The sew tool then operates like Join Boundaries, except boundaries are merged rather than joined.

If you want the vertices of the merged edges to be placed at equal distance from merged edges original vertices, then keep the Shift key pressed as show in the picture below.

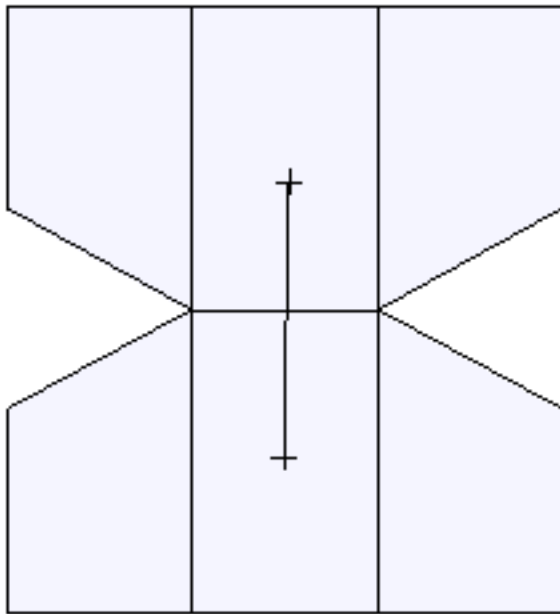


Figure 15. Using Sew tool with Shift key pressed

Finally, the Sew tool can act as the close boundary command if you keep the Ctrl key pressed while dragging over a boundary edge. Only one boundary edge needs to be crossed when closing a boundary.

Manipulators

Manipulators allow the user to interact with selection for moving, scaling and rotating. As vertices, edges or faces are selected, a three axis system X, Y and Z is displayed as shown below. Clicking and dragging on one of the squares bearing the axis names moves the selection along the axis direction. Dragging the diamond like shape scales the selection along the direction. Finally clicking and dragging along a circle rotates selection about the relevant axis. The grey sphere at the axis origin can also be grabbed and freely moved to achieve freehand translation.

This basic behavior can be modified using key modifiers and other mouse buttons. You don't need to know all of them as there are other ways of achieving the same result, however they can prove to be quite handy shortcuts.

- **Shift**-scaling scales uniformly along the three directions (and not just one)
- **Ctrl**-scaling scales the manipulators rather than the selection. The manipulator is reset if the editor window is closed

- **Ctrl**-clicking in a scale, move or rotate area activates the value slider at the right of the editor window. It is then possible to enter a precise value for the operation activated.
- **Shift**-clicking on translation labels constrains movement to a step by step motion, step value being equal to the grid subdivision
- **Ctrl**-clicking on a translation label brings the selected axis perpendicular the screen, outwards. **Shift-Ctrl**-click brings it perpendicular as well but inwards. This provides quick selection for Right, Front and Top views and the like.
- **Ctrl**-clicking on the grey sphere at the axis system center moves the whole manipulators set about feature points. Feature point are : selection center, vertices (when vertex mode is enabled), middle of edges (when edge mode is enabled) and faces centers (when face mode is enabled).
- **Shift**-clicking on rotation handles constrains rotation to steps of 5 degrees

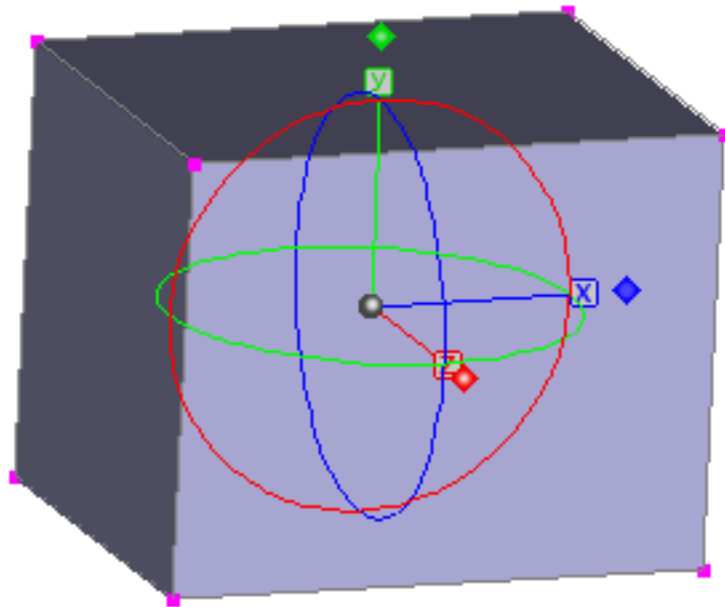


Figure 16. XYZ Manipulators axis

In addition to the XYZ view mode, there are two other view modes. View modes are toggled using the **W** key. The second view mode is called UV and is shown below. This mode purpose is to be able to achieve 2D like edition. Rotation, translation and scaling occurs in the 2D plane. Moreover, a third scaling handle (top right corner of manipulator) allows non uniform scaling in both directions.

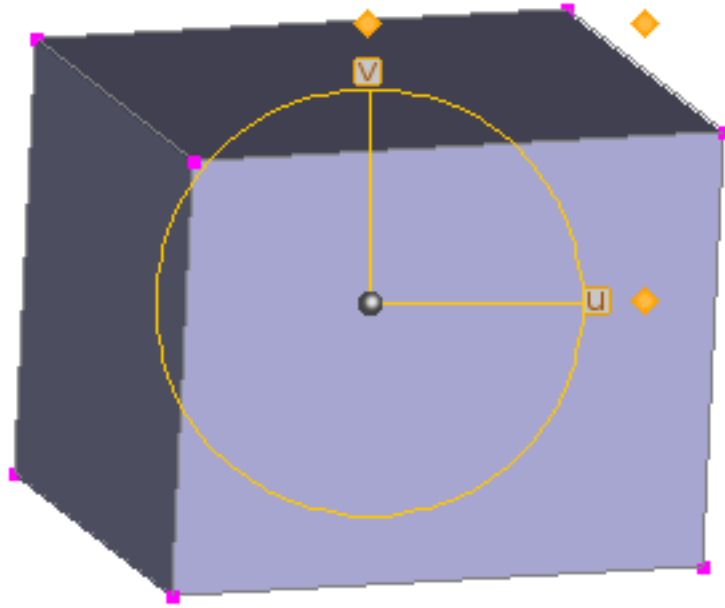


Figure 17. UV view mode

The third view mode is called the NPQ mode. N stands for 'normal', meaning the N axis always indicates the normal to the selection. Note that the definition of 'normal direction' is not the same for vertices, edges and faces so the manipulator orientation might change depending on the editing mode being selected. P and Q direction are arbitrarily chosen.

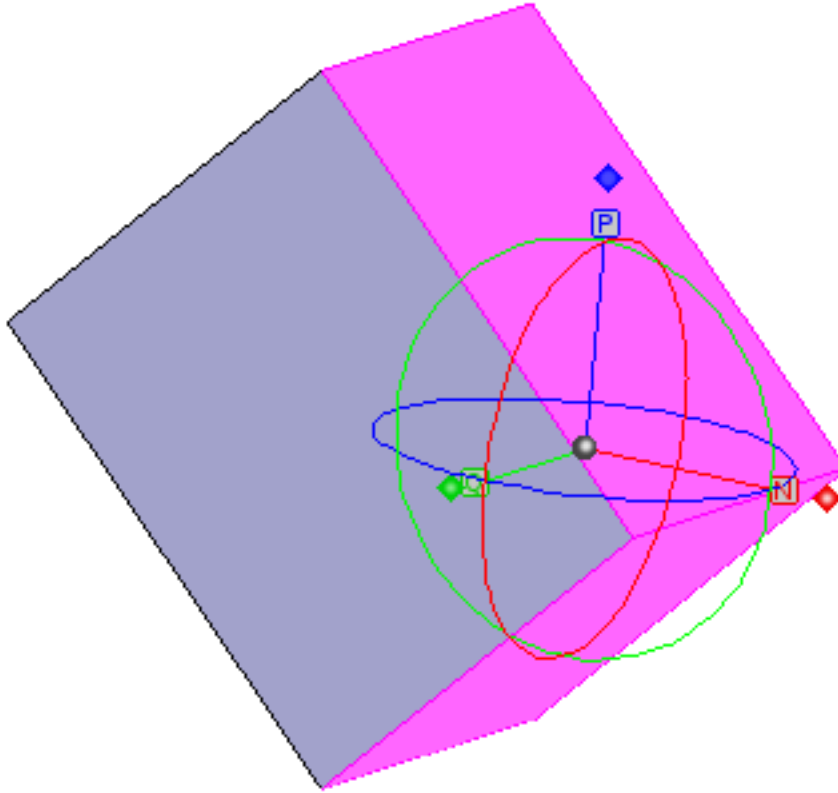


Figure 18. NPQ view mode

Commands

Only commands that differ to those of the triangle mesh editor are described.

Edit Menu

Copy mesh / Paste mesh: This command copies a mesh as a whole which can be pasted in any other PolyMesh editor window. As a result, the polymesh will consist of two disjointed meshes. It is intended that these two meshes are unified later on, presumably using Join Boundaries. The pasted mesh inherits texture and material parameters from the mesh it has been pasted in. Parameters are set to a default value and any texture parameters pertaining to the pasted mesh are lost. The polymesh editor clipboard is independent from AoI main clipboard.

View along normal to current selection: As the item title says, this command rotates the view (not the object) so as to align the normal to the selection along the viewing direction.

Scale selection. Scales the whole selection around its center using the slider/text field at the right of the window.

Mesh Menu

Smoothing Method. Mesh smoothness can be only set to none, shaded or approximated. Approximation smoothing uses Catmull-Clark smoothing with variable edge smoothness. Smoothing levels specify the number of subdivisions to be applied for interactive views and renders. The greater the number, the finer the mesh. A high number of subdivisions leads to high memory usage and long computations. For this reason, the subdivision levels are limited to 6. The default numbers are good guesses. An additional tri-mesh smoothing is carried out after Catmull-Clark subdivision when rendering, so you don't need to bother whether the subdivision level is high enough. Since this level greatly affect editor responsiveness in interactive views, the interactive level can be decreased/increased using the X and C keys (provided you didn't change the Keystrokes shortcuts). The S key toggles the view between smoothed or unsmoothed (this does not affect the real mesh smoothing status). Interactive and rendering levels can also be set using the two spinners at the bottom of the editing window.

Currently implemented smoothing algorithm make it possible to specify a smoothness coefficient ranging from 0 to 1 to each edge. [0-1] values for vertex smoothness is not possible, however any vertex can be specified as a corner, i.e. sharp. Corners/edges smoothness can be set using relevant widgets at the bottom of the editor window (depending on edit mode).

Auto Smoothness. Edge smoothness parameters are calculated according to the angle between the two faces that neighbor and edge. The dialog asks for a minimum angle, maximum angle, minimum smoothness and maximum smoothness. If the angle between two faces is lower than Min Angle, then the smoothness of the edge is set to Min Smoothness. If the angle is between the Min Angle and the Max angle, then the smoothness is computed as a linear interpolation between Min Smoothness and Max Smoothness. If the angle is above Max Angle, then the edge smoothness is set to Max Smoothness. Min and max smoothness are convenient denominations, it generally happens that the value for Min Smoothness is greater than Max Smoothness for practical purposes. An example of smoothness as a function of angle is plotted in the figure below.

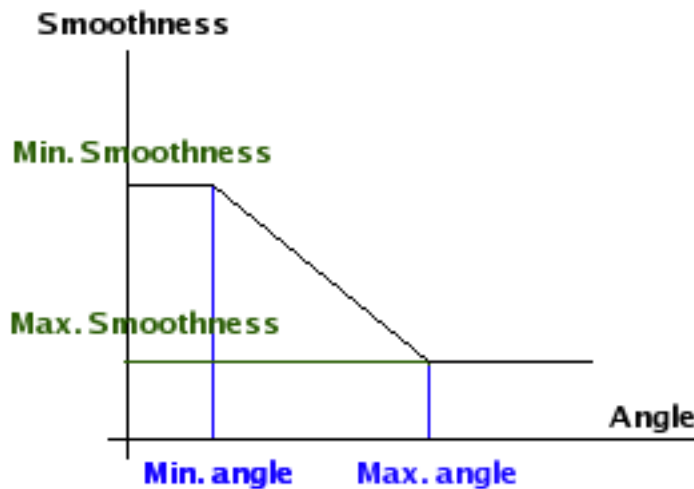


Figure 19. Edge smoothness vs Angle between two faces

These rules are applied to the *triangulated mesh* rather than the polymesh. This allows to compute smoothness values for edges added inside polymesh faces which consist of more than 3 vertices. If the Auto Smoothness feature is disabled, polymesh edges smoothness will be set to values close or equal to those of the triangulated mesh. Additional edges smoothness will have to be setup using face properties.

So it may happen a mesh shape changes in a more or less pronounced way upon disabling auto smoothness feature.

Smooth mesh. Smooths the whole mesh according to the Catmull-Clark algorithm. The smoothed mesh always end up a quad mesh due to the nature of the algorithm, however any kind of mesh can be smoothed (triangular, polygonal)

Subdivide mesh. Subdivides the whole mesh in a manner similar to "Smooth mesh", however the mesh is not smoothed. Only new points are added. As for the smoothed mesh, the resulting mesh is a quad mesh.

Thicken mesh. This command is available only if the edited mesh is opened. In this case, selecting the mesh command will thicken the mesh by an amount specified using the slider/text field on the right side of the window. The thickening may happen along a given direction or the selection normal.

Mirror modelling. It is possible to set up mirrors in the editor so that only half to one eighth of the mesh has to be edited. The mirrors can be set in the XY, YZ and/or XZ plane. When this feature is enabled, any face that lies on the mirror plane is a "mirror spot". A face is said to be lying on the mirror if the relevant coordinate of all its vertices is equal to zero. For example, a face is a mirror source on the YZ plane if all the x coordiantes of its vertices are 0. If several neighboring faces have all of their vertices lying on the plane, then the whole group (region) acts as a mirror source. It is possible to mirror the mesh using several disjointed groups/faces. Mirrors are cumulative. For example, if all three mirrors are used, then one eighth of the mesh is modeled. Mirrors can be removed through unchecking the relevant menu items. If you want to keep the mirrored mesh as a result, then use the Mirror off command. A dialog will then allow you to keep the resulting mirrored mesh. Mirror can be toggled on/off in the view using the N key. As for the S smoothing toggle, this does not affect the true mesh mirroring status.

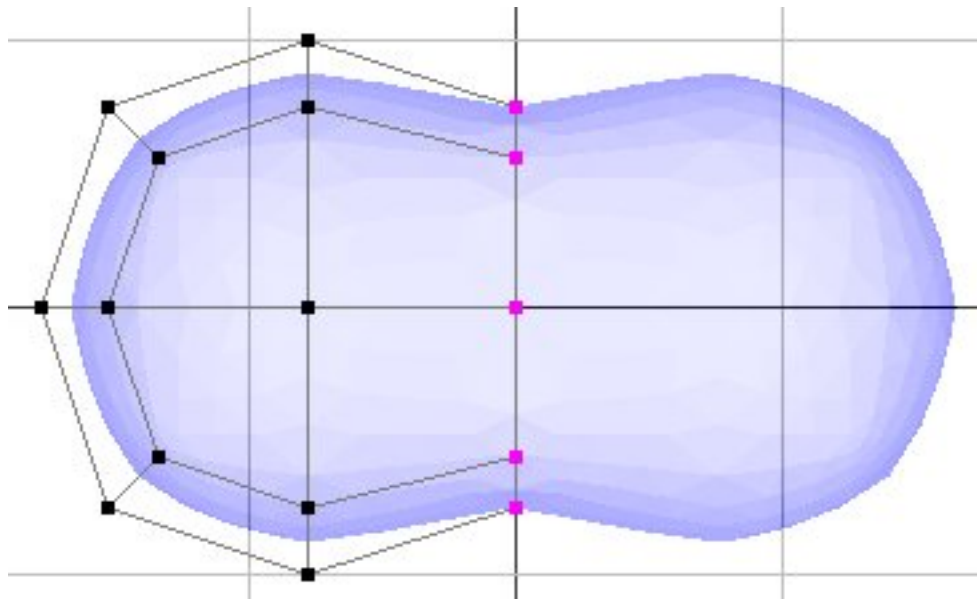


Figure 20. A mirrored mesh

Mirror whole mesh. This command replaces the mesh by its mirrored version. Mirror can be any of the three XY, YZ and XZ plane. Normals are inverted in the process.

Invert normals. Inverts all normals to the faces of the mesh. You don't normally need to do that (commands like Mirror take care of inverting normals). However, this commend may be used when a faulty model has been imported.

Check and repair mesh. This command checks the mesh for invalid data. This is mainly useful for debugging purposes, but it also might be helpful to pinpoint what the problem is if you suspect a bug in the PolyMesh plugin. If possible, some basic corrections will be applied to the mesh in case it turns out to be faulty.

Save as Model. This command exports the current mesh in a format suitable for polymesh templates that can be recalled at polymesh creation time in AoI main window. The template is saved in the `PolyMeshTemplates` subfolder of the `Plugins` folder.

Vertex Menu

Connect. This command connects selected vertices with edges. The following rules are applied in order to find out which vertices should be connected:

- Connected vertices must belong to the same face;
- When connections can be carried out in several ways (ambiguity) then the connections that lead to the most perfect quads are established;
- No triangular face shall be created (preserving quad mesh as much as possible) unless *only two vertices* are selected, in which case the user's action prevail.

Move along (Normal, X, Y, Z). Constrained movement along one of these directions. Amplitude is entered using the slider/text field at the right of the window. See PolyMesh Editor Window features description.

Collapse. All edges coming from the selected vertex (vertices) are collapsed. In other words, all vertices sharing an edge with a selected vertex are moved to the location of the selected vertex. See figure below.

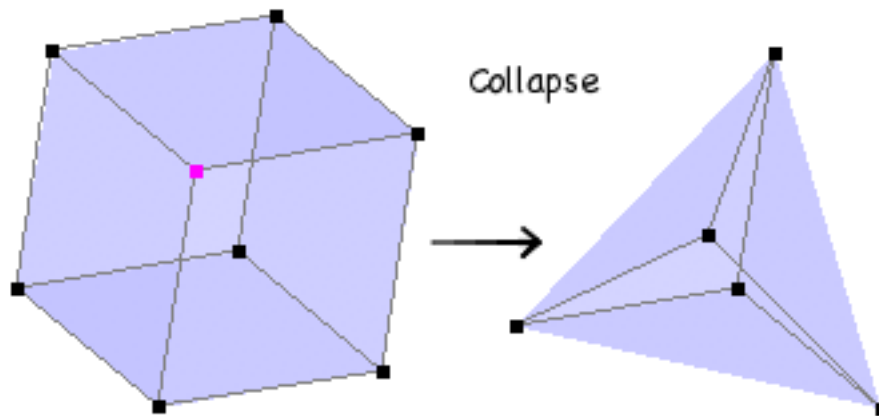


Figure 21. Vertex collapse

Facet. Selected vertex (vertices) is deleted and replaced by the face built on its neighbor vertices. See figure below.

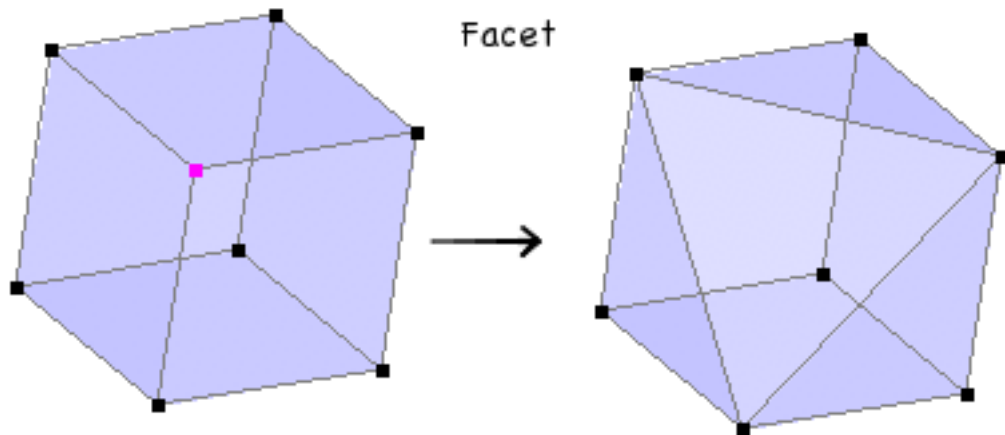


Figure 22. Facet vertices

Bevel. Bevels the selected vertices exactly like Facet does, except amplitude is controlled using the slider/text field at the right of the window. See figure below.

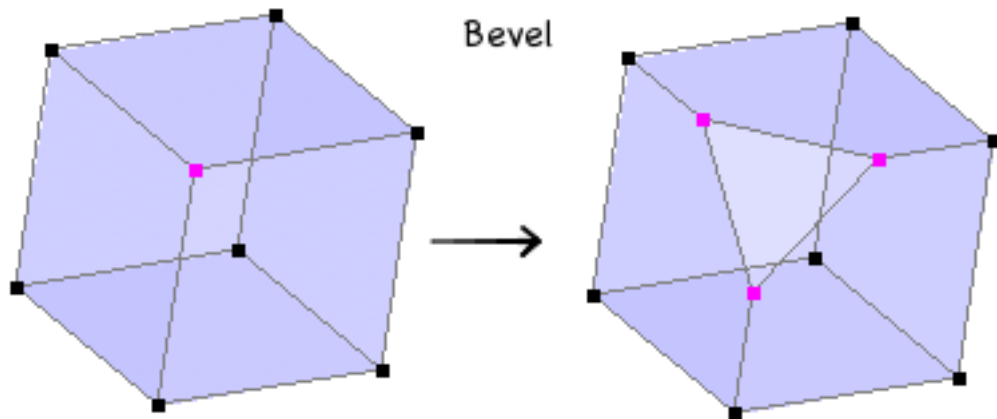


Figure 23. Bevel vertices

Inflate. This command is available if four or more points are selected. A mean sphere is computed, its center being the selection center and its radius the mean distance between selection center and each selected vertex. Varying the amplitude brings vertices from initial locations (0) to the mean sphere (1) along the radii.

Spherical. This command is available if four or more points are selected. The closest sphere to selection is computed (which yields generally a sphere quite different than the mean sphere computed by the Inflate command). Varying the amplitude brings vertices from initial locations (0) to the computed sphere (1) along the radii.

Flattens. This command is available if four or more points are selected. The closest plane to selection is computed. Varying the amplitude brings vertices from initial locations (0) to closest plane (1) along the

normal to the plane.

Select Boundaries. If one or more vertex is selected, then every vertex belonging to a boundary crossing the initially selected vertices becomes selected. If no vertex is initially selected, then every vertex crossing by a boundary (no matter which one) becomes selected.

Close Boundary. Each boundary crossing a selected vertex is replaced by a face. It is not necessary that the whole boundary is selected.

Join Boundaries. This command joins two boundaries much like the triangle mesh editor does. Two and only two vertices must be selected, one for each boundary to join. An edge is created between these two vertices and then other vertices of the two boundaries are connected using the rules of the Connect command. If one boundary has more vertices than the other, then triangular faces will be created. Otherwise, this command only creates quad faces.

Edge Menu

Divide. Divides selected edges in n equal parts. Since this command is used generally to connect vertices after being selected, the editor enters point selection mode after this command has been executed.

Move along. Same as the Vertex menu command.

Extrude. Extrudes individual boundary edges along the chosen direction. Extrusion amplitude is set using the slider/text field. Please note that only boundary edges can be extruded.

Extrude Region. Extrudes groups of edges along the chosen direction. Extrusion amplitude is set using the slider/text field. As for extrude, only boundary edges can be extruded.

Collapse. Brings together the two vertices of every selected edge.

Merge. Merges consecutive selected edges into a single edge.

Bevel. Bevels selected edges. Use the slider/text field at the right of the window to select bevel amplitude. The editor does not impose a maximum value so it is possible to end up with edges beveled *further* than their bordering faces would allow (b). Just before that point, faces that borders the edge collapse, i.e they have a null area. The PolyMesh can detect such situations and remove faces which have an area too small to be meaningful (c).

Select edge loop. Starting with selected edge(s), this command tries to find a loop of edges going back to originally selected edge(s).

Select edge ring. Same as above, except selected edges are perpendicular to the edge loops.

Insert loops. This command may be used to quickly insert an edge loop in between two loops. Select one (or several) edge(s) and then select the **Select edge strip** command. Check that strips are properly selected (since on some occasions the loop selection is not carried out properly, this selection is not automatic). Then select the Insert loops command. The position of the inserted loop(s) can then be varied using the slider.

Select boundaries/Close boundary. These commands work the same way than the corresponding Vertex menu commands.

Find similar... Given a selection of edges, this command selects other edges similar to the ones selected. In this case, similar means having the same length. Tolerance with respect to length for similitude check can be specified in the Find Similar... dialog.

Bevel properties. When applying a certain amount a beveling, it sometimes happens that vertices overlap. In this case, it is generally wished that the edges connecting overlapping vertices are collapsed. This behavior is not automatic but it can nonetheless be achieved setting two parameters. The Bevel proper-

ties command brings the window shown below. If you wish to collapse small edges during bevel in order to avoid overlapping vertices, check the Apply checkbox. The Limit length value allows to tune the limit under which edges are collapsed. *Caution*: every edge of the mesh is affected, not just those being beveled. Beware of deleting small edges that do not take part in the bevel process.

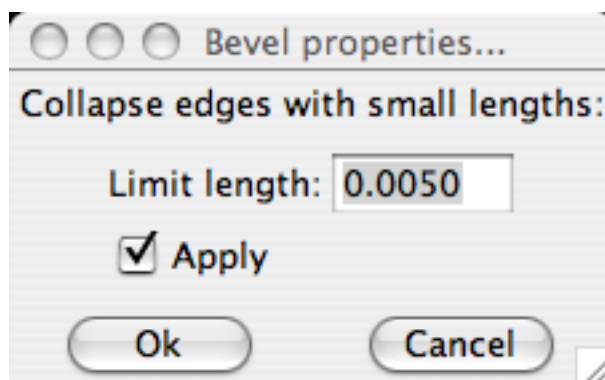


Figure 24. Bevel properties window

Face Menu

Move along. Same as the Vertex menu command.

Extrude faces. Extrudes individual faces along the chosen direction. Extrusion amplitude is set using the slider/text field.

Extrude Region. Extrudes groups of faces along the chosen direction. Extrusion amplitude is set using the slider/text field.

Smooth faces. Selected faces are smoothed according to the Catmull-Clark algorithm. Neighbor faces are partially subdivided in order to accomodate subdivision resulting from smoothing.

Subdivide faces. Selected faces are subdivided in the same way as the Catmull-Clark algorithm does. However, no smoothing occurs. As for smoothing, neighbor faces are partially subdivided in order to accomodate subdivision.

Collapse. Selected faces or groups of selected faces are replaced by a single vertex. To do: optimize vertex location when considering a group of several faces.

Merge. Merges several faces into a single face.

Triangulate faces. Selected faces are replaced by triangulated faces. Triangulation is carried out the same way as for calculating a rendering mesh, so this process doesn't change mesh surface whatsoever. Triangulating faces is useful if they happen to have a more than reasonable number of vertices and prove difficult to work this.

Find Similar... This command has the same purpose as the Find Similar... for edge edit mode. However, parameters for deciding when a face is similar to another one are a bit more comprehensive. You can specify a tolerance on face orientation : 0.01 (default) means all faces having the same normal as the already selected ones whereas 180 degrees means face orientation doesn't matter. Faces shapes (angles) allows to select faces having the same shape as the currently selected ones but size doesn't matter since only angles between faces edges are compared. Faces shapes (distances) constrains the faces sizes as well. Given this set of parameters the face mode Find Similar... is a very powerful tool to select faces akin in any aspect.

Preferences

Reload Polymesh Keystrokes... When it is loaded for the first time, the Polymesh plugin adds its own keystrokes to the AoI keystroke pool. Keystrokes aren't modified hereafter even when updates are released. The point is that you might have changed keystrokes contents for a reason or another. However, some scripts associated to the keystrokes might become obsolete and indeed raise errors. In this case, it is advised to reload the keystrokes anew. Existing keystrokes associated to PME will be deleted and reloaded using the latest keystrokes list shipped within the plusing file.

Edit Keystrokes... This command makes it possible to edit keystrokes directly from the PM editor window. Resulting dialog is equivalent to the keystrokes edit panel available using AoI Prefs menu item.

Tips and Tricks

Triangulation artifacts

It may happen that for complex faces triangulation fails. Let's take the following example of a cog wheel which has been created using the cog script, extruded and subdivided before being converted to a polymesh. Closing the two end caps of the polymesh using select and join boundaries leads to artifacts on the faces (see image below).

Select the Polymesh menu item from the Tools menu. The following dialog appears:

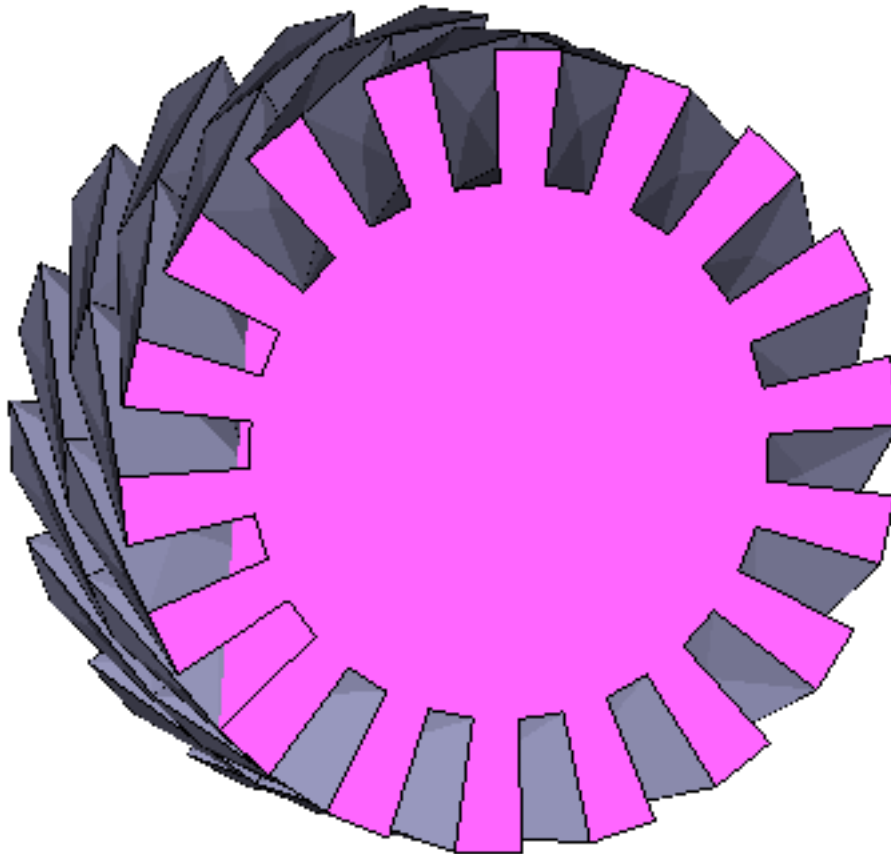
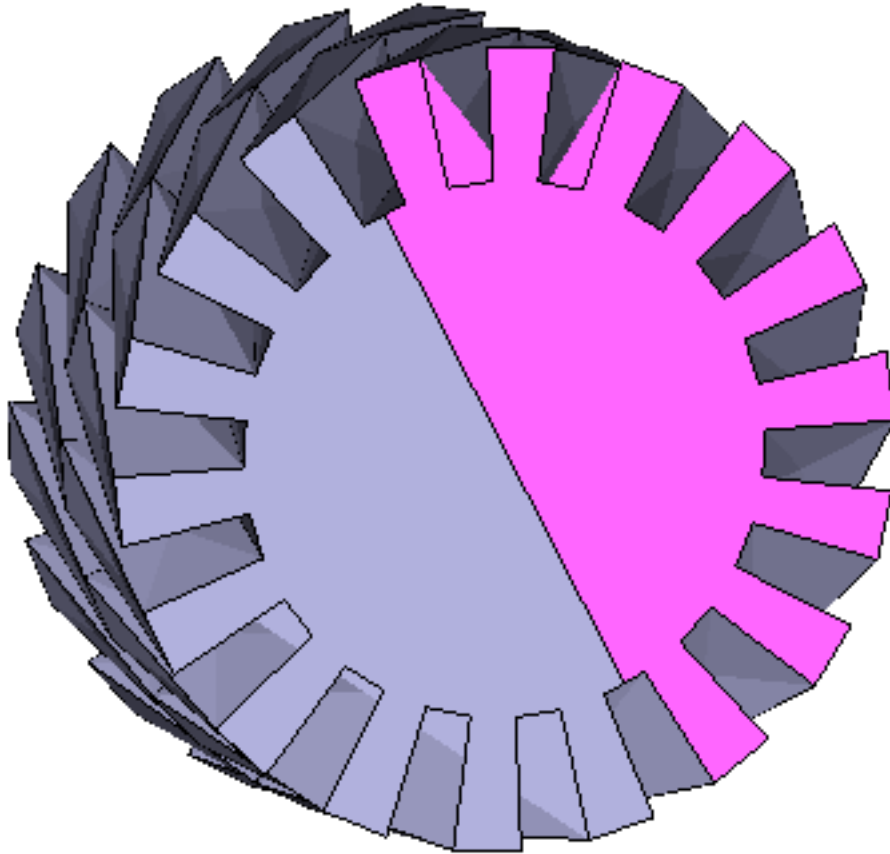


Figure 25. Artifacts due to face triangulation

There are several ways to get rid of these artifacts. The point is to split the face into a subset of simpler faces. The most obvious thing to do is to split the face in two using two opposite vertices, although it doesn't immediately solve the problem.

**Figure 26. Artifacts still occurring although the face has been split in two**

To split the face in four parts, let's divide the newly created edge in two. Selecting this vertex plus two opposite vertices allows to split the original into four using the Connect command.

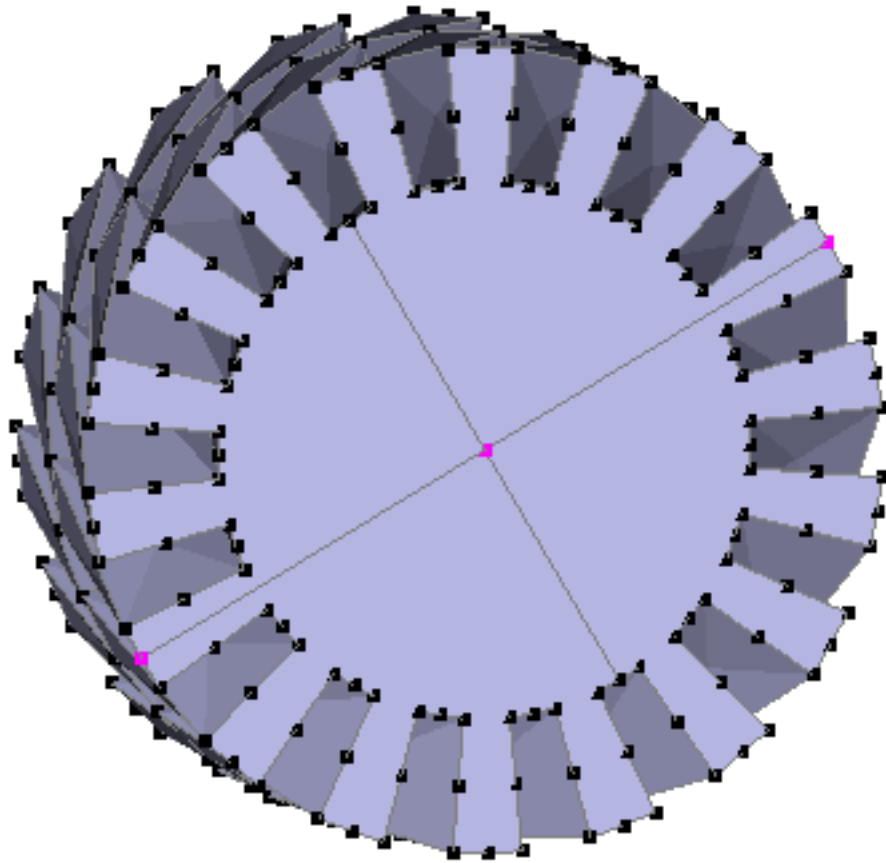


Figure 27. Splitting the face in four cures artifacts

Given the symmetry of the face, however, there is a simpler way of getting rid of the artifacts. Select the face and then the Subdivide faces command from the Face menu.

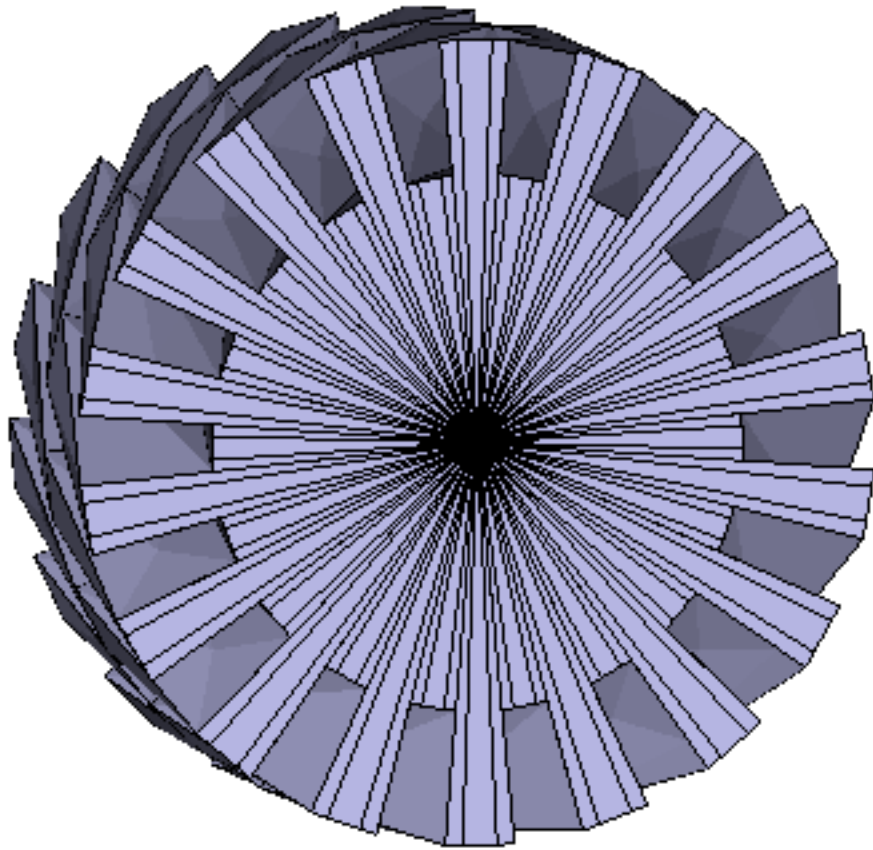


Figure 28. Same face after subdivision

Hopefully, artifacts occur only with complex and peculiar faces. For example, the same face is correctly triangulated if its edges aren't subdivided.