Subdivision Modelling

An introduction to subdivision modelling in Maya

Revision: 001

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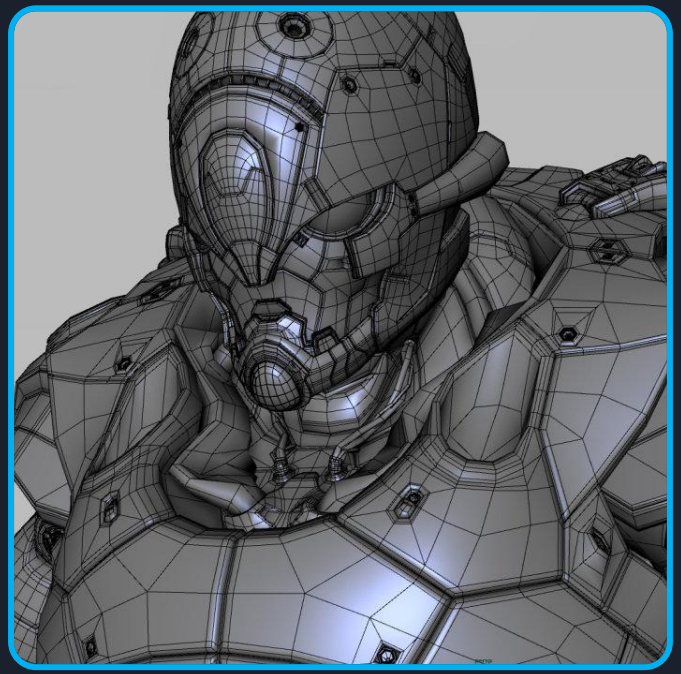
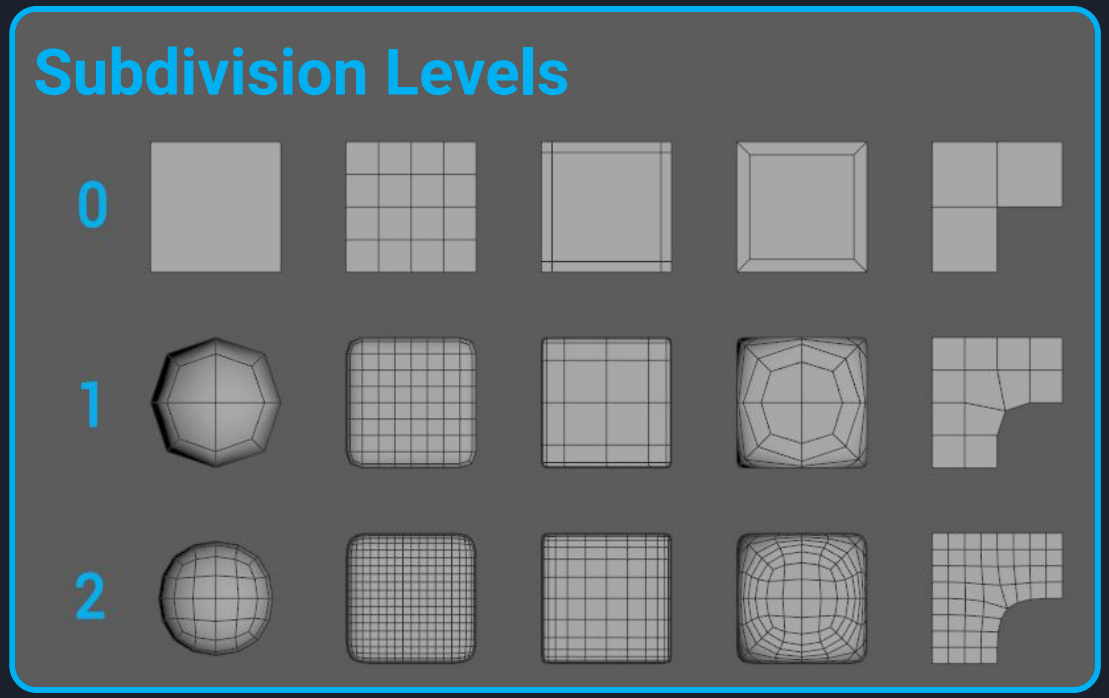
Subdiv Modelling|Contents



Artwork by David Letondor

This lesson will introduce subdivision modelling, demonstrate its uses in industry and examine techniques to create efficient subdivision meshes. This lesson will cover the following:

Subdiv Modelling | Introduction



Subdivision modeling is a process for creating complex high-poly meshes utilising simplified base geometry.

The process starts with a standard polygonal mesh, which is subdivided creating new vertices and faces. The position of the new vertices and faces is determined by the position of the original vertices and the refinement scheme (algorithm) used for subdivision.

Autodesk Maya utilises a subdivision algorithm called Catmull-Clark. Developed in 1978 by Edwin Catmull and Jim Clark, Catmull-Clark is an approximating scheme that utilises B-splines to approximate the position of vertices when a mesh is subdivided.

Subdiv Modelling|Use In Industry

1

2

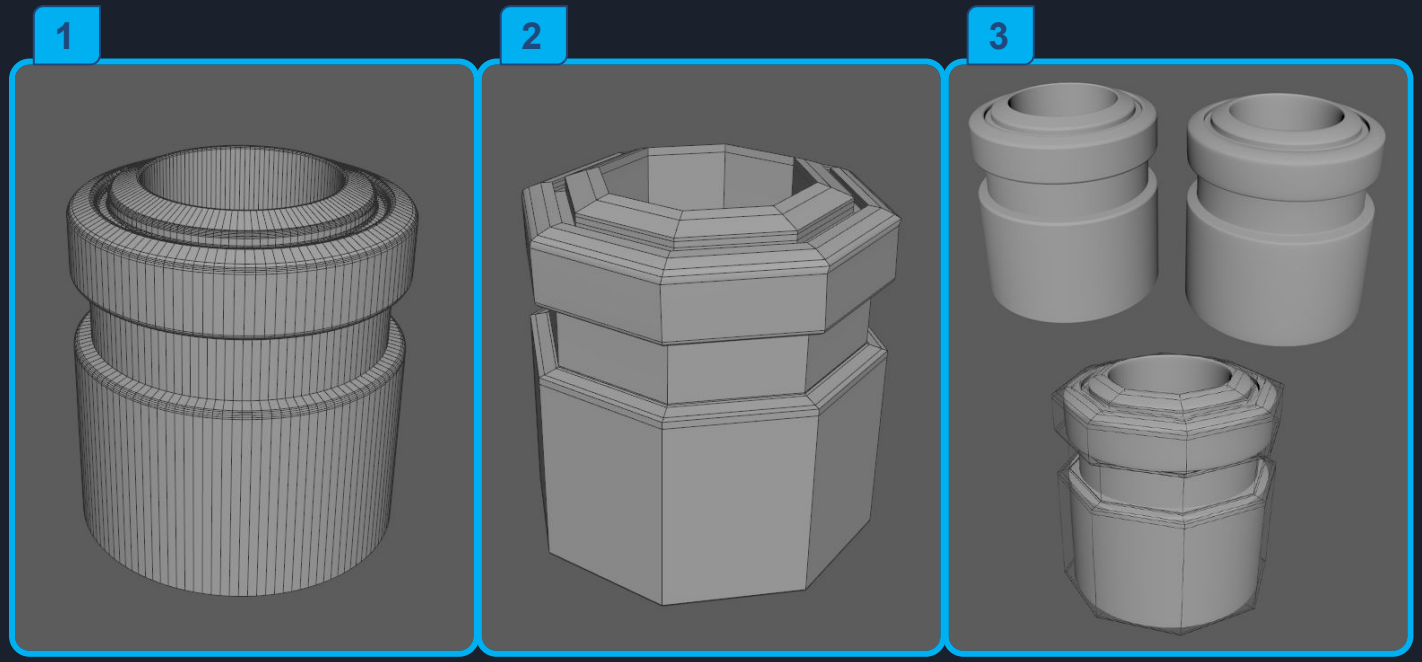
3

In games development subdivision modeling is used to create high-poly meshes which can be baked into normal maps and applied to low-poly meshes.

In film and animation subdivision modeling is used to create high-poly characters, props and environments for rendering.

1. Dentist chair by Mark Bolak
2. Camera body by Paul Pepera
3. Hover bike by Paul Pepera

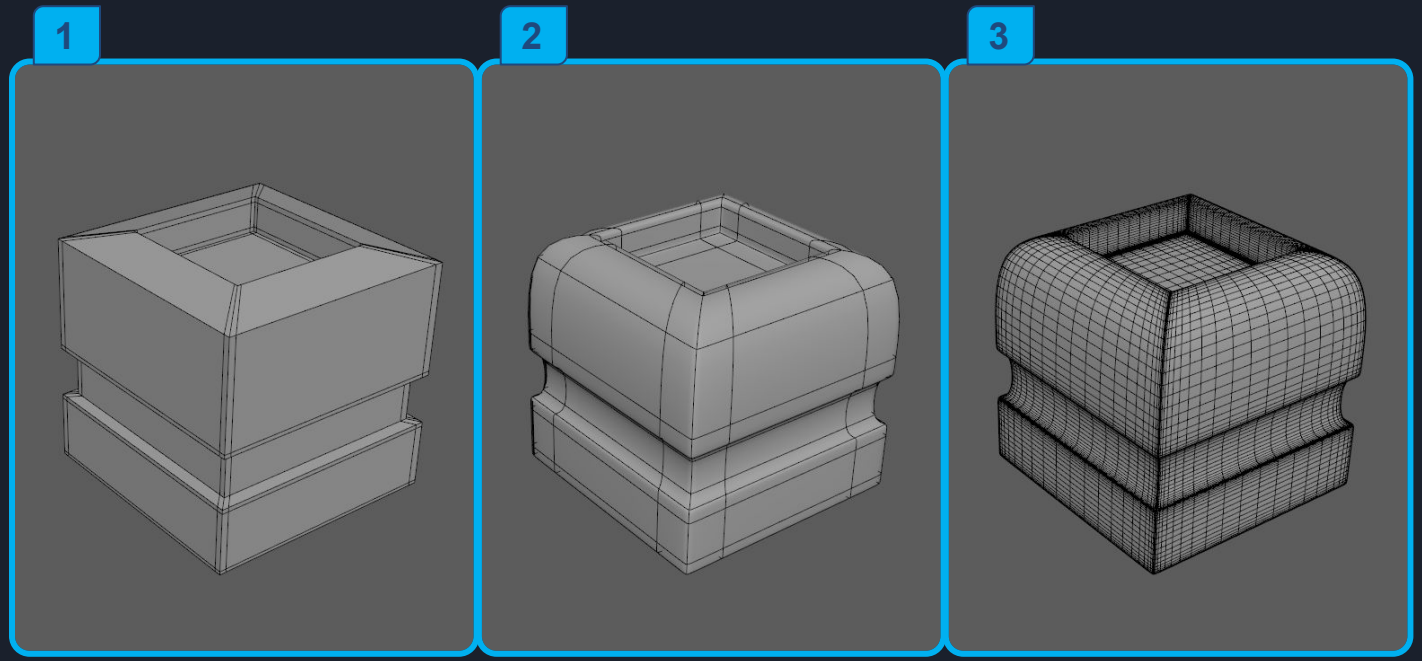
Subdiv Modelling|How It Works



Creating complex high-poly mesh using standard geometry can be difficult and time consuming and the resulting mesh would be hard to alter due to the high number of vertices, edges and faces. Subdivision modeling allows a high-poly mesh to be created from a simplified base mesh which allows adjustments to be made quickly and easily.

1. A high-poly mesh created using standard geometry.
2. The same object created for subdivision.
3. Top left, the high-poly mesh. Top right, the subdivided mesh. Bottom, the subdivided mesh with cage.

Subdiv Modelling|How It Works

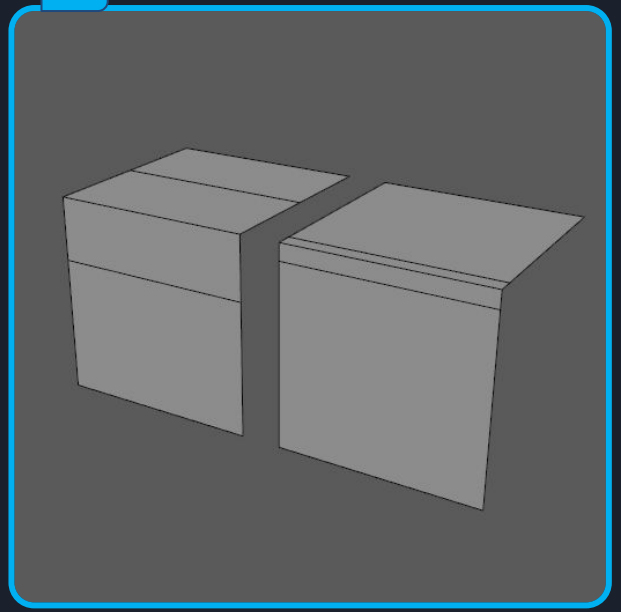


The workflow for subdivision modelling involves three steps:

1. A low-poly mesh is created which acts a control cage for the subdivided mesh.
2. Smooth preview is utilised to preview the subdivision and alterations are made to the low-poly mesh where required to create the desired form.
3. Once the mesh is completed and no further alterations are required the mesh can be smoothed if required converting the mesh to high-poly geometry.

Subdiv Modelling|How It Works

1



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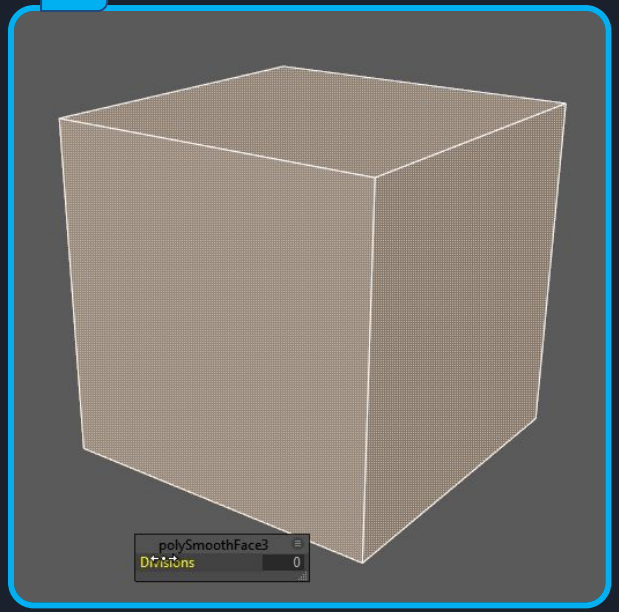
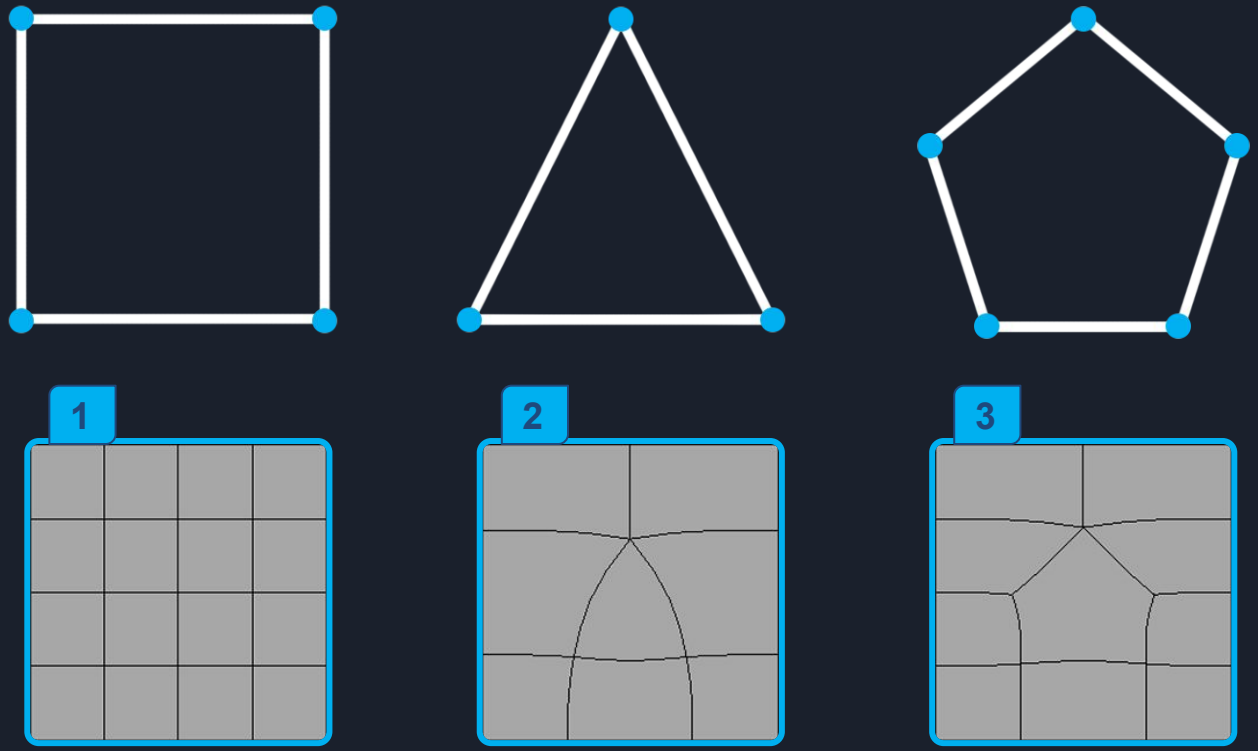


1. The original vertices define the overall shape of the mesh, when the mesh is Subdivided points are added between each vertex, and averaged creating a bezier curve. The distance between the vertices affects the average and thus the angle of the curve. The closer the vertices, the sharper the curve, the further apart the softer the curve.

2. In this example a polygon cube subdivided four times, note how the position of the vertices are averaged each time the mesh is subdivided.

Subdiv Modelling|Polygons & Subdivision



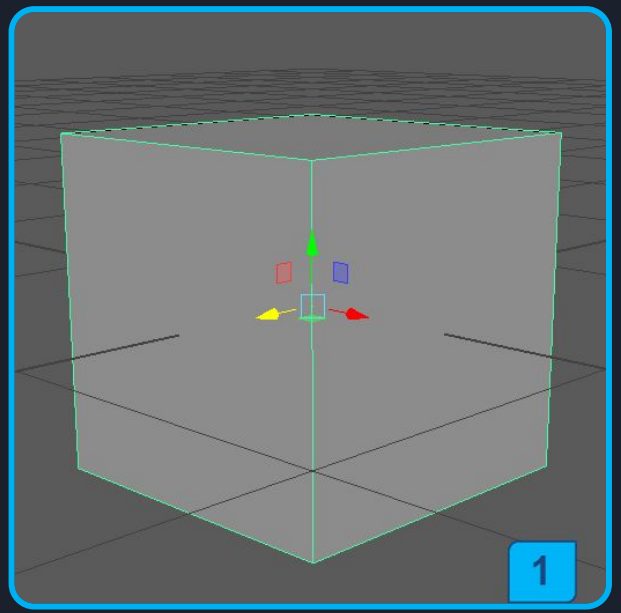
1. **Quadrilaterals (Quads)** are polygons with four sides, connected by four vertices. Quads can be cleanly subdivided resulting in clean curves. Keeping a mesh in quads will minimise smoothing and deformation errors.
2. **Triangles (Tri's)** are polygons with three sides, connected by three vertices. Tri's cannot be subdivided cleanly and may result in smoothing and deformation errors.
3. **N-Gons** are polygons with more than four sides. N-Gons also cannot be subdivided cleanly and may result in errors.

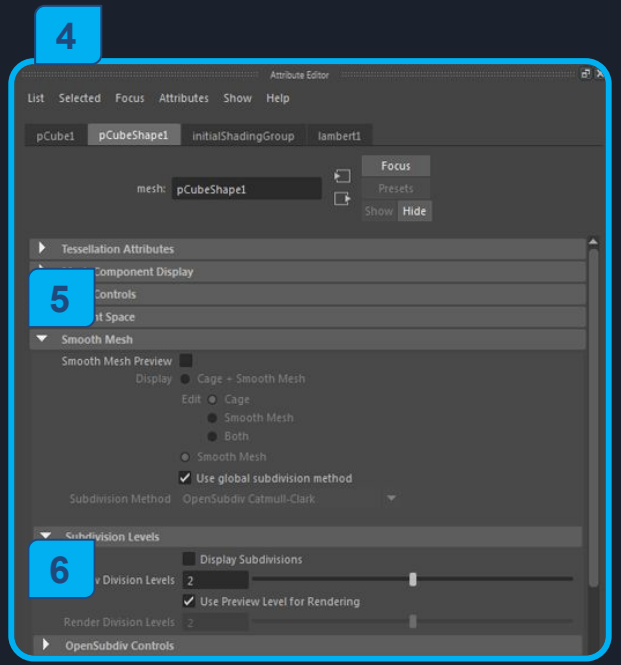
Subdiv Modelling | Smooth Mesh Preview

1 = Original Mesh

2 = Smooth Mesh Preview+Cage

3 = Smooth Mesh Preview





The smooth mesh preview allows subdivision surfaces to be previewed before smoothing.

1. **1** = Original Mesh.
2. **2** = Smooth mesh preview + cage.
3. **3** = Smooth mesh preview.
4. Settings can be found in the Attribute Editor.
5. Under **Smooth Mesh**, smooth mesh preview can be enabled. and the preview type selected.
6. Under **Subdivision Levels** the smooth preview subdivision levels can be changed.

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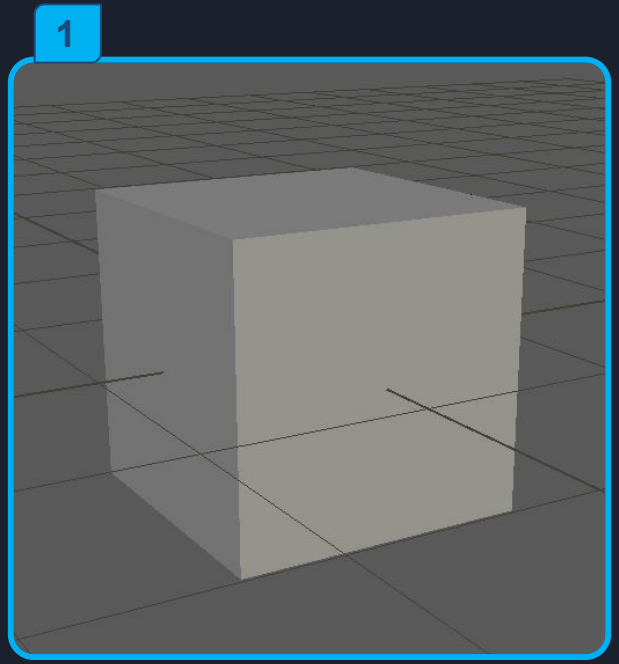
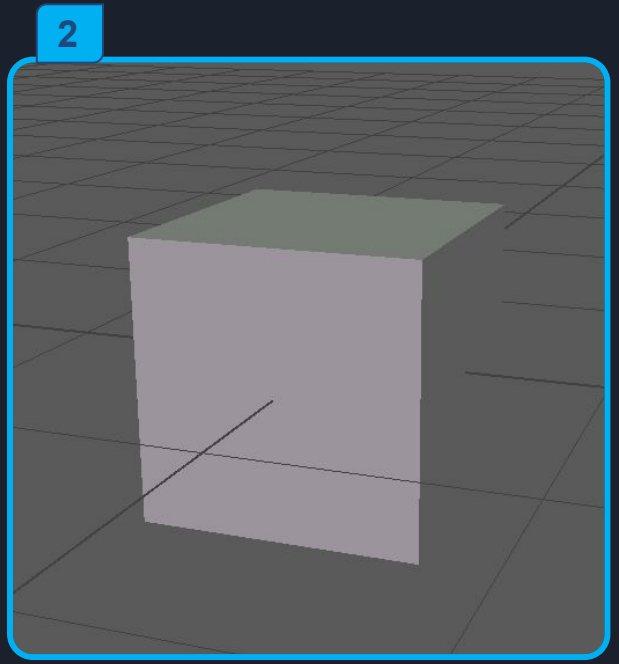
Subdiv Modelling|Smooth Mesh





Smoothing a mesh will subdivide the original mesh adding new polygons and averaging the vertices using the selected subdivision algorithm. Smooth mesh should only be used once a mesh has been completed as the process cannot be reversed.

1. **Smooth** can be accessed via the marking menu in object mode. The number of divisions can be altered with the slider.

2. **Smooth options** allow the subdivision method, number of divisions and other settings to be adjusted.

TIP: Increasing the subdivision level above 7 will impact performance.

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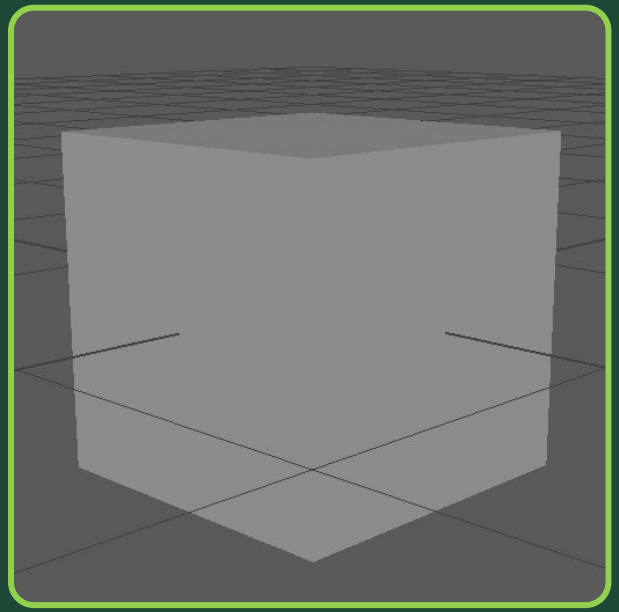
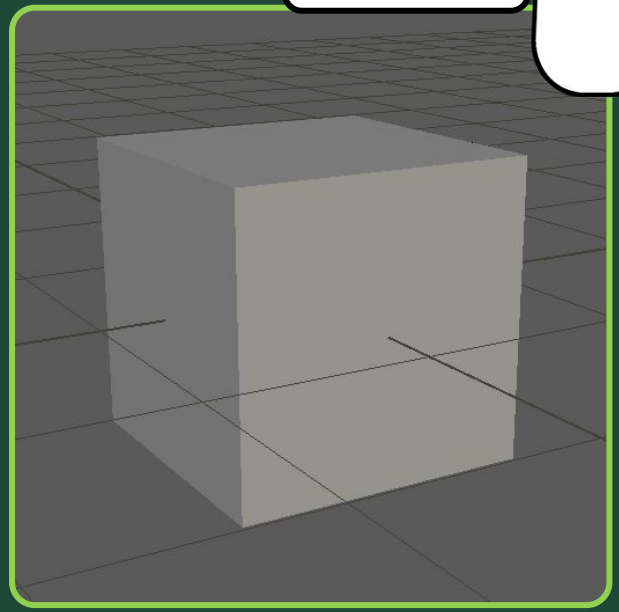
Subdiv Modelling|Smooth Mesh





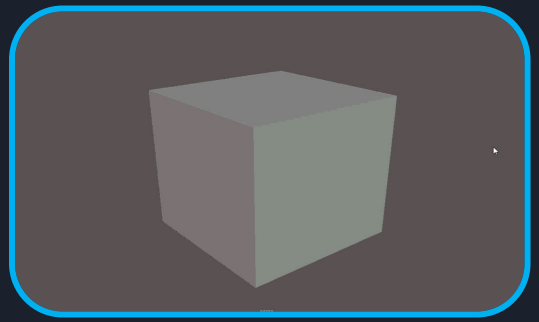
1. Create a **Polygon Cube** and select it in object mode.
2. Using the keyboard shortcuts **1**, **2**, **3** cycle through the smooth mesh preview.
3. Hold down Shift and RMB and select **Smooth** from the marking menu.
4. Utilising the slider adjust subdivision levels to 4.
5. Click outside of the object to finalise the smoothing.

TIP: Holding down the MMB and dragging left/right will increase and decrease the subdivision level.

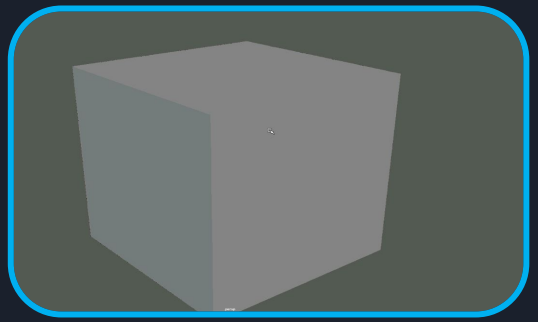
Subdiv Modelling|Common Tools

Tools commonly used in subdivision modelling

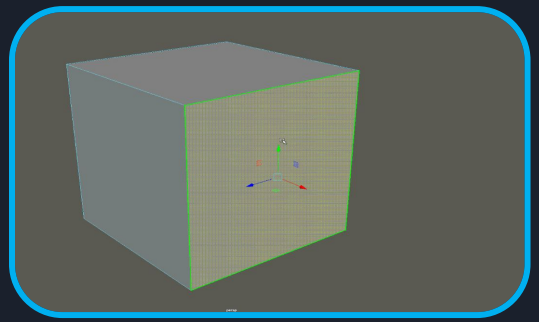
Multi-cut Tool



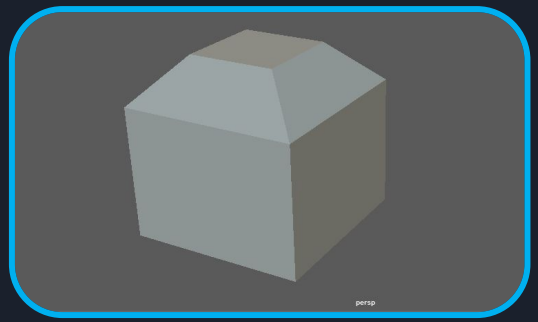
Bevel Tool



Extrude Tool



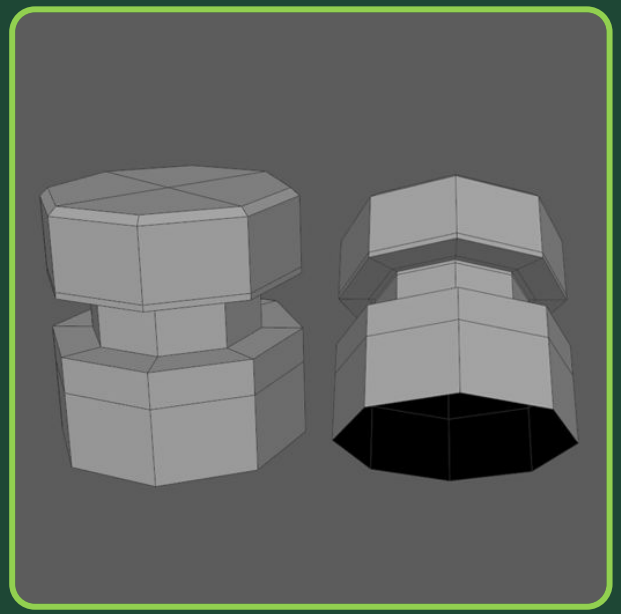
Insert Edge Loop Tool

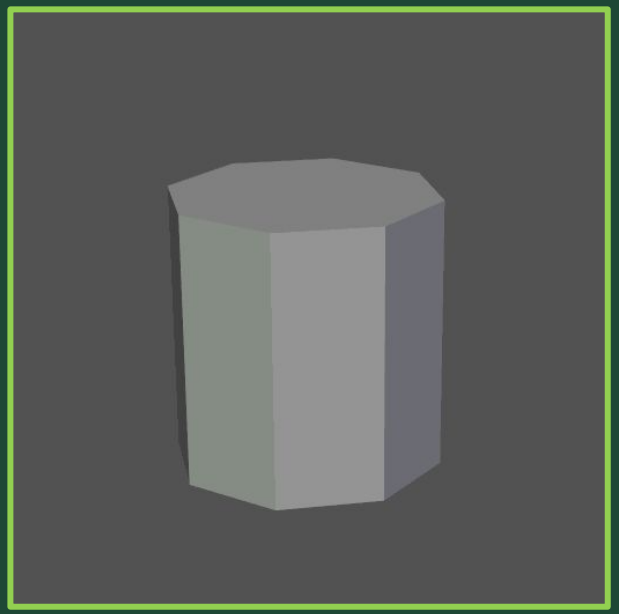


The tools used to create subdivision meshes are the same as those used to create standard meshes and should be familiar from earlier lessons. Tools that are commonly used include:

1. The **Multi-cut Tool** is used to cut geometry and adjust topology.
2. The **Bevel Tool** is used to bevel selected edges or faces.
3. The **Extrude Tool** is used to extrude faces from existing geometry.
4. The **Insert Edge Loop Tool** is used to insert edge loops into a mesh.

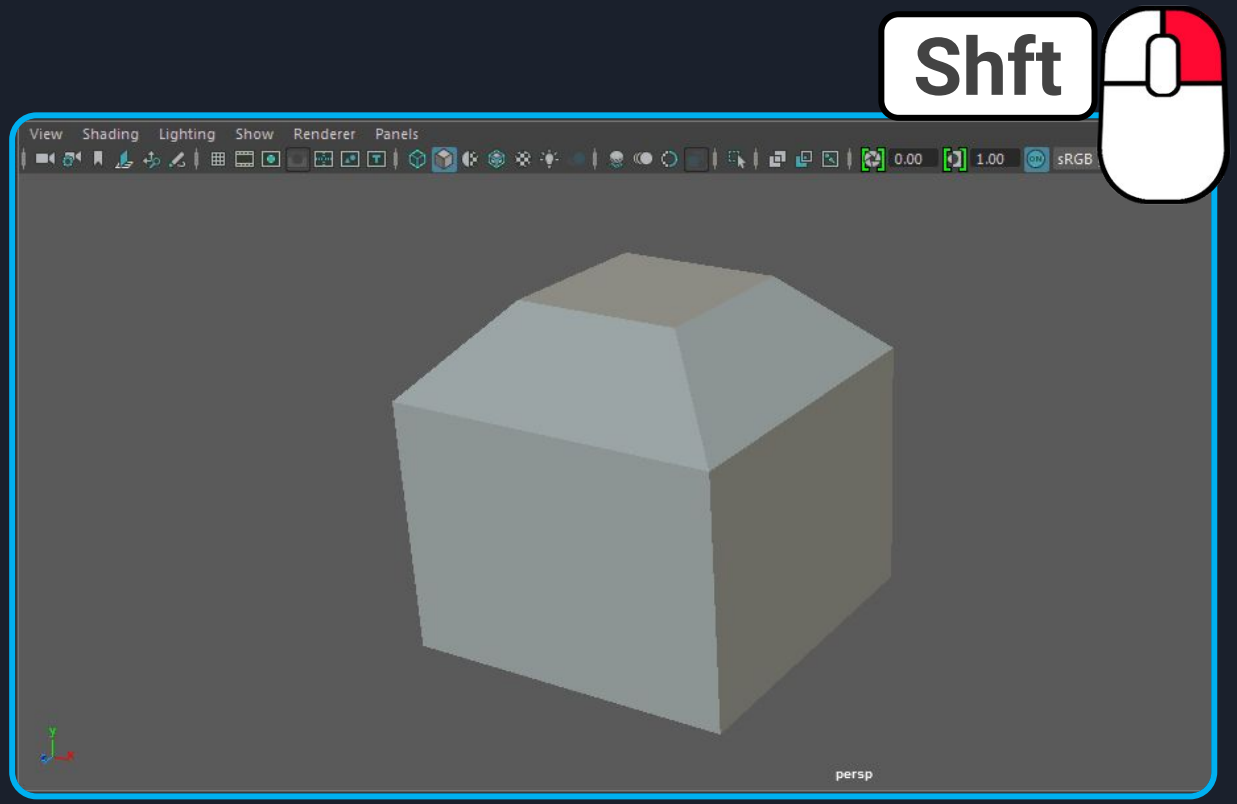
Subdiv Modelling|Common Tools





1. Create a **Polygon Cylinder** with 8 sides and select it in edge mode.
2. Using the **Insert Edge Loop Tool**, add four loops around the cylinder.
3. Using **Extrude Face**, extrude the center of the cylinder inwards.
4. Utilising **Bevel Face**, bevel the top faces.
5. Remove every second edge from the top of the cylinder to create quads and delete the faces on the bottom.
6. **3** toggle smooth mesh preview.

Subdiv Modelling|Insert Edge Loop



Adjusting the insert edge loops settings will give greater control over how loops are inserted.

1. **Auto complete** will insert an edge loop on click, toggling it off will insert a preview and allow settings to be altered before the edge loop is inserted.

2. **Relative distance from edge** will insert an edge loop based on the percentage distance along the selected edge.

3. **Equal distance from edge** will ensure that the inserted edge loop will maintain an equal distance from the closest edge.

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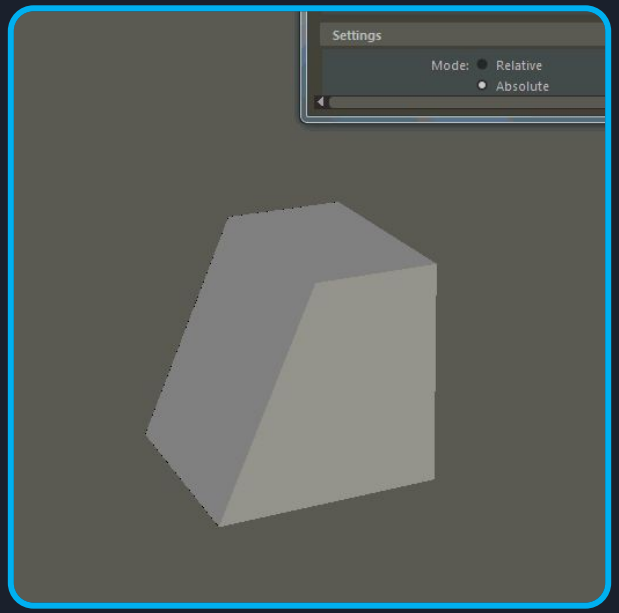
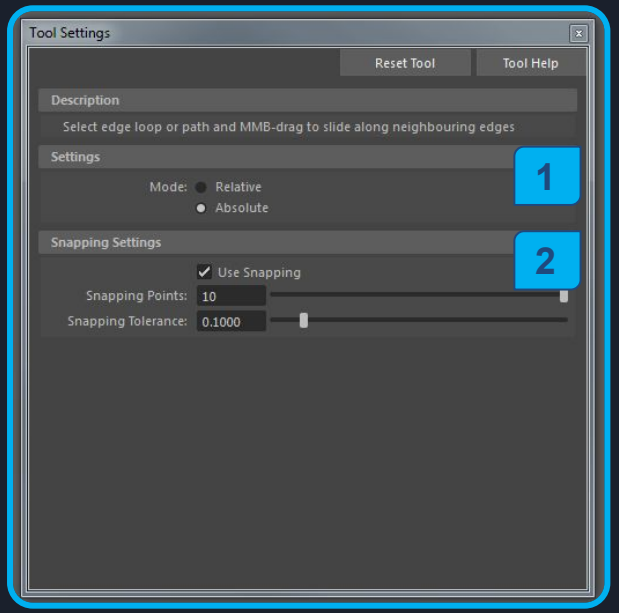
Subdiv Modelling|Slide Edge





The slide edge tool can be used to slide selected edges along a face without affecting the overall form of the mesh.

1. **Settings** allow the slide mode to be toggled. Relative moves the edge based on a percentage distance along the selected edge. Absolute moves the edge on an absolute distance along the selected edge.

2. **Snapping Settings** allows snapping for the edge slide tool to be enabled, disabled and adjusted.

TIP: Holding down shift will move the edge along each vertex normal.

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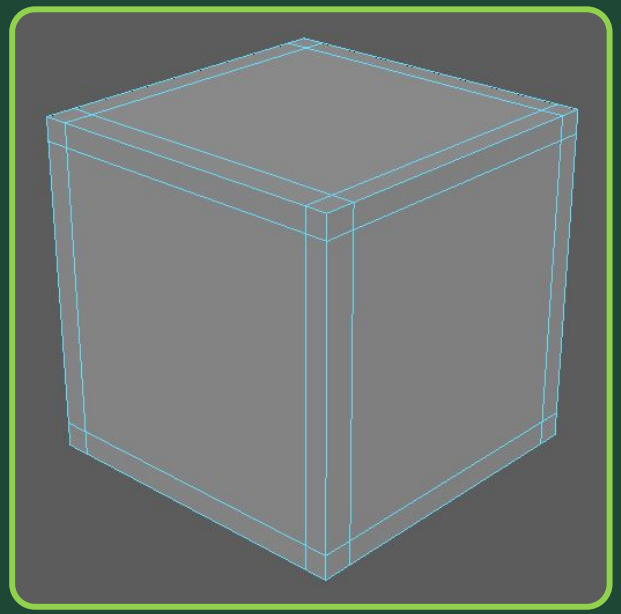
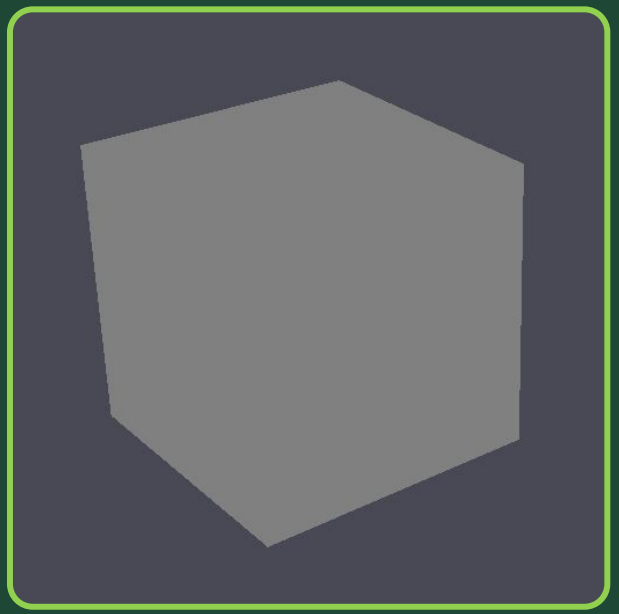
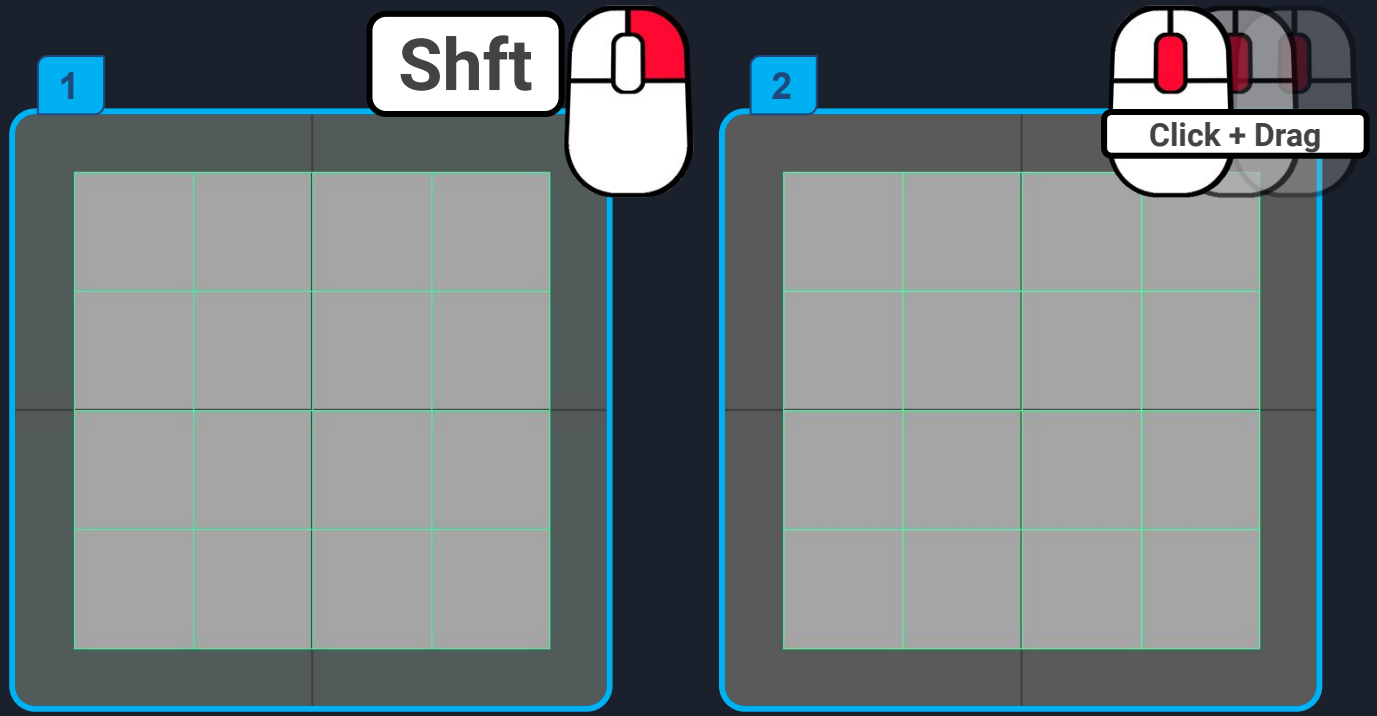
Subdiv Modelling|Edge Loop & Slide Edge





1. Create a **Polygon Cube** and select it in edge mode.
2. Hold down Shift and RMB and select the **Insert Edge Loop Tool**, insert edge loops by LMB clicking on an edge. Add edge loops to Match the image on the left.
3. Using the keyboard shortcut **3** toggle smooth mesh preview.
4. Hold down Shift and RMB and select the **Slide Edge Tool**, adjusting the edge loops with MMB check the results in smooth mesh preview.

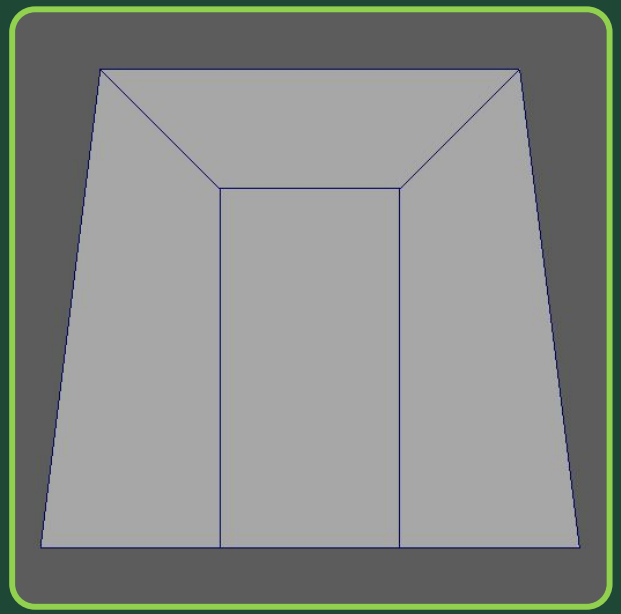
Subdiv Modelling | Merge & Target Weld

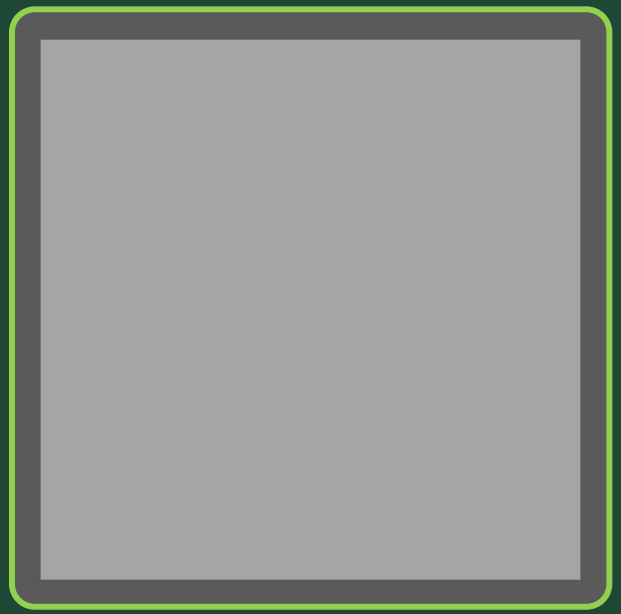


1. The **Merge Vertices** function can be used to merge two or more selected vertices into a single vertex. The vertex will merge to an average point between the selected vertices. The distance threshold slider can be used to adjust the threshold in which the selected vertex will merge together.

2. The **Target Weld Tool** allows one or more vertices/edges to be welded to a single vertex/edge of choice. As the tool remains active the target weld tool can be used to quickly manipulate mesh topology.

Subdiv Modelling|Merge & Target Weld



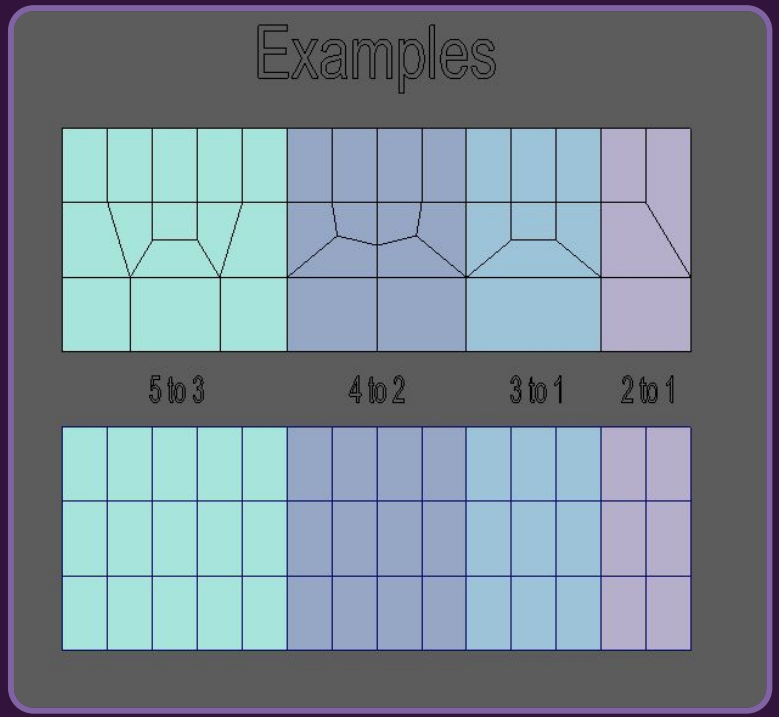


1. Create a **Polygon Plane** with 3x3 subdivisions and select it in Vertex mode.

2. With the vertices you intend to merge selected, hold down Shift and RMB and under Merge vertices select **Merge Vertices**. Adjust the distance threshold until the vertices merge together.

3. In Vertex Mode hold down Shift and RMB and under Merge vertices select the **Target Weld Tool**. Once active, click and drag one vertex to another to weld them together.

Exercise|Step Down Methods



Step down methods are used to transition between geometry of differing density, mastering step down techniques will aid in creation of topology that will subdivide cleanly.

1. Open the scene, “Lesson_SubD_StepDown”.
2. Utilising the Multi-cut tool, Target weld tool and the weld function, mimic the stepdown patterns illustrated on the left.

You have 15 minutes

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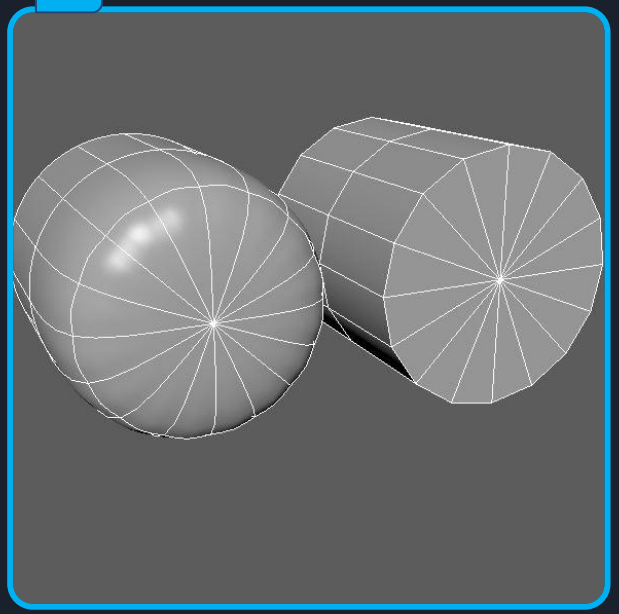
Subdiv Modelling|High Valence Vertices

1



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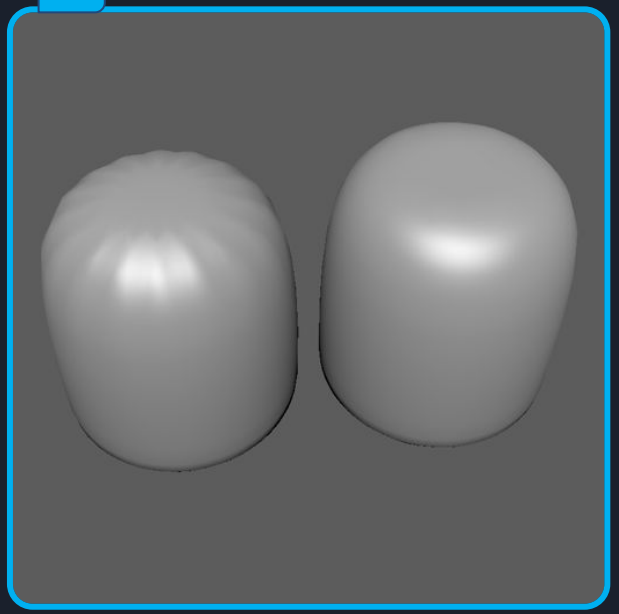
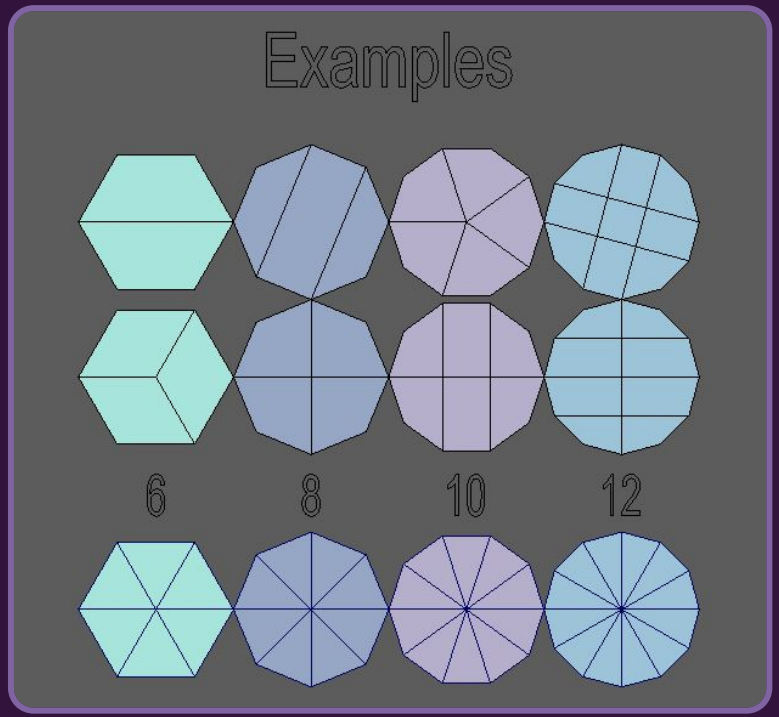


A high valence vertex is a vertex connected by more than four adjacent edges. High valence vertices should be avoided where possible because they can produce a wavy surface when subdivided, this is particularly noticeable when capping cylindrical objects.

1. A cylinder that has a high valence vertex in the center, note the wavy surface when subdivided.

2. A comparison of a subdivided cylinder with a high valence vertex in the center and one of the same shape without.

Exercise|Closing Cylinders



When subdivision modelling It is important create meshes in quads where possible to facilitate clean subdivision and minimise smoothing errors, this is particularly important when closing cylinders.

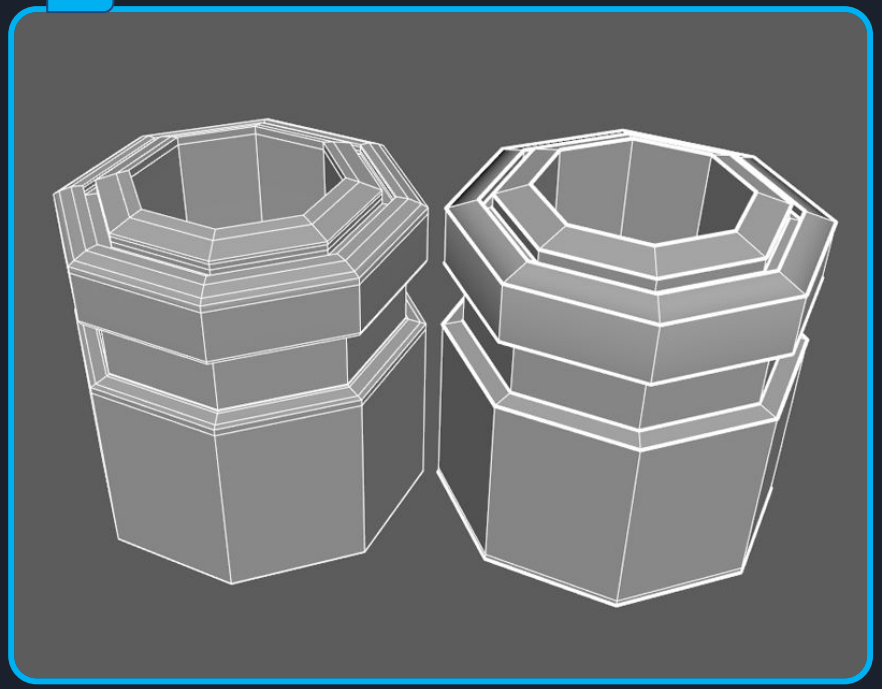
1. Open the scene, “Lesson_SubD_ClosingCylinders”.
2. Utilising the Multi-cut tool and removing edges mimic any of the cylinder closing methods illustrated on the top two rows.

You have 15 minutes

Subdiv Modelling|Crease Weights

Edge/Vertex Weighting in Maya

1



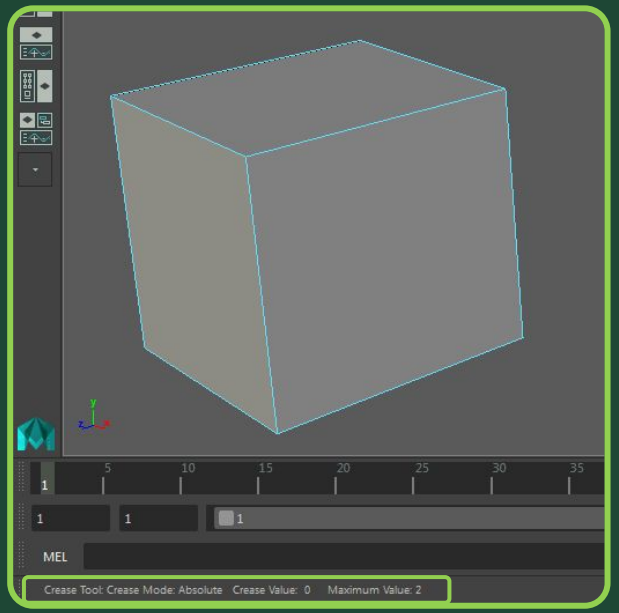
The **Crease Tool** allows hard edges to be added to a subdivision mesh without adding supporting edge loops, this simplifies the creation of the base mesh and makes changing edge hardness faster and easier.

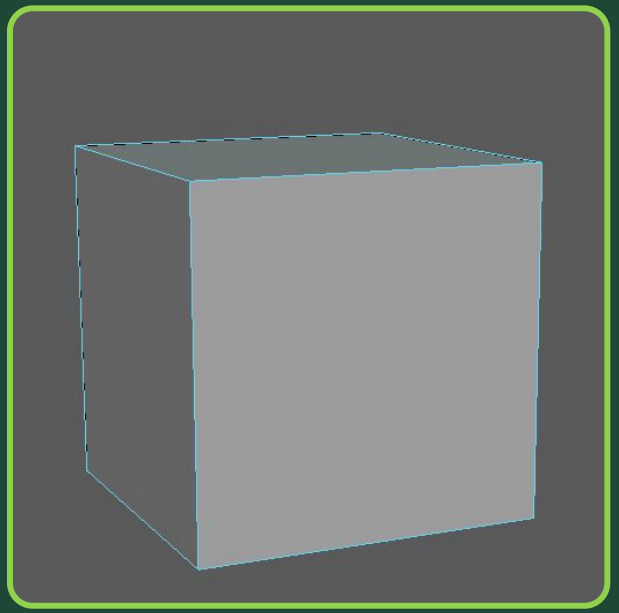
The **Crease Tool** can be accessed via the marking menu in both edge and vertex mode. Creased edges are indicated by heavier lines and creased vertices by a small circle encompassing the vertex.

1. On the left a standard SubD mesh, the right a creased mesh.

TIP: Crease weights are not supported by all renderers/3D packages and may need to be smoothed before exporting.

Subdiv Modelling|Crease Weights

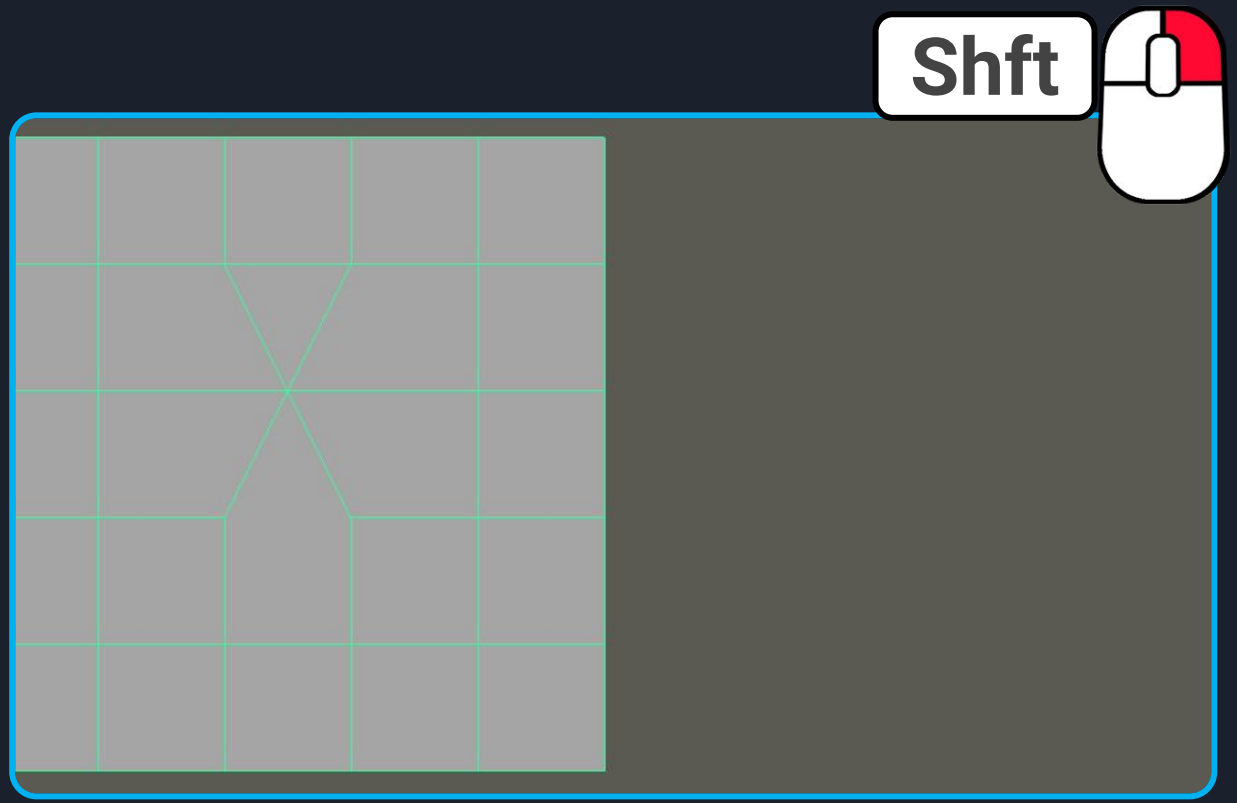




1. Create a **Polygon Cube** and select it in edge mode.
2. Select the edges to crease. Hold down Shift and RMB and select the **Crease Tool**, drag the MMB to increase and decrease the crease value. The crease value is visible in the help line.
3. Using the keyboard shortcut **3** toggle smooth mesh preview to see the results.

TIP: Crease values range between 0 and 7. The value of the crease will be displayed in the bottom left in the help line.

Subdiv Modelling|Analysing Issues



When subdivision modeling it is important to eliminate/minimise geometry that can cause smoothing or deformation errors. **The Cleanup Tool** can be utilised to identify topology that may cause issues when subdivided, including Tris, N-Gons and Lamina faces.

The Cleanup Tool can be accessed via the marking menu in object mode. The cleanup tool can be set to clean up matching polygons automatically or set to select the matching polygons, allowing the user to resolve the geometry issues manually.

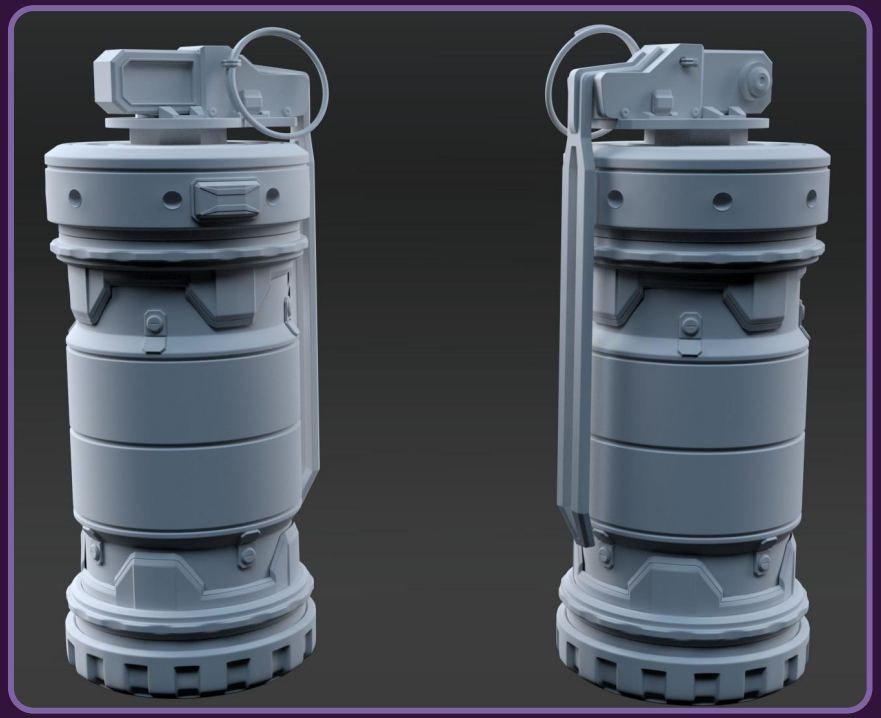
Exercise|Cleanup Tool Exercise

The cleanup tool can be utilised to identify geometry that can cause smoothing and deformation errors, mastering its use will aid in creation of topology that will subdivide cleanly.

1. Open the scene, “Lesson_SubD_Cleanup”.
2. Utilising the cleanup tool, find and resolve all of the topology issues in the provided mesh to ensure that it will subdivide cleanly.

You have 15 minutes

Exercise|Sci-Fi Grenade



1. Futuristic Sci-Fi grenade by Jorge Corona

Utilising the knowledge and tools demonstrated in this lesson create a high-poly Sci-Fi Grenade with subdivision surfaces.

You have 40 min