
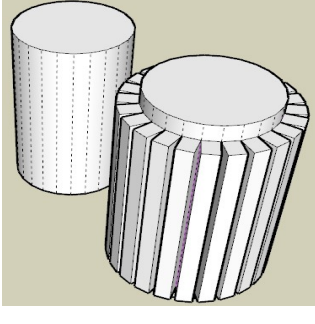

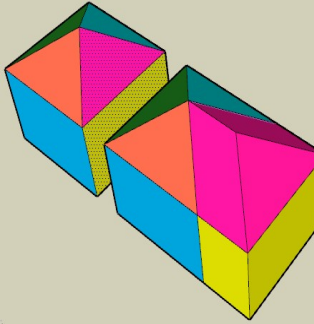

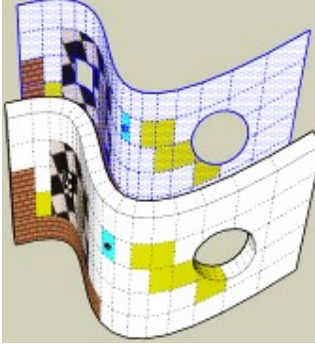

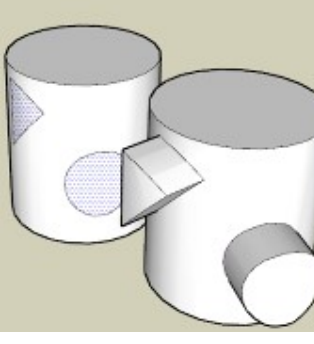

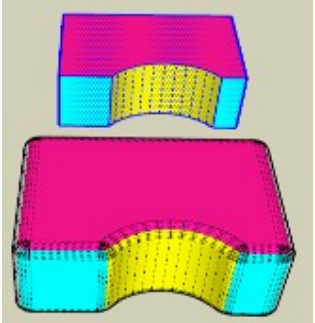

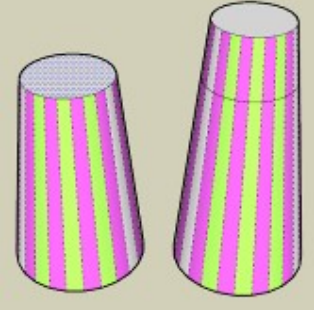


# JOINTPUSHPULL

## MULTI-FACE PUSH PULL – INTERACTIVE EDITION

VERSION 4.3 – 21 FEB 2018

BY FREDO6

<p><b>NORMAL</b></p>  <p>Similar to <b>native Push Pull</b>, but in multi-face. Faces generated are <b>non-jointed</b>.</p>		<p><b>VECTOR</b></p>  <p>Faces are offset <b>along a custom direction</b> picked graphically in the model (or along model axes). Faces generated are <b>jointed</b>.</p>	
<p><b>JOINT</b></p>  <p>Faces are offset along their normal but are kept <b>jointed</b>. Useful for <b>thickening</b> shapes.</p>		<p><b>EXTRUDE</b></p>  <p>Faces are offset <b>along an average direction</b>, keeping faces <b>jointed</b>. Gives more consistent results than Joint mode</p>	
<p><b>ROUND</b></p>  <p>Combination of <b>Normal and Joint</b> mode depending on the angle between faces, with <b>automatic rounding of gaps</b> between faces</p>		<p><b>FOLLOW</b></p>  <p>Faces are offset along the direction given by their adjacent edges. This concept was introduced by <b>a4chitect's Smart Push Pull</b> plugin<sup>1</sup>.</p>	

The home page of JointPushPull is on the Sketchucation web site at:

<https://sketchucation.com/plugin/715-jointpushpull>

<sup>1</sup> See <http://sketchucation.com/forums/viewtopic.php?p=197828#p197828> on Sketchucation forum

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# JOINT PUSH PULL

## *Multi-face Push Pull – Interactive Edition*

VERSION 4.0 – 20 OCT 2017

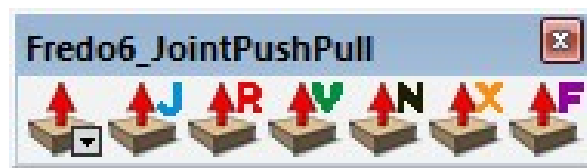
*by Fredo6*

### 1. Overview

**JointPushPull** is a suite of interactive tools generating the offset geometry of one or several faces, typically push-pull or thicken.

The common characteristics of JointPushPull tools are:

- **Pre-selection mode** (faces and groups / components) with launch from toolbar, main menu, and contextual menu
- **Interactive selection mode**, where faces can be selected across the boundaries of components and groups, individually, as a surface, all connected or connected by material. Interactive selection works across boundaries of Components and Groups.
- **Visual dragging of faces**, with enabling / disabling of Sketchup inferences
- **Preview mode**, for faster feedback when selection includes a large number of faces
- **Modification of parameters after generation**, with recalculation of shape
- **Various options**: support of thicken and push pull mode, 3 modes of generation of borders (contour, grid, none), generation as a group, etc....
- **Random Push-Pull**, with specification of range
- **Quick Launcher** and configurable icon toolbar



### Note about the old JointPushPull v2.x

The previous version of JointPushPull (v2.x) can coexist with the new version 4.x. It is released on Sketchucation under the name **Joint Push Pull Classic**.

The new version includes all functionalities of JPP 2.x (and more), except:

- Auto-scaling of holes and faces embedded within faces (can be done if there is a request)
- More accurate texturing of borders when original faces are textured

## 2. Installation

- **Sketchup Versions: 6 and above** (Free and Pro). Works better with **v8 M2 and above**.
- **Platforms:** Windows XP, Vista, 7 and Mac OSX all versions
- **IMPORTANT:** JointPushPull requires the Shared Library **LibFredo6 v7.8 or higher**.

Since SU8 M2 and SU 2013, there are now several ways to install a plugin.






- **SCF Plugin Store**, recommended method
- **EWH** (when published)
- SU Extension Manager to install a **.rbz file**
- Unzipping into the SU Plugins directory from a .zip file (see details below)

Instructions for installation of JointPushPull and LibFredo6 can be consulted at:

<https://sketchucation.com/plugin/715-jointpushpull>

All installations however will end up with the following **footprint** in the SketchUp Plugins directory:

- **one script file** *Fredo6\_JointPushPull.rb*
- **one subfolder** *Fredo6\_JointPushPull*. This subfolder contains the library files, the icons, cursor files, language files, ...

	Name	Type
	<i>SU Plugins root directory</i>	Plugins Root Folder
	<b>Fredo6_JointPushPull</b>	Folder
	<b>Fredo6_JointPushPull.rb</b>	Ruby file
	<b>Fredo6_!LibFredo6</b>	Folder
	<b>Fredo6_!LibFredo6.rb</b>	Ruby file

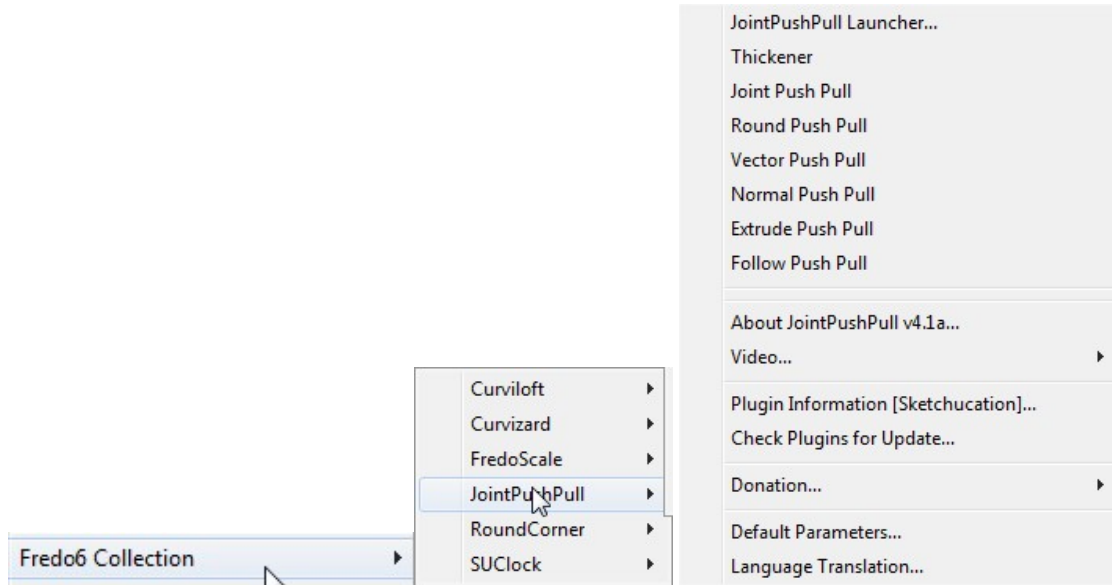
**CAUTION:** NEVER rename or move files from their folders. If you are unsure of your unzip operation, do it in a neutral folder and check that you reconstruct the right footprint. Then transfer the folders and files to the SU Plugins Directory.

**Note:** you can select an alternative plugin directory (see **AdditionalPluginFolders** at <http://sketchucation.com/forums/viewtopic.php?f=323&t=39073#p345150>).

### 3. Menus, Toolbar and Configuration

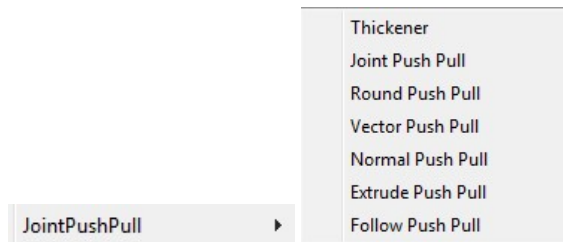
#### Main menu

By default in *Tools > Fredo6 Collection > JointPushPull*. All functions are available in this menu, whether shown or not in the toolbar.



#### Contextual menu

Whenever the selection includes a face, the contextual menu shows an entry for JointPushPull:

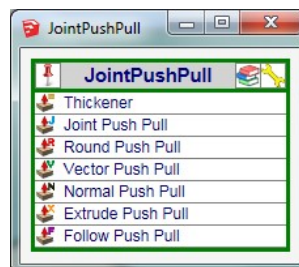


Note: From the Default Parameters dialog box, you can configure which commands are shown in the contextual menu (you can even remove them all).

#### Quick Launcher



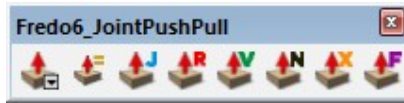
This is a small floating window which displays all JointPushPull tools in a list. It can be invoked from the menu or the toolbar icon:



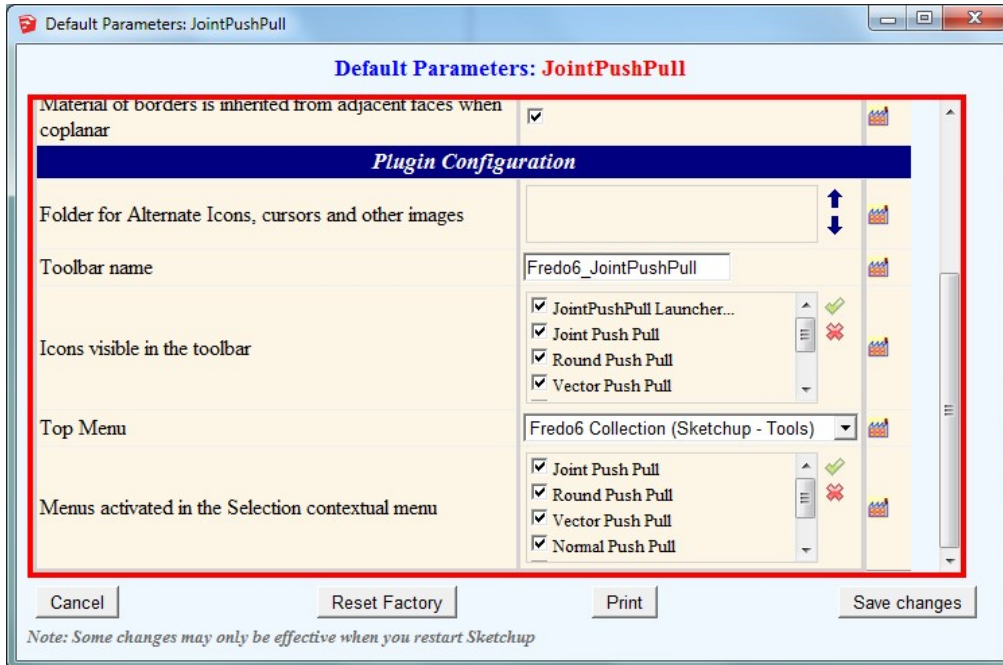
Optionally you can **pin** the Quick Launcher window on your viewport for subsequent use. By default the window closes when you launch a command.

## Toolbar

Toolbar name is *Fredo6\_JointPushPull* by default (you can change it).



All icons<sup>2</sup> are shown right after installation. However, you can configure which icons are visible in the Default Parameters dialog box.



## Buttons Palette

The buttons palette shows the available parameters. Parameters may differ between tools.

Since **JointPushPull 4.0**, the Button Palette has a **Simple mode**, with only basic parameters, and an **Expanded mode** for more advanced usage. You can toggle between the two modes using the button with *chevrons* >>> on the left side of the palette. For instance, here are the Simple and Expanded mode for the Joint tool:

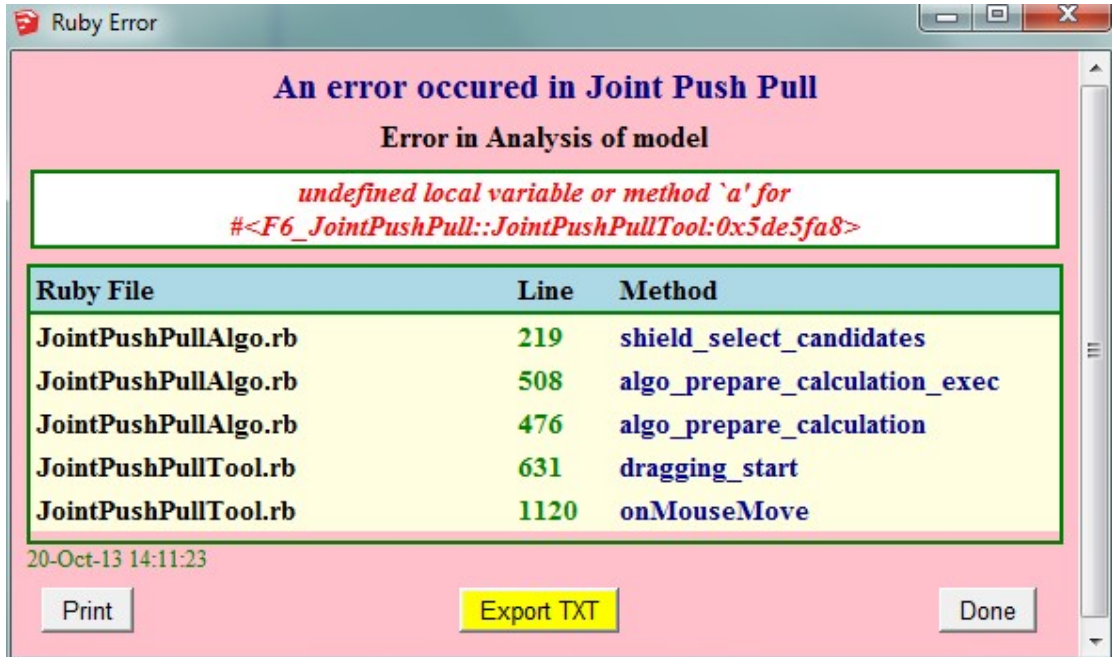


<sup>2</sup> Thanks to **Daniel S.** for designing the icons

## Error Handling

In some circumstances, JointPushPull may be unable to perform the operation, either because the contours are not compliant or simply because there are still bugs in the script.

If this happens, you may get an error message shown as the dialog box below:



Although this is purely technical information related to the Ruby script, it can be useful for the author to trace the cause of error. For instance, exporting as txt file (or simply copy / paste) and posting on Sketchucation.



## 4. Common workflow

JointPushPull workflow includes 3 or 4 steps:

- 1) **Interactive Face Selection mode** – you can also invoke JointPushPull with a valid pre-selection of faces and/or groups/components including faces.
- 2) **Dragging mode** – Once faces are selected, you can
  - Drag the mouse to pull or push faces visually
  - Type the offset directly in the VCB when cursor is over a face
  - Double-click on a selected face to repeat the push pull with the same parameters
- 3) **Preview mode** (*when applicable*) – this intermediate mode allows the visualization of the result before generation. It is only triggered when the selection includes a ‘large’ number of faces (*see below to adjust this number*).
- 4) **Generation** – the geometry is generated in Sketchup. At this stage,
  - you can either change some parameters via the button palette or the VCB,
  - or click on other faces for a new selection.

JointPushPull provides a **Rollback button** to navigate back along these states. The **Escape** key is equivalent. Ctrl-Z and Undo are also supported.

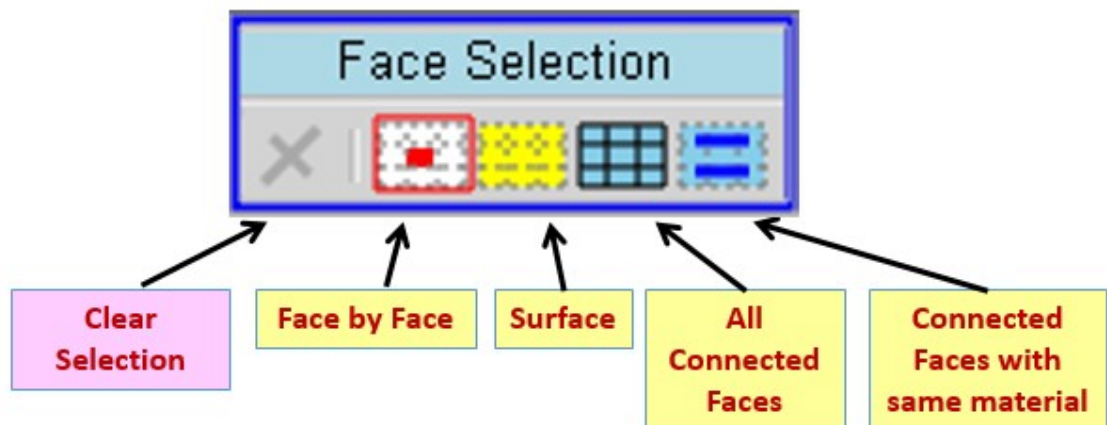
**All parameters are preserved across Sketchup sessions**, for each individual JPP mode.

### 1) Interactive Face Selection

**JointPushPull** allows selecting faces within groups and components at any level (you’ll see a coral or gray bounding box if you hover over faces within a group or component).

The principle of interactive selection is similar to the native Sketchup PushPull. You hover faces or surfaces, and then click – drag to perform the push-pull operation.

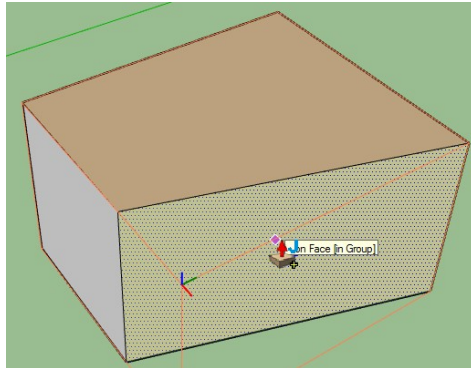
**You have 4 options** to specify the **selection scope**. They are available in the button palette. You can also cycle through these options by typing **TAB** or **Shift TAB**.



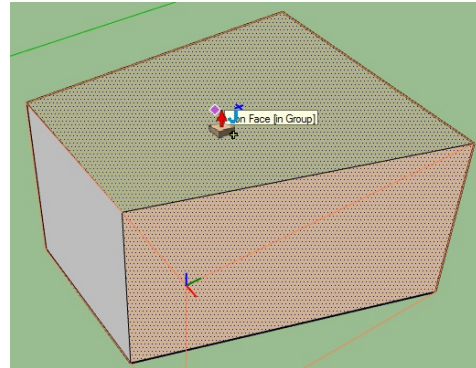
**Note:** when there is already an initial selection, the selection is blocked. You cannot add or remove faces by hovering over faces. Just type **ESC** to clear the initial selection if you wish to do the selection interactively.



When you hover over a face, faces are highlighted based on the selection scope, showing the result of a click:

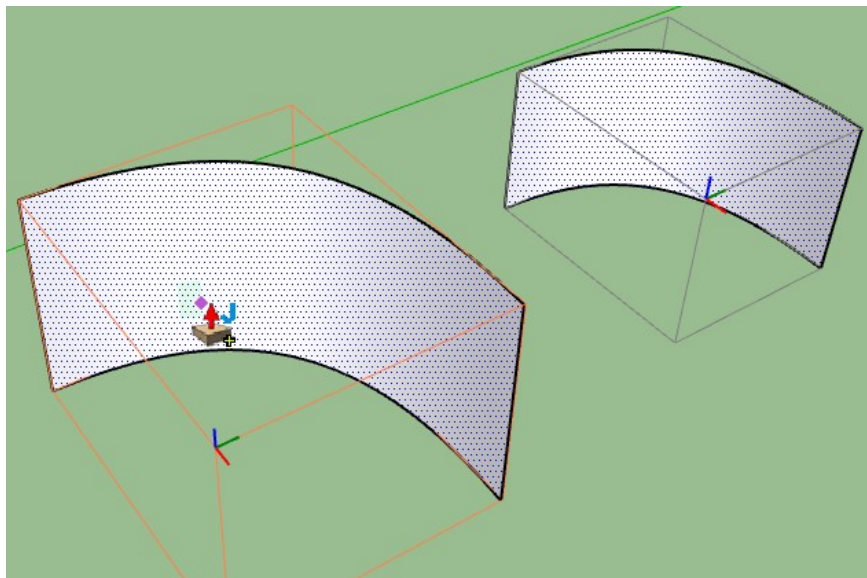


Single-Face selection mode

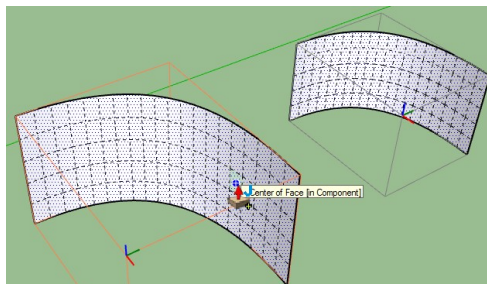


Same-Material selection mode

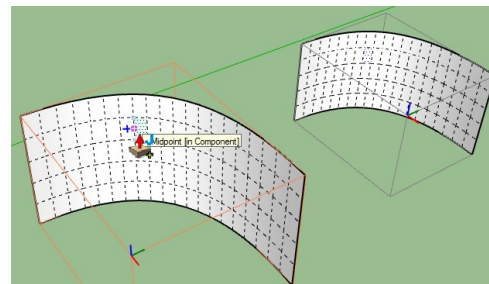
For surfaces, that is, a set of adjacent faces connected by smooth and/or soft edges, the whole surface is automatically selected if you are in Geometry Hidden mode.



Otherwise, selection is based on the current selection scope, *Single-Face* or *Surface*.



Surface selection mode



Single-Face selection mode

Note that in the examples above, a Bounding-box is shown when you hover over faces within components or groups. The selection is reflected on all instances of components.

## 2) Multi-face Selection

For convenience, there is a **multi-face interactive selection mechanism**.

When you hover over a face (or surface), press **Shift** (without clicking) to keep the face(s) permanently selected. As long as Shift is kept depressed, faces under the mouse will be permanently selected.

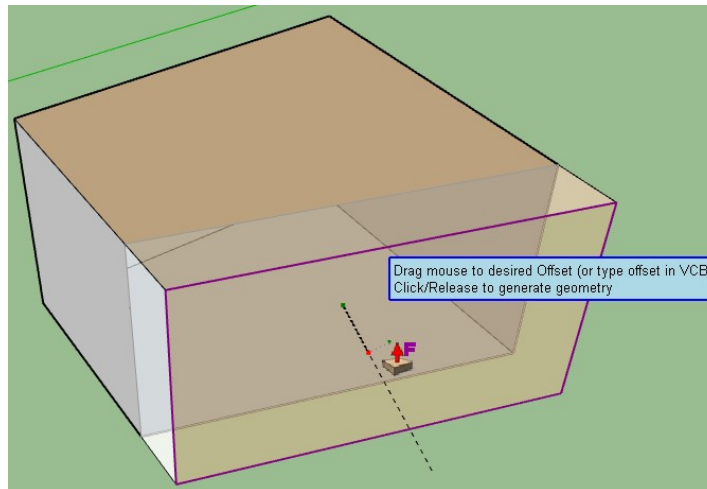
To **unselect** permanently-selected faces, just move over a selected face, press **Shift**. This will unselect the face(s). As long as Shift is kept depressed, faces under the mouse will be permanently deselected.

This feature also works to modify a pre-selection. Using the Shift method, you can add/remove faces.

## 3) Push-pulling faces by dragging

When the selection is done, click and drag one of the selected faces. The interactive push-pull will start right away.

**The direction of dragging** is indicated by a dashed line. The offset is indicated in the VCB and the offset button in the palette. It depends on the type of Push-pull and can also be influenced by the forced plane or vector if specified.



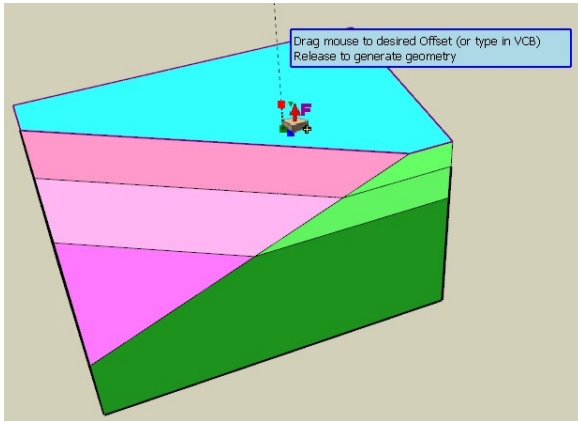
The push-pull operation is natural, as in Sketchup:

- **Click-down – Drag – Release**, or
- **Click-release – Drag – Click again**

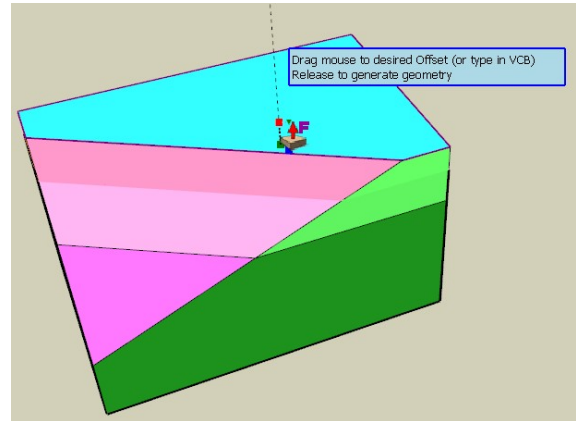
#### 4) Simulation of the Push-Pull

**JointPushPull** tries simulating the resulting shape when pushing or pulling faces:

- Original faces are hidden temporarily when you have the finishing option “push-pull” on (i.e. not thickening)
- Properties of edges are also simulated. When in push-pull mode, lower border edges are hidden to show border continuity



*Thickening Mode*



*Push-Pull Mode*

- Painted faces are simulated by their color (with no shading). For textured faces, the average color is used.



Note: During the dragging and Preview steps, **JointPushPull** only displays a **limited amount of faces and borders**. Therefore, when there is large number of faces in the selection, you may not see a simulation of all faces and borders as in the final geometry (like above).

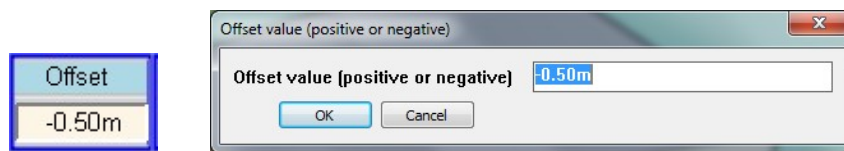
## 5) Typing Offset in the VCB

Before, during or after dragging, you can type the offset in the VCB. It can be positive or negative (zero value are ignored). The conventions are:

- Positive number is in the direction of pull.. if you already started dragging
- A float number is considered in current model units (architectural measures are also supported)
- You can specify and force the unit. Ex: “3.4cm”
- You can use formulas. Ex: “3.2 / 2 + 5cm”

**This method is strongly recommended when you have a very large number of faces to push-pull.** This avoids slow performance in dragging faces.

You can also enter the offset value by clicking on the offset field in the button palette. It also supports unit specification and formulas.



Note: the offset value is preserved across JPP sessions and Sketchup sessions.

## 6) Repeating Push-Pull

You can repeat a push-pull operation with the same offset on other faces by:

- Selecting faces and **double-clicking** on them
- Hovering over the selection and typing **Return**

Before repeating push-pull, you can of course modify some parameters, in particular the offset. So a fast way to Push Pull without dragging faces is:

- Change the offset in the VCB, with the mouse NOT on a face
- Double-click on the face(s) to push-pull.

You can repeat within the same JPP session, across JPP sessions or even across Sketchup sessions, since parameters are always kept.

## 7) Sketchup Inferences

JointPushPull supports Sketchup inferences when picking and push-pulling faces.

Actually, **the choice of the face and the point under the cursor when you drag the mouse may be important**, because the initial picked point and face are used to determine:

- the reference origin-target, in particular in the Vector push-pull mode
  - the face-side orientation, taken from the face under the mouse.
- a) In Vector Mode, pressing **Shift** (down and toggle) will lock / unlock the current direction
  - b) In other JPP modes, **Shift** will turn inferences on or off. This may be useful to avoid being bothered by undesired inferences.

Note: when you drag faces, offset faces and borders drawn in the viewport occult inferences to underlying model objects.

## 8) Preview Mode

The Preview step is useful when the model to push-pull includes a large number of faces. To adapt to the performance of your computer, this ‘large number’ of faces can be specified in the Default Parameters dialog box (*see this section later in this document*).



In the Preview step, the cursor shape is a green checkmark.

In the Preview step, you can interactively modify all parameters: offset and others. The changes will be reflected.

When finished, you can generate the geometry by

- Clicking anywhere in the model
- Typing RETURN
- Clicking on the checkmark button in the palette

## 9) Rollback



At each step you can rollback to go to the previous step. This can be achieved by pressing the orange back arrow button in the button palette. You can also press **Escape**.

### In Selection Mode

- Rollback will undo the selection

### In Preview Mode

- Rollback will go back to selection, with selected faces selected again
- You can also resume dragging by pressing Escape

### When the geometry is just generated

- Rollback will go to Preview mode. You can change parameters and click again.

**Sketchup Undo**, via Ctrl-Z or Undo button is supported and normally safe. It will first act as a rollback on the current operation and then as a classical undo, resetting the selection.

**IMPORTANT:** The main difference between Ctrl-Z and ESCAPE is that Escape will just undo the current operation, whereas Ctrl-Z will undo ALL past operations, possibility beyond the initial state when you launched JointPushPull (this is as it works in native Push Pull).

## 10) Exiting JointPushPull



Once geometry is generated, you can **exit JointPushPull** by clicking on the **Exit icon** in the main palette (or pressing **SpaceBar**) or clicking anywhere in an empty zone of the model.

## 5. Common Parameters

All JointPushPull modes share a few parameters and configurations. These are

- a) **Finishing option** (push-pull or thickening)
- b) **Configure borders** (contour, grid or none)
- c) **Generate in Group**
- d) **Forcing a Planar (or vector) Direction**
- e) **Random Offset** (Normal and Joint tools)

### 1) Finishing

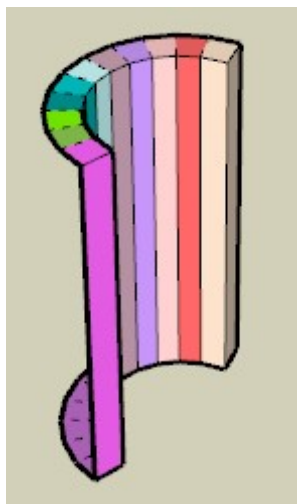
As for the native Sketchup Push-Pull, there are 2 modes: Offset and Thickening.



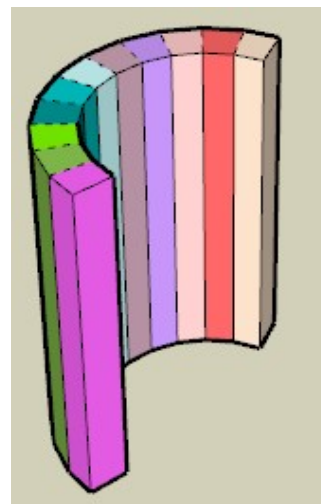
- **Push-Pull** offsets the face and therefore erases the original face.



- **Thickening** preserves the original faces and creates the offset faces. For convenience, the orientation of the original and offset faces is adjusted so that their recto side points toward the outside. A small + is shown in the bottom-right corner of the cursor.



*Push-Pull by Offset*



*Thickening*

The finishing option can be changed by 2 methods:

- a) Clicking on the button in the palette



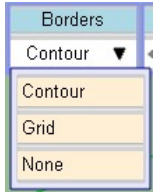
- b) Pressing **Ctrl** in toggle mode (i.e. press-release), like for the native SU Push-Pull

Note that the finishing option is preserved across JPP sessions (and SU Sessions) individually for each tool.

There is an exception for **single, standalone face** which is always handled as thickening, as it is for the native Sketchup push-pull.

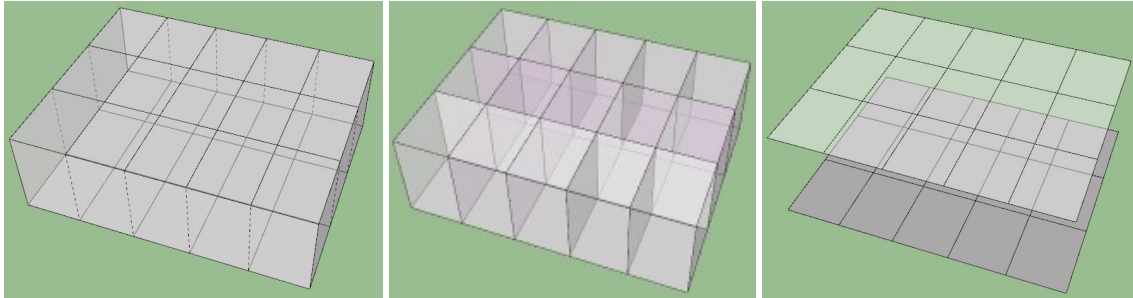


## 2) Border faces



You can control the creation of border faces, with 3 options available from the drop-down menu in the button palette (expanded mode):

- Contour:** Border faces are only generated for edges bordering the whole set of adjacent faces. This is the default mode for all JPP tools that keep faces jointed (Joint, Vector, Extrude, Round, Follow).
- Grid:** Border faces are generated for each individual face. This is the default mode for Normal push-pull, as offset faces are usually non-jointed.
- None:** Border faces are simply not created. You simply offset the face(s) or surface(s).

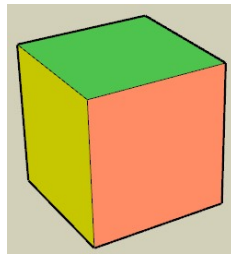


*Contour*

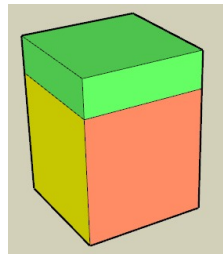
*Grid*

*None*

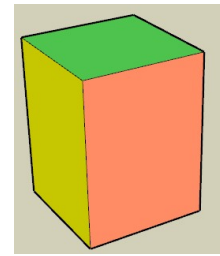
Note that, in general, borders inherit the material of the corresponding top face. There is however an exception in Push-Pull mode, borders will inherit the material of the adjacent face which is coplanar if any.



*Original*

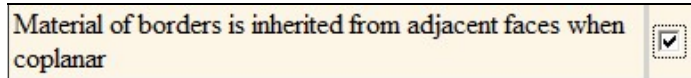


*Thickening*

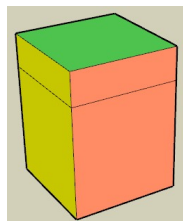


*Push-Pulling*

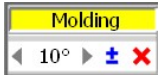
This is the behavior of the native Sketchup push-pull. However, if you prefer that borders always inherit the material of their adjacent coplanar face (if any) whatever is the finishing option, you can set this parameter in the Default Parameter dialog box.



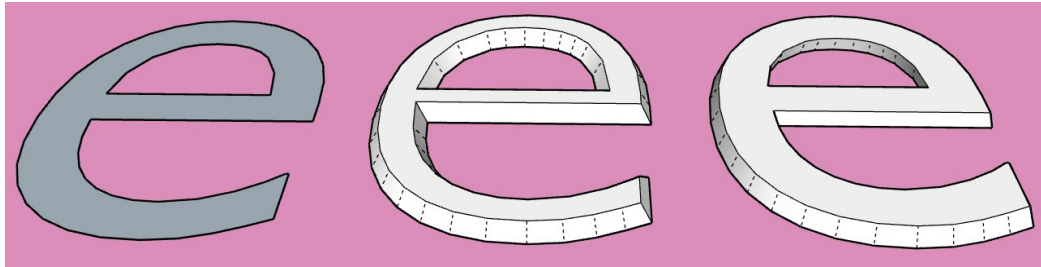
In such a case, the result with Thickening will be:



### 3) Molding



The concept of Molding is to expand or shrink the extruded faces by **offsetting** their border. In contrast, the tapering option uses the center to the bounding box of the faces to perform the tapering. A good illustration is for extruding letters, as show below:



*Original model*

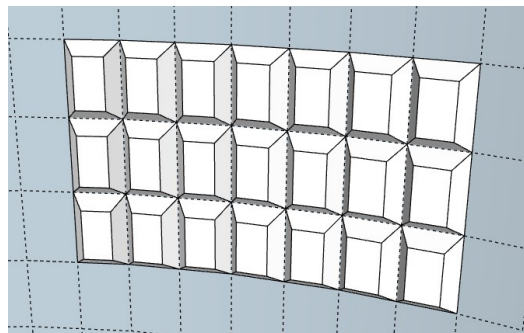
*Molding*

*Tapering*

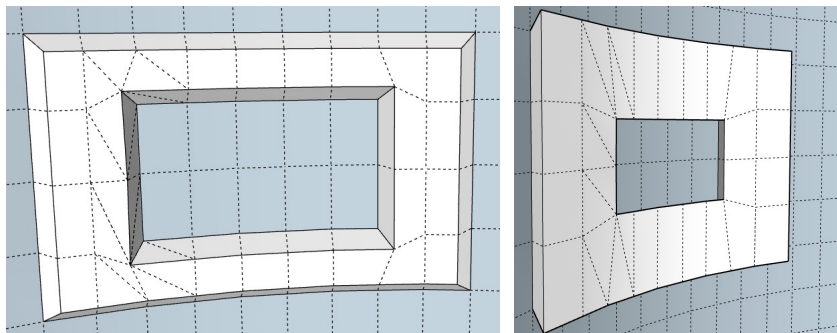
For Molding, the slopes around the face(s) contour, inside and outside, are oriented in the same manner, whereas, for Tapering, the inside slopes are oriented reversely compared with the outside slopes.

This option is available for the **Normal**, **Joint** and **Extrude** tools.

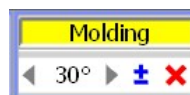
For Normal tool, Molding operates on the individual faces:



For Joint and Extrude tools, Molding operates on the contours of all selected faces:



The palette allows to set the angle of the slope for the border faces. The angle can be positive or negative, corresponding to expanding versus shrinking the extruded faces.



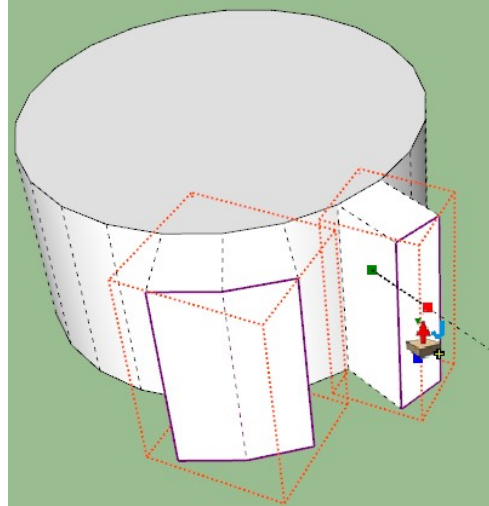
An angle of 0° means NO molding. The Plus/Minus sign simply allows to switch to the opposite angle.

#### 4) *Generate as Group*

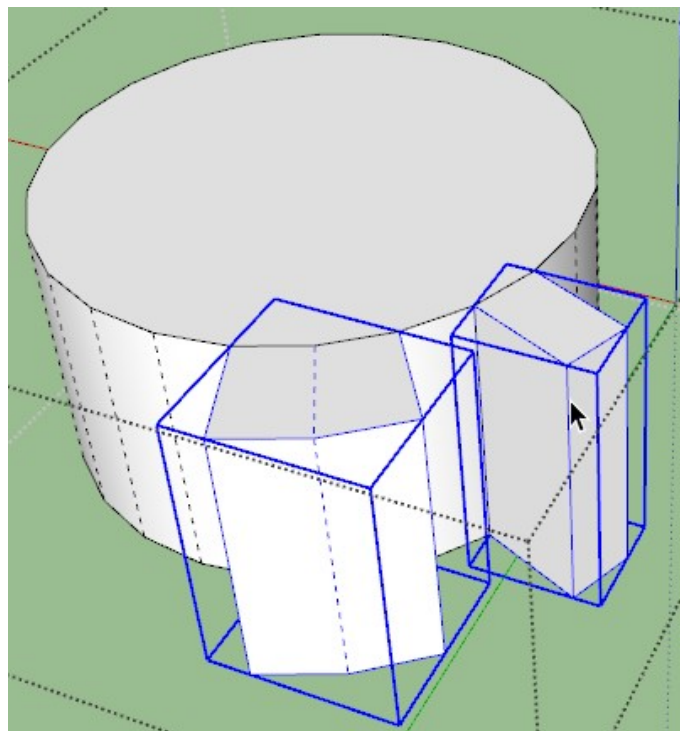


You have the option to **generate the offset in a Group** instead of in the context of the original faces.

This option is visible when you drag faces, with a dashed bounding box shown in orange.



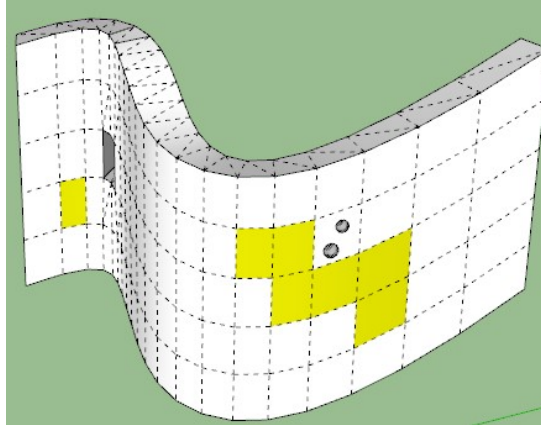
Note that **groups are generated for each adjacent set of faces**, at the same level of embedding as the original faces when included in components and groups (i.e. not at the top level of the model).



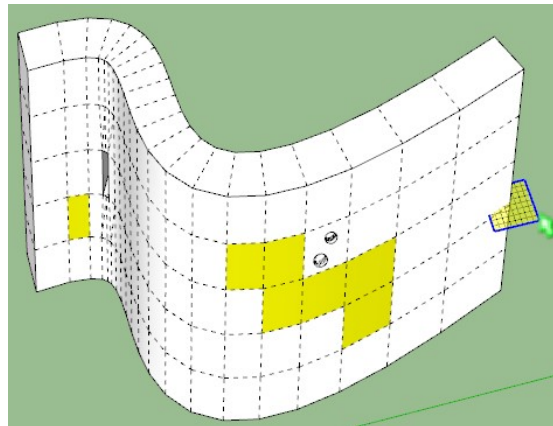
## 5) Forcing a Plane or Vector Direction

In some situations, you may want to offset along a privileged direction rather than along the face normal only.

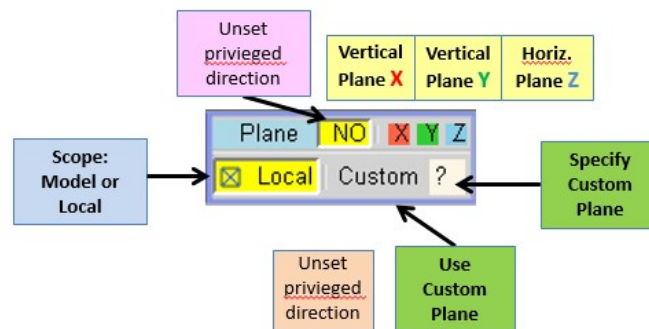
For instance, when you push-pull a curved surface with Joint push-pull, the natural result is, as shown below:



As you can notice, the top thickening surface is not planar. To get it planar, you need to **project the offset on the horizontal plane**:



For all JPP modes except Vector<sup>3</sup>, you can set a **privileged plane** via the button sub-palette:



<sup>3</sup> For Vector tool, you will set a privileged direction. See the section on Vector Push-pull later in this document

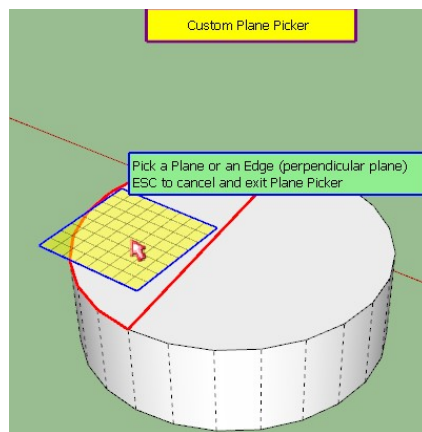
For convenience, JPP offers several settings for planar direction.

- **Plane can be an axis plane**, defined by its normal direction and color: **X**, **Y** or **Z**. Note that you can type the corresponding **Arrow** to set the plane, and **Arrow Down** to unset the privileged direction.
- You can define a **custom plane** (see below)
- All planar directions are referenced by their **scope**.
  - **Model**: reference is absolute
  - **Local**: reference is about the axes of the component or group embedding the faces. If the group / component is rotated, then axis directions will also be rotated.

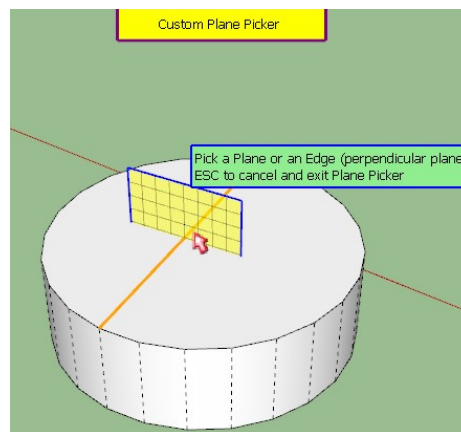
**Important**: the offset is always measured along the projected direction if a privileged plane has been forced.

### Setting a custom Plane

- a) **Click on the 'Question Mark' yellow button**. You enter a special mode: Custom Plane Picker. The button palette is not displayed.
- b) **Pick a face** (plane = plane of the face) or **pick an Edge** (plane = plane perpendicular to the edge). The plane is indicated by a semi-transparent grid.
- c) The Plane Picker is closed and the privileged plane is set as the current **custom plane**.



*Picking a face plane*



*Picking an edge plane*

### Using a custom plane in JointPushPull

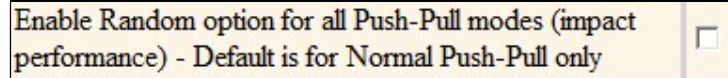
Simply click on the small **C** button.

Note: if there is a current plane active, axis or custom, it is shown as a small grid by the cursor in the viewport.

## 6) Random Offset

Random Offset is available by default for Normal Push Pull.

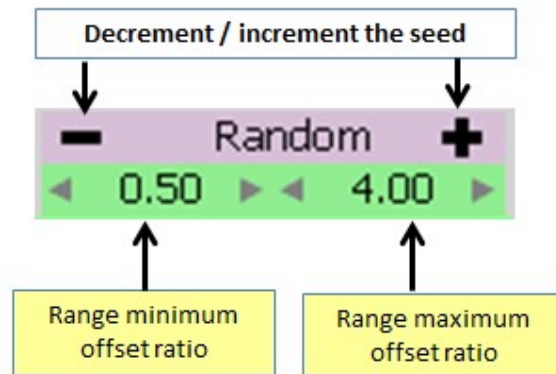
For other JPP modes, except Round, it is also available. However for performance reasons, it is not enabled by default. You have to go to the Default Parameters dialog box to enable it. Then, after usage, it is advised to disable it again.



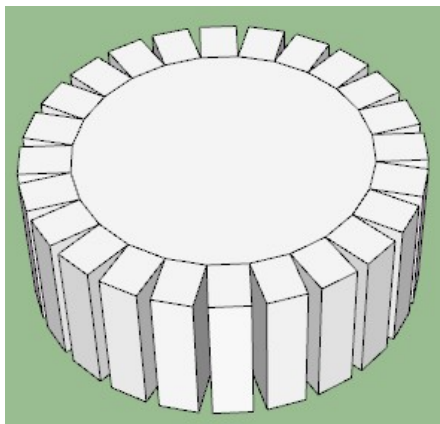
Random offset is based on 2 parameters:

- **The range of offset**, given by a minimum and maximum ratio by reference to the current offset. Bounding value can be positive, negative or zero.
- **The random seed**, which determines the pattern of randomization.

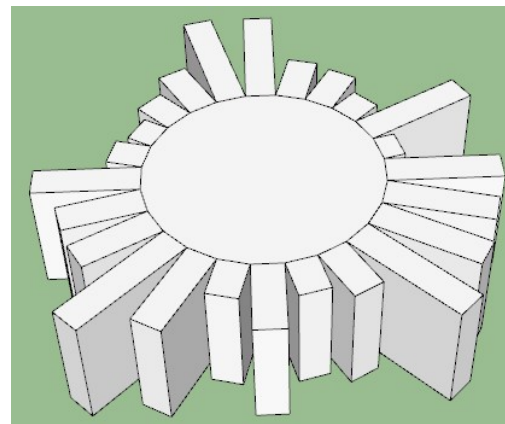
The corresponding buttons in the palette allows configuring these parameters:



In the settings above, the offset of faces will range between 0.5 times and 4 times the current offset set by the user.





Constant offset

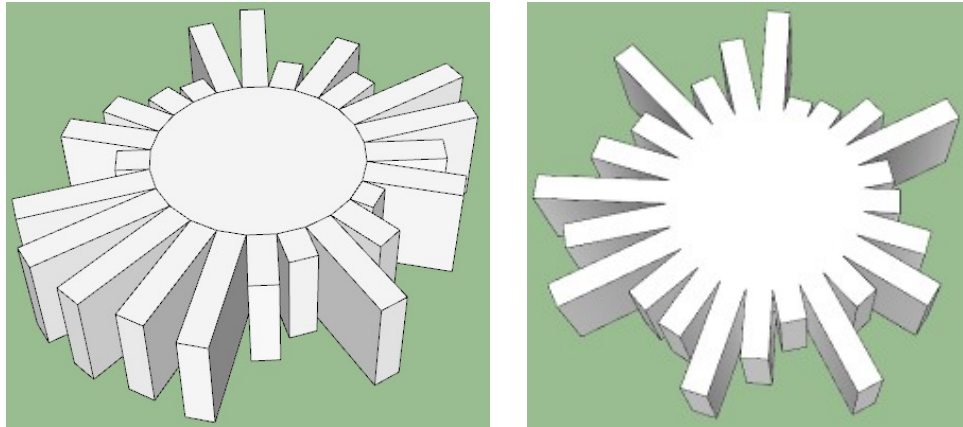


Same offset in Random

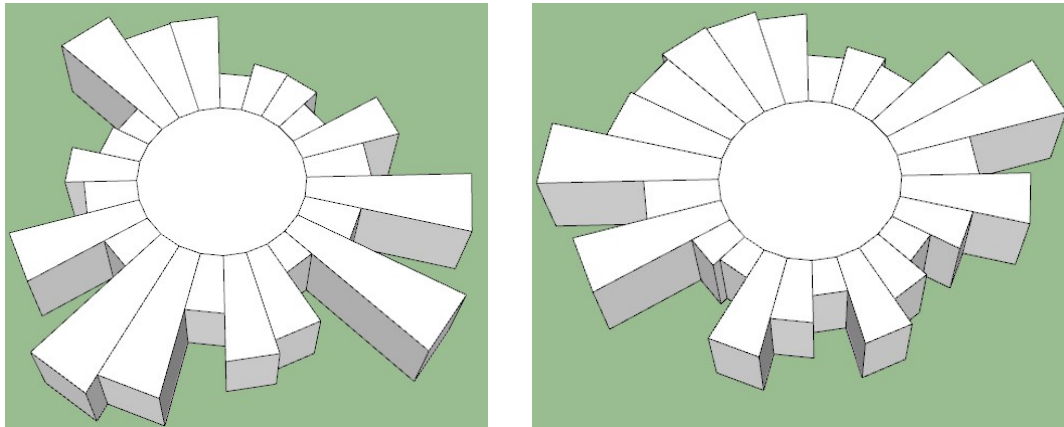
Note: you should always make sure that the range includes the value 1.0, because the face dragged under the cursor is always extruded by the current offset (so its own factor is 1.0).



You can change the seed by clicking on the  or  buttons and obtain different randomization patterns so that you can choose the one you judge interesting.



Hereunder are some randomizations with **Joint Push Pull** (note: you should set the borders to **Grid** for making sure they are filled)



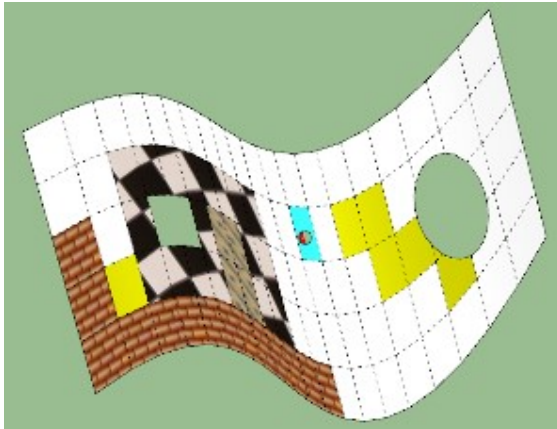
## 6. JOINT Push-Pull



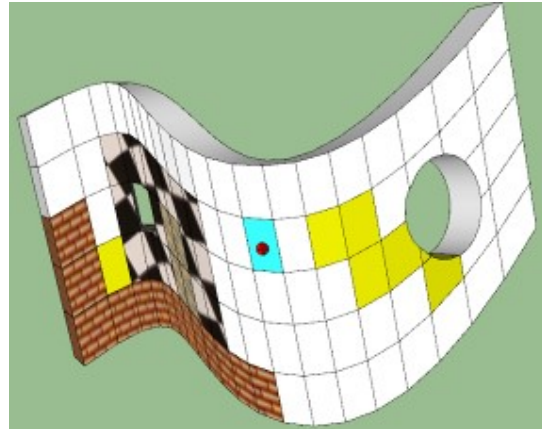
**PURPOSE:** Offset faces along their normal and keep them **jointed**

Faces are offset along their normal but are kept **jointed**. This is the most appropriate tool for **thickening** shapes.

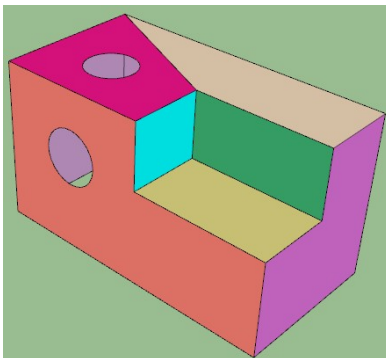
The Joint mode works on smooth surfaces as well as 'boxy' shapes with sharp edges and corners:



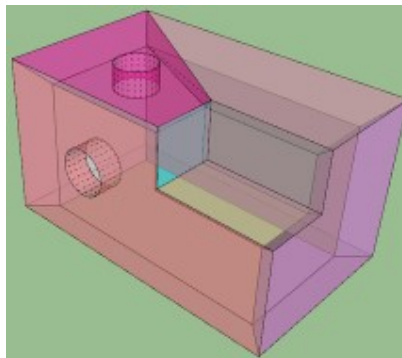
*Original shape*



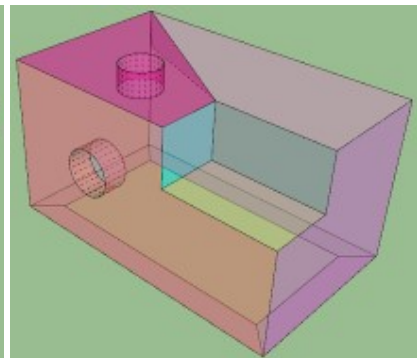
*Thickening*



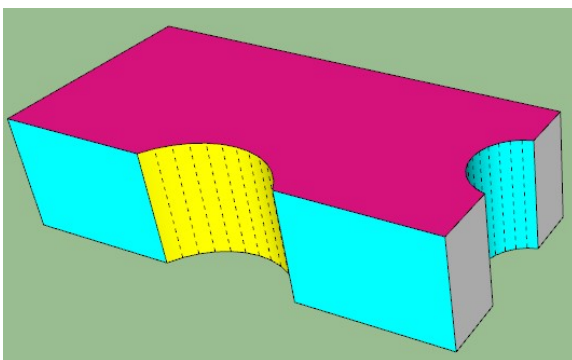
*Original shape*



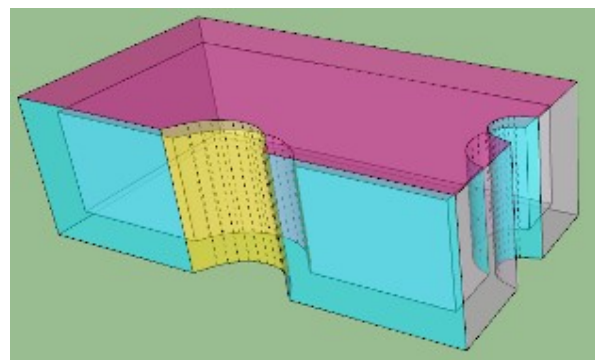
*Thickening*



*Push-Pull*



*Original shape*



*Thickening*

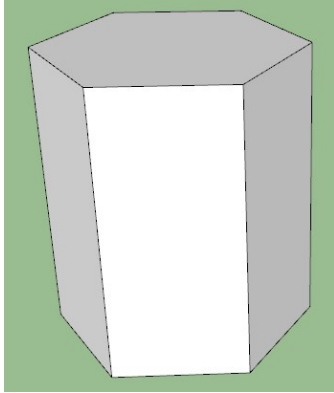
On top of the common options, there is **one specific feature** for Joint Push-Pull:

### 1) Influence of neighbor faces

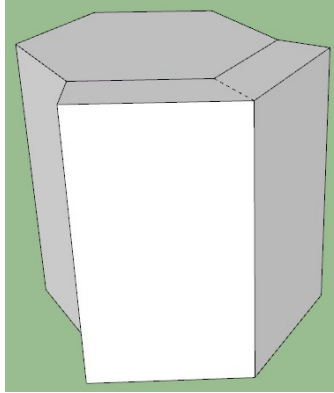


The direction at a vertex is calculated by averaging the normal of the vertex faces which are part of the selection. Other faces are ignored.

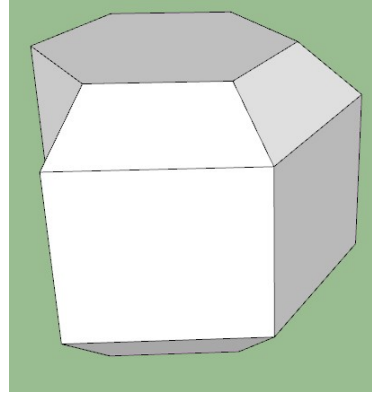
You can however enable the influence of these other neighboring faces (i.e. not part of the selection), by setting the corresponding option in the palette. Not sure this is useful, but this generates the offset as if the outside faces were part of the selection.



*Original shape*



*NO influence from Neighbors*



*Influence from Neighbors*

## 7. NORMAL Push-Pull



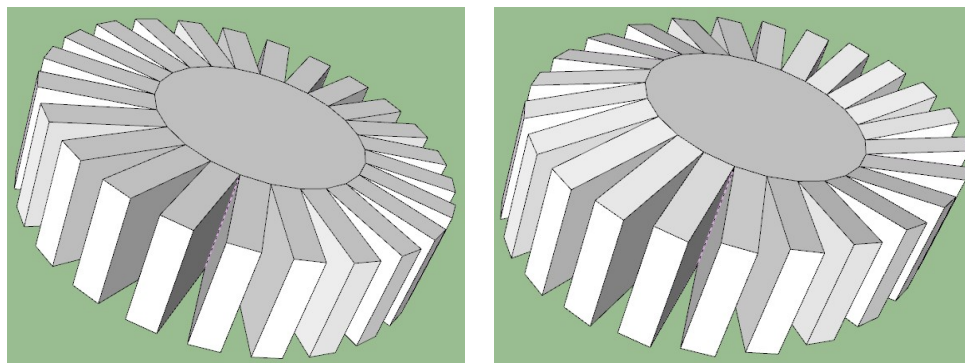
**PURPOSE: Offset faces along their individual normal**

**Normal Push-Pull** equivalent to the native Sketchup Push-Pull, but in multi-faces version, with additional options.

However, it does not fully cover some features of the native tool:

- Create automatic intersections and holes when pushing in solid objects
- Prevent push-pull beyond certain offset (this can be a plus or a minus however)

Push-pull or thickening is performed by **offsetting individual faces along their normal**. But you can of course apply a privileged plane, as shown below:



*NO privileged plane*

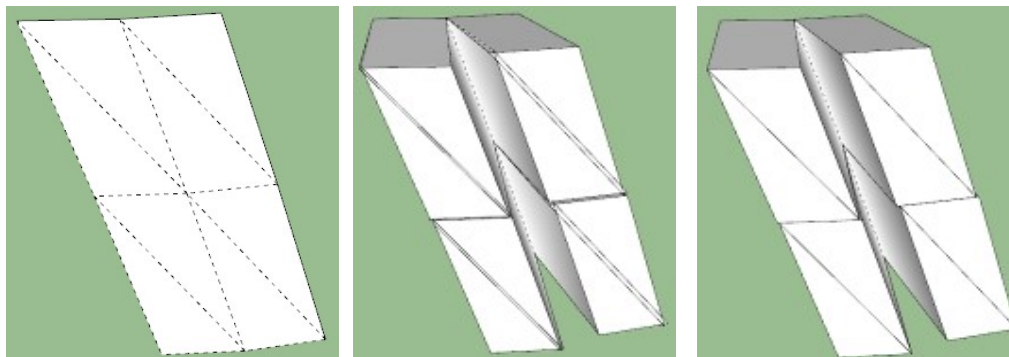
*Privileged plane = Z plane*

On top of the common options, there are **2 specific functions** for Normal Push-Pull:

### 2) Quad Preservation



When faces are arranged in quads, that is 2 triangles whose common edge follows the diagonal conventions (*Cast Shadows = false*), you have the possibility to force a **jointed push-pulling by quad** instead of by individual triangle.



*Original quads*

*NO preservation of quads*

*Preservation of quads*

### 3) Tapering

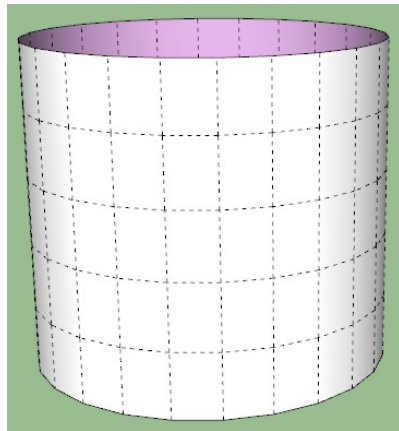
This function will **scale the generated offset faces individually** by a given factor. The scaling is done radially about the barycenter of each face.

This is controlled by a button in the palette where you can enter the tapering factor (increment are by 0.1, i.e. 10%). You can also enter the value, followed by 's' in the VCB.

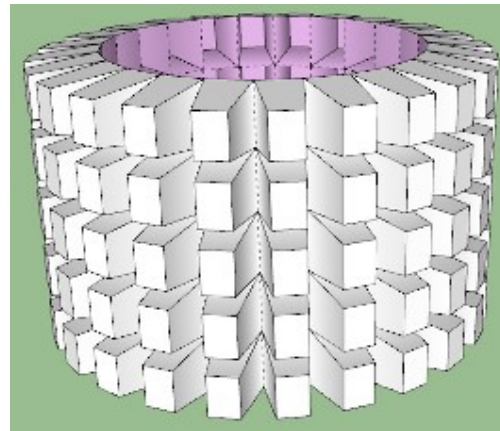


The natural case is when the tapering factor is 1.0: offset faces have the same size as the original faces.

If the factor is **different from 1.0**, you can create a **tapering** effect:

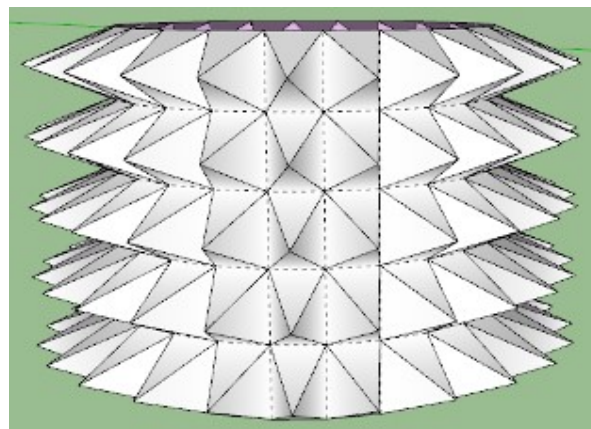


*Original faces*



*Tapering factor = 0.7*

Actually, you can even generate **spikes** by setting the factor to **0.0**



*Tapering factor = 0.0 - Spikes*

Note: I left the possibility to enter negative factors. In such cases, the faces will be twisted. Not sure it is useful for architecture purpose, but maybe for modern art!





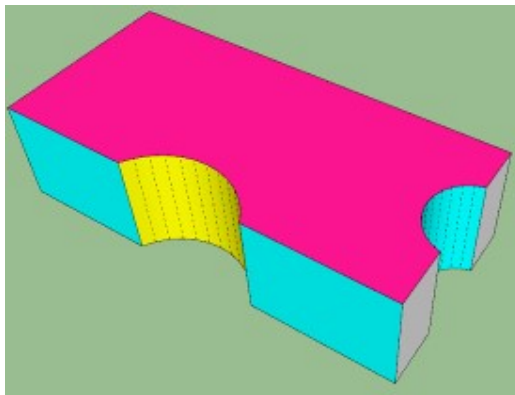
## 8. ROUND Push-Pull

**PURPOSE:** Combine Joint and Normal push-pull and fill gaps by rounding

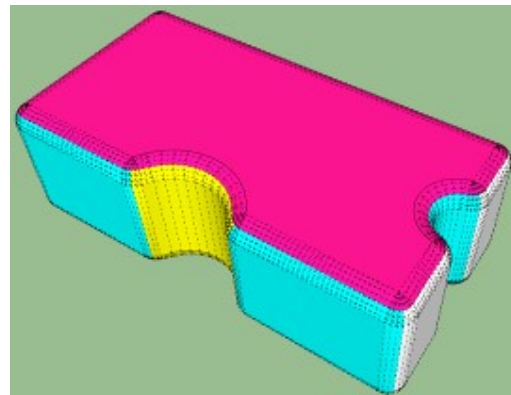
**Round Push-Pull** is a combination of Normal and Joint push-pull tools. It is controlled by a *'joint angle'*. The spirit is to keep jointed adjacent faces that show a small deviation, lower than the joint angle, and round the junction of faces that have a sharp edge.

The objective, or at least the intention, is primarily to serve **3D printing**, providing a way to keep the thickness more uniform for some complex shapes mixing boxy and smooth sections. In JointPushPull 3.0, the implementation is partial, because the script should also round the original faces when the shape includes concave junctions.

In the example below, faces participating in the cylindrical section are kept jointed, whereas faces participating in the box are offset along their normal and joined by a rounding.

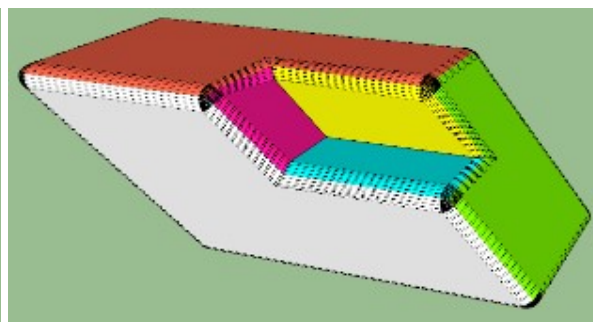
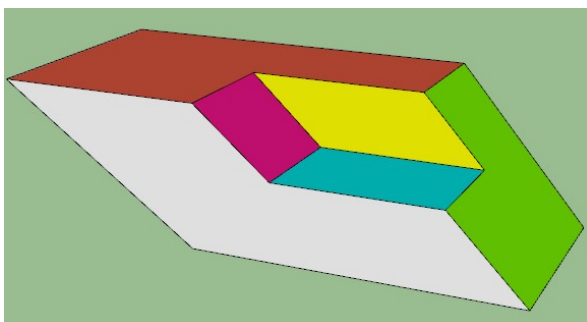


*Original shape*



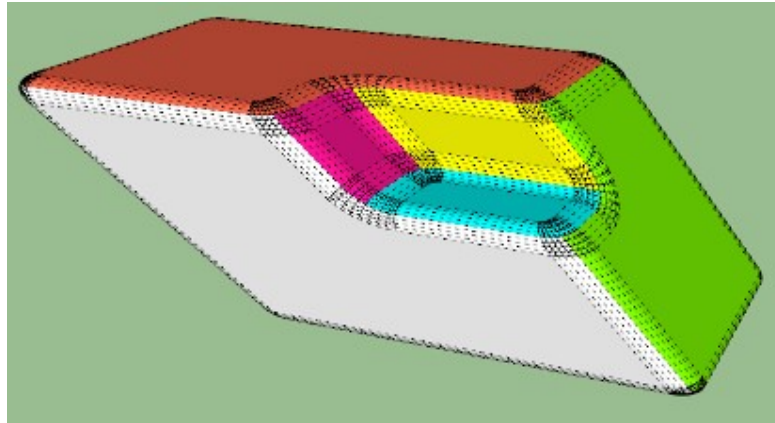
*Round Push Pull*

**Note:** I finally did not implement the mathematical solution for keeping thickness *exactly* uniform. The reason is that it does not give aesthetical results when edges angles are not at 90 degrees. Instead, I used an algorithm close to RoundCorner. Still, it may not give a 'nice' result (see below in the concave part of the shape).



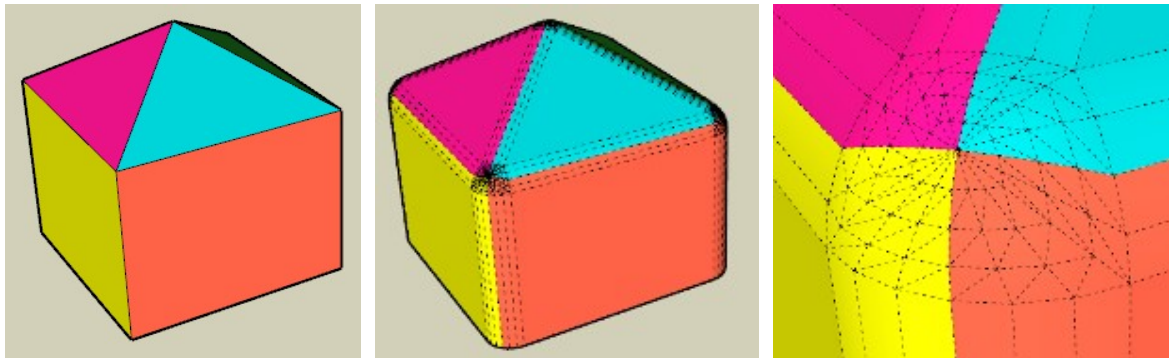


A good alternative is to perform a regular Joint Push-pull on the shape and then apply a RoundCorner:



*Joint push-pull followed by a RoundCorner*

Round Push-Pull can handle corners with any number of edges. The corner junctions are however handled differently than for RoundCorner:



*Original shape*

*Round push-pull*

*Details of 4-edges corner*

The rounding occurrence and shape are controlled by 2 parameters, as shown in the button palette:

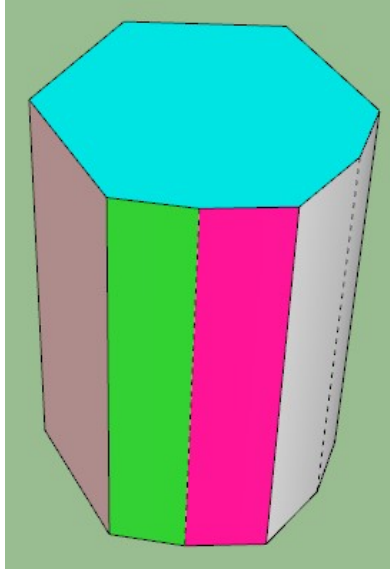


- **The Joint Angle** is used to determine when to round or to join two adjacent faces. If their angle is lower than the Joint angle, then the extrusion keeps them jointed. You can set the Joint Angle via the palette or by typing an angle in the VCB:
  - Angle in degrees followed by 'd', ex: **30d** for 30 degrees
  - Angle in radians followed by 'r', ex: 0.4r for 0.4 radians (~22.9 degrees)
  - Angle in grades followed by 'g', ex: 20g for 20 grades (18 degrees)
  - Slope in % (i.e. tangent of the angle: 100% = 45 degrees)

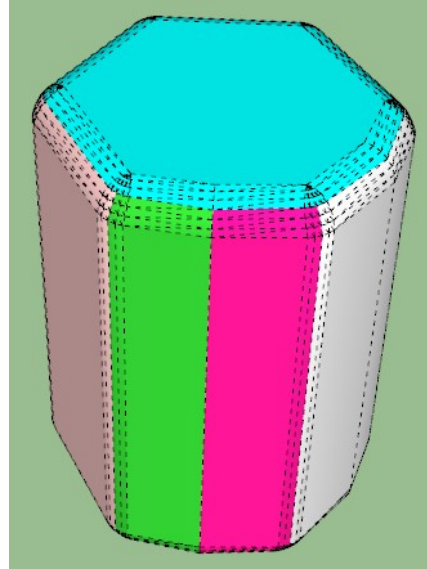
Formulas are accepted.

- The Number of Segments** is given for a nominal circular section of 90 degrees. This is because the number of segments for each rounding is adjusted depending on the angle of its contributing faces. Therefore a value of 6, means 6 segments for perpendicular faces (so 24 segment for a full circle). You can set the Number of Segments for rounding via the VCB by typing its value followed by 's' (for instance '8s'). Note that because roundings are textured, the number of segments is always adjusted to a multiple of 2.

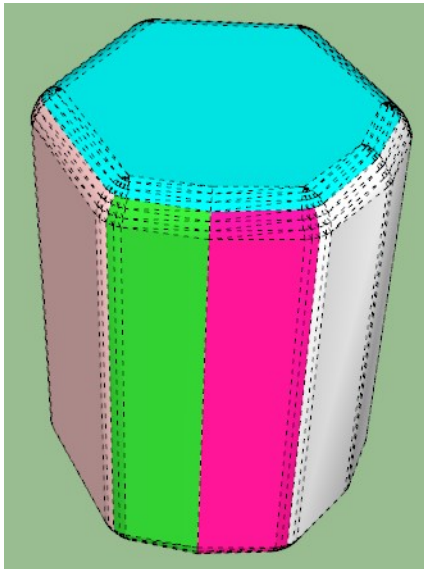
The example below illustrates the impact of the value of the Joint Angle:



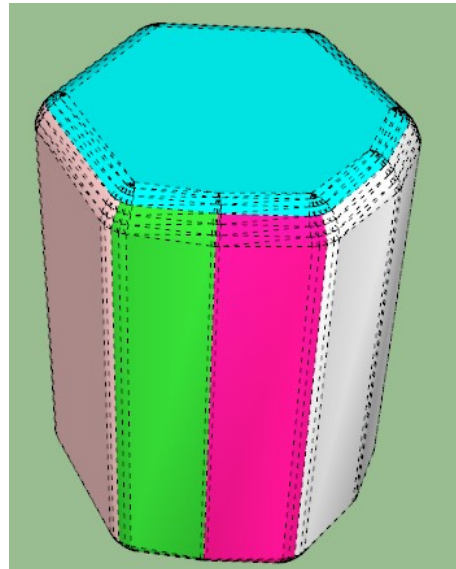
*Original shape*



*Joint Angle = 30°  
2 edges are rounded*



*Joint Angle = 15°  
3 edges are rounded*



*Joint Angle = 10°  
4 edges are rounded*

## 9. VECTOR Push-Pull



**PURPOSE: Offset selected faces along a vector, keeping them jointed**

Vector Push-Pull is a straight offsetting of faces along a vector

- specified visually by dragging the direction in the viewport, or
- along axes, local or model, or,
- along a persisted custom direction specified by the user

**Vector Push-Pull always keeps faces jointed.**

**The specified offset length is counted along the direction vector, not the normal of faces.**

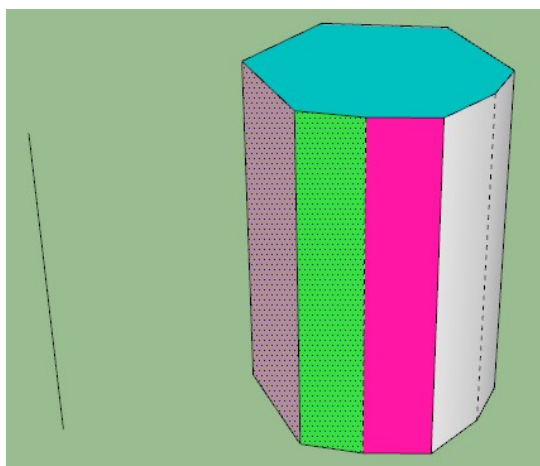
### 1) Specifying the direction in the viewport

Once you have selected faces, you click and then drag the mouse to perform an interactive push-pull. The faces follow the direction given by the mouse. The origin point may be important as you'll be matching a target to determine visually the direction vector.

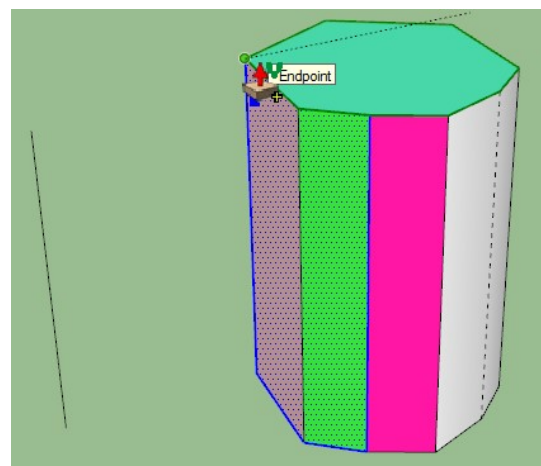
You can (and should) use inference to lock the end of the direction vector on a point of the model. Moving the mouse in the 'empty' space of the viewport is quite misleading otherwise.

For convenience, Vector push-pull offers the possibility to **lock the direction by pressing or toggling Shift**. Once the direction is locked, you can freely adjust the offset (or type it in the VCB).

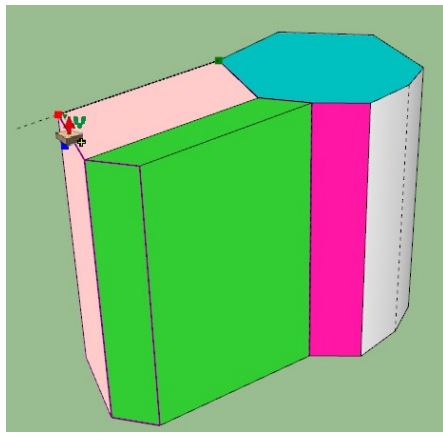
Here is an illustration. A line has been drawn on the left to serve as a guide for specifying the target.



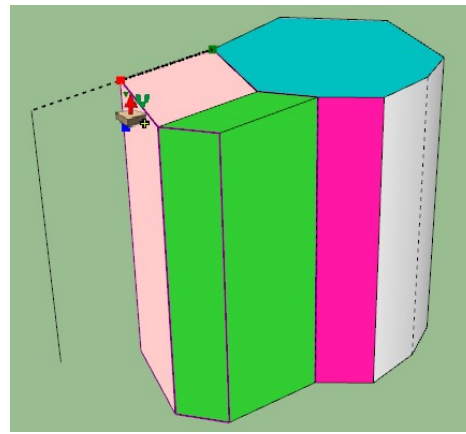
*Original Model  
2 faces are selected*



*Clicking with origin on  
a corner of a face*



*Origin is dragged to the target (top of line)*



*Direction is locked (Shift)  
Offset can be freely adjusted*

## 2) Specifying the direction as an axis

You can set the directions to be along an axis by clicking on the corresponding buttons in the palette.



In practice, you can also use the Arrow keys to specify the direction (Arrow-Down for NO privileged direction).

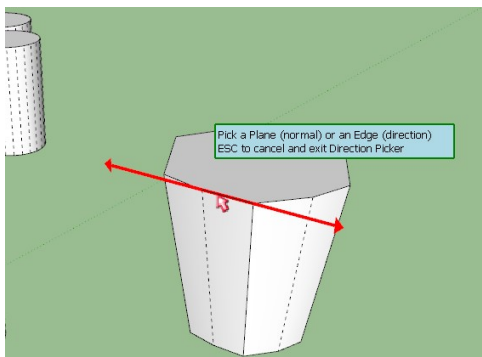
## 3) Specifying and using a custom direction

If you want to set a particular direction, for example, if this direction is materialized in the model by an edge or a face normal, or if you plan to use it for several Vector push-pulls in other sessions, you specify a **custom direction**. It will be preserved across Sketchup sessions for later re-use.

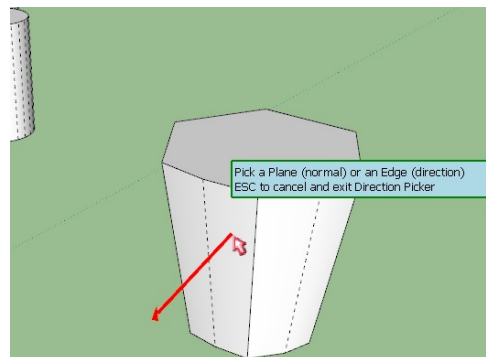
Just click on the button with a yellow question mark **?**. You will enter the **Custom Direction Picker** mode. You can later recall it by pressing the **C** button.

The Custom Direction Picker allows selecting:

- **an edge** in the model: the direction is the edge line
- **a face** in the model: the direction is the normal to the face.



*Direction based on an Edge*



*Direction based on a face normal*

#### 4) Automatic keeping of last direction in memory

For convenience, the **last direction used in a Vector push-pull is kept in memory**.

When you pursue with another Vector push-pull in the same JPP session, or invoke again Vector Push-Pull, or even close / reopen Sketchup and invoke Vector Push-Pull, the vector direction is *locked* on this 'last' direction.

If you wish to specify another direction, just press **Shift to unlock it**.

The benefit is that:

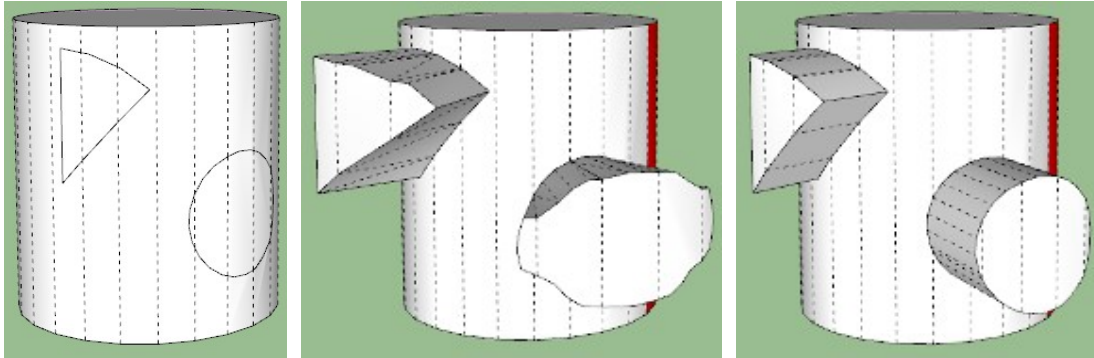
- You can use double-click to repeat a Vector push-pull with the same direction as previously specified.
- You can quickly perform several Vector push-pulls in a row without having to go through a lengthy adjustment of direction again.

## 10. EXTRUDE Push-Pull



**PURPOSE:** Extrude a set of adjacent faces and preserve their overall shape

**Extrude Push-Pull** is adapted to the extrusion of shapes embedded within shapes. Joint Push-Pull will not give a nice result because, keeping the faces jointed will geometrically create distortion.



*Original shape*

*JOINT push-pull  
Shape is distorted*

*EXTRUDE push-pull  
Shape is preserved*

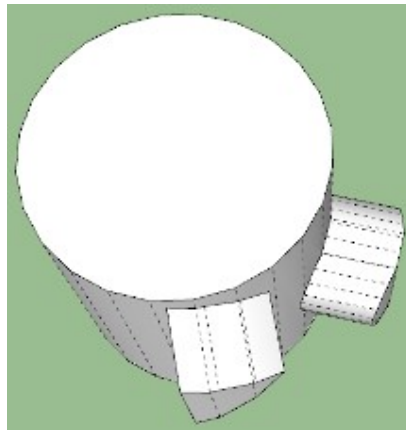
In practice, Extrude push-pull is a particular case of Vector push-pull with the vector computed as the average of face normals. So, extruded faces are **always jointed**.

On top of the common options, there are **2 specific functions** for Extrude Push-Pull:

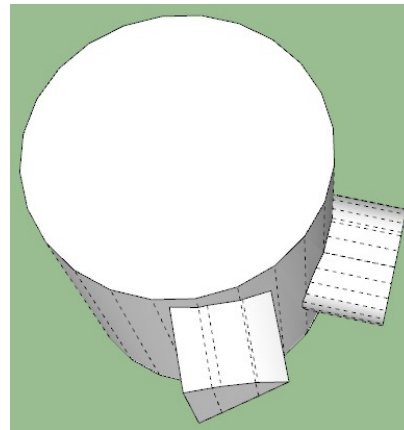
### 1) Flatten extruded faces



The top faces generated follow the shape and curvature of the original faces. You can however impose that they are flattened on the plane of extrusion.



*Regular Extrude*



*Extrude with Flattening*



## 2) Tapering of extruded faces

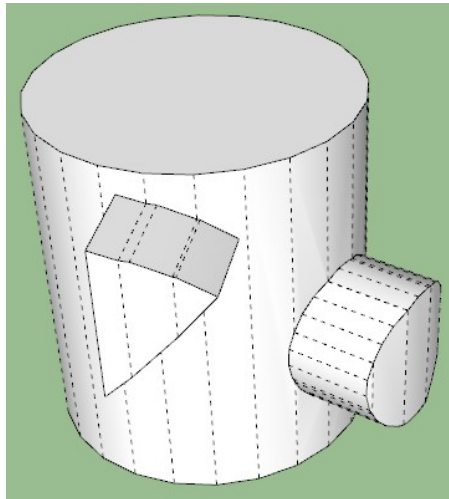
You can set a Tapering factor that will be applied collectively to all extruded faces.

This can be controlled by the button in the palette:

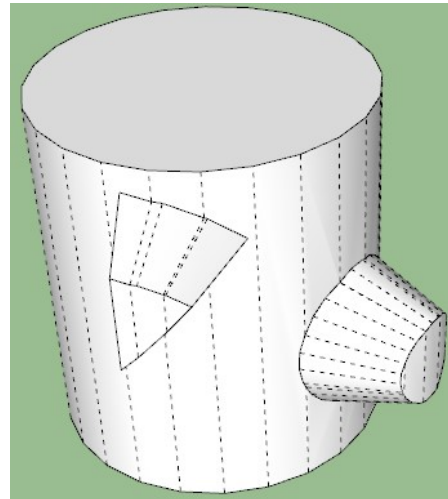


Tapering factor of **1.0** means **NO scaling**.

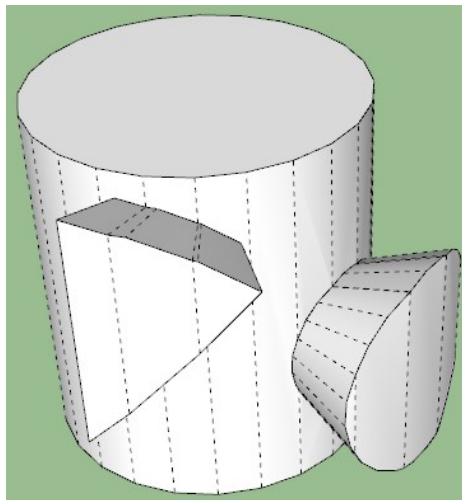
Tapering factor of **0.0** will generate **spikes**.



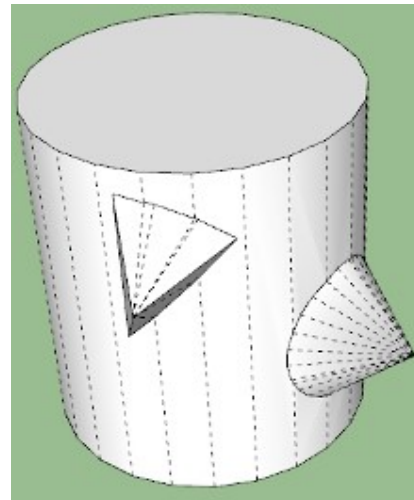
*NO Tapering – Tapering factor = 1.0*



*Tapering factor = 0.6*



*Tapering factor = 1.5*



*Spikes - Tapering factor = 0.0*

## 11. FOLLOW Push-Pull

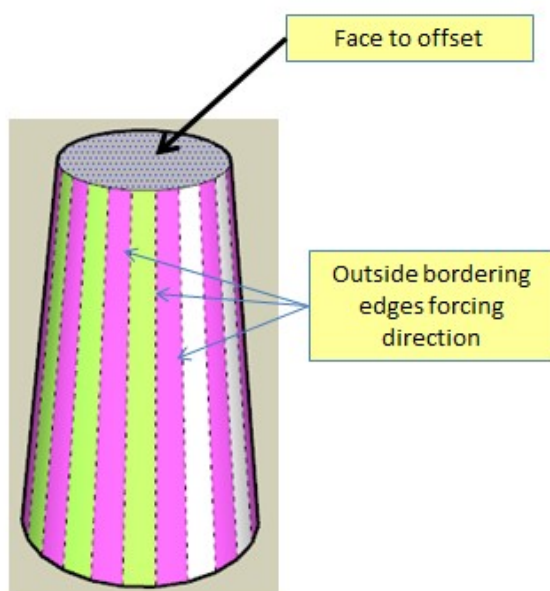


**PURPOSE: Push-Pull faces along the direction of their external borders**

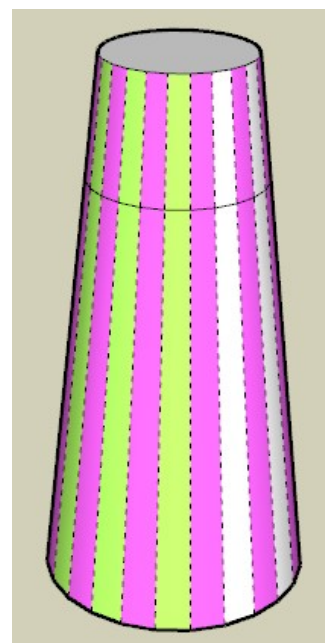
This special push-pull mode was introduced by **a4chitect** in a plugin called *Smart Push Pull*. The implementation of **Follow PushPull** is simply a generalization of Smart Push Pull to multi-faces and the support of the common options available in all JPP tools (thicken / push-pull, borders, etc...).

The push-pull is guided by outside bordering edges for outer faces. For inner faces, Joint push-pull is used.

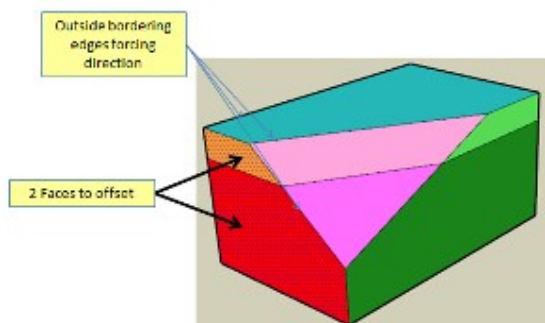
The following examples illustrate the concept:



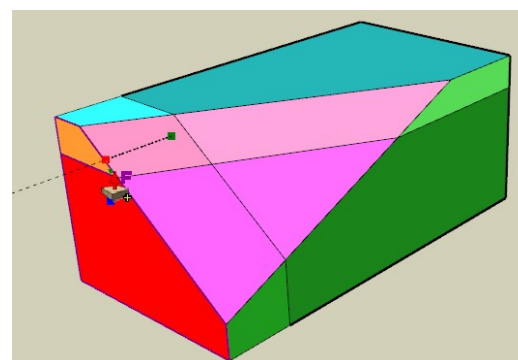
*Original shape*



*Follow Push-Pull of top face*



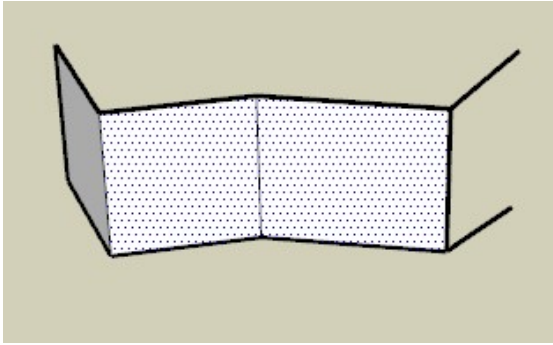
*Original shape*



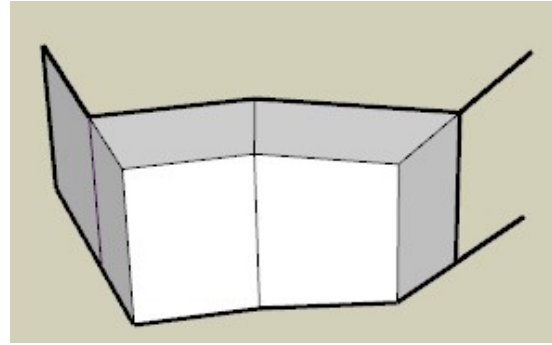
*Follow Push-Pull of 2 faces*

Follow Push-Pull requires indeed that you are clear with the outside bordering edges imposing directions.

For convenience, Follow push-pull allows using **lonely edges** to guide the push-pull.



*Original shape – 2 faces selected*



*After Follow push-pull*

## 12. THICKENER



**PURPOSE: Just a No-Frill version of JointPushPull**

The thickener is simply a version of Joint PushPull without the options and the button palette. The idea was to have a simple mode similar to the native Sketchup puh-pull, but acting on surfaces instead of an individual face.

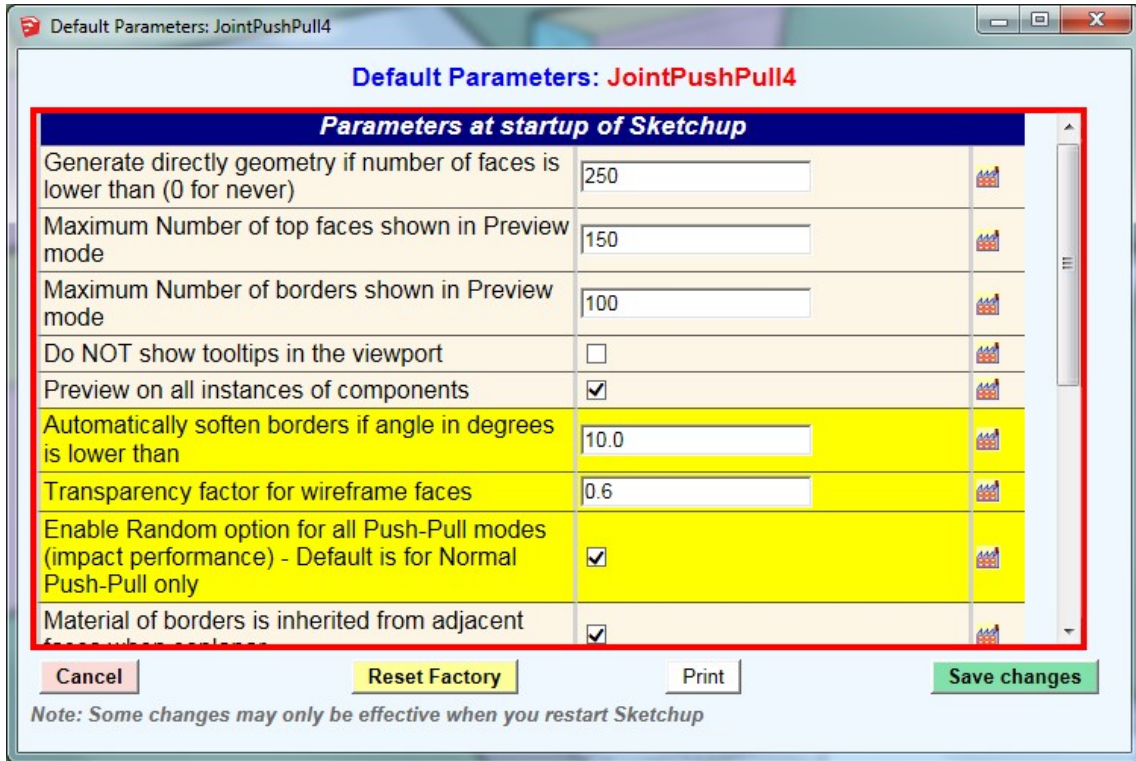
The default selection mode is Single-Face (and Surface when faces are separated by smooth/soft edges).

With the Thickener, you can still:

- Select and multi-select face (in Single-Face selection mode), including across boundaries of groups and components.
- Interactively push-pull by dragging faces
- Set the offset value in the VCB
- Toggle between Thicken and Offset modes by using Ctrl.
- Set planar directions with Arrows.

### 13. Other Options – Default Parameters

JointPushPull provides a few options that are defined in the **Default Parameters dialog box**. When you change them, you may have to close JointPushPull and reopen it again to have them effective.



#### 1) Number of faces for auto-generation of geometry

Generate directly geometry is number of faces is lower than (0 for never)	200
---	-----

This parameter allows controlling **whether you go to the Preview mode or directly generate the geometry** after dragging faces (or modifying any options like offset, finishing, ...). This parameters must be set based on the performance of your computer.

A value of 0 means that you will always go to the preview mode.

#### 2) Number of faces and borders shown when dragging and preview

Maximum Number of top faces shown in Preview mode	100
Maximum Number of borders shown in Preview mode	100

These 2 parameters allows controlling **how many faces are drawn in the viewport when dragging** and in the Preview mode. The values should be adjusted to the performance of your computer.

### 3) Show / Hide tooltips in the viewport



For convenience, JointPushPull displays tooltips in the viewport for each step of the workflow. After a while, you may be familiar with the process, and may want to disable them in order to gain more real-estate visible in the viewport.

### 4) Preview on all component instances



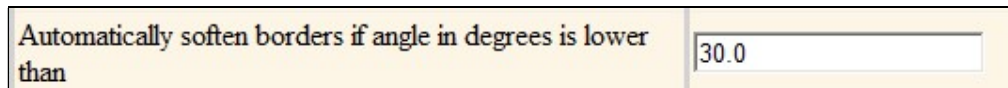
When you select faces embedded within a component, the push-pull will also apply to the other instances of the component in the model if any.

JointPushPull echoes push-pull to all component instances when dragging and in preview mode. This allows the user seeing the real impact of the operation.

As this is impacting performance on slow computers, you may want to disable this feature.

Note that the option only affects the visual feedback of JointPushPull. The geometry will be generated in all component instances.

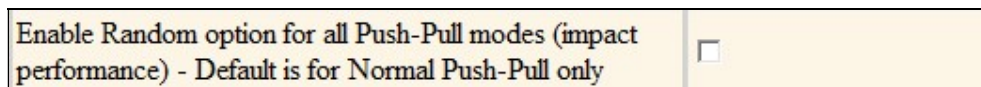
### 5) Auto-softening of border edges



Bordering edges properties are determined by the original shape. In particular, vertices within a curve will generate soft / smooth bordering edges.

However, the generated shape may present sharper angle than in the original shape or you may not correspond to a curve in the original shape. So, this option allows performing automatic softening based on the specified angle, regardless of the original edge properties.

### 6) Random option for all Push-Pull tools



JointPushPull is optimized for tools which maintain faces jointed, namely Joint, Vector, Follow.

The Random offset option forces the algorithm to downgrade this optimization, even for all cases when randomization of offset is not used.

Whenever you need Random for Joint, Vector or Follow tools, just enable this option and re-launch the JPP tool. You will see the random parameters in the palette. When finished, just disable the option.

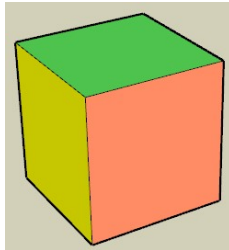


## 7) Material inheritance

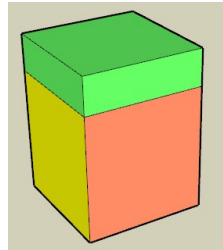
Material of borders is inherited from adjacent faces when coplanar



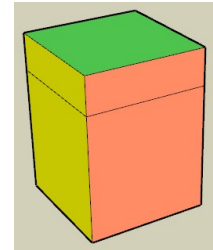
For Thickening mode, this option allows altering the behavior of the texturing for borders when coplanar to outside border faces:



*Original shape*



*Option is OFF  
Border material inherited  
From top face*



*Option is ON  
Border material inherited  
from adjacent border faces*

Note that the middle picture corresponds to the behavior of the native Sketchup Push-Pull.

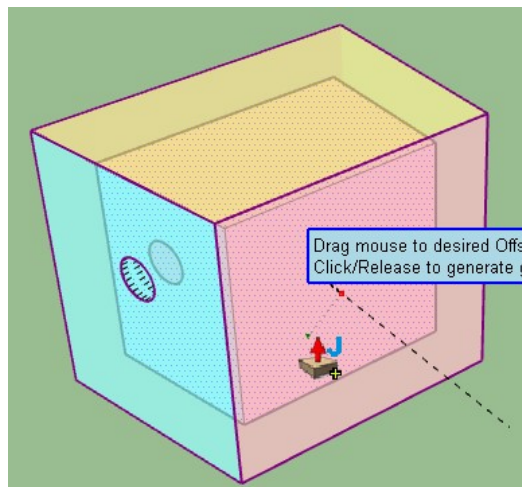
## 8) Transparency for wireframe simulation

Transparency factor for wireframe faces

0.9

When dragging faces, JointPushPull simulates the geometry with a wireframe. The Transparency parameter allows to set the **transparency of the wireframe faces**. This factor is comprised between 0.3 and 1, the value of 1 meaning opaque. The default value is 0.75.

The idea of transparency<sup>4</sup> is to allow to better grasp visually the original shape when dragging faces.

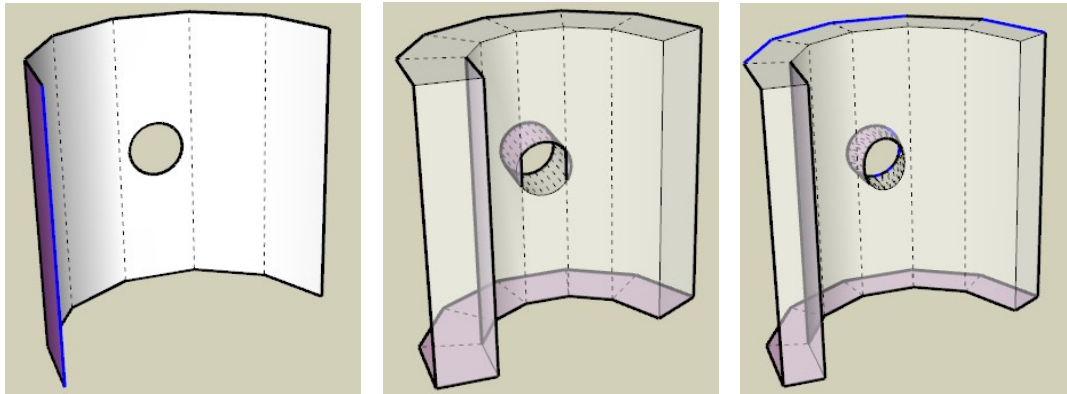


<sup>4</sup> Original idea came from a suggestion by JQL

## 14. Limitation and Future Work

In version 3.0, JointPushPull includes some limitations:

- 1) **Texturing on borders with true textures:** the texturing is not adjusted to the proper scale and orientation inherited from the top face. This is better handled in JPP v2.0.
- 2) **Holes and Embedded faces for Joint push-pull:** Holes and faces embedded within faces are extruded orthogonally. In practice, there should be an option to:
  - Either extrude orthogonally
  - Or extrude with a scaling adjustment, as in JPP 2.0



*Original shape*

*JointPushPull v3.0  
Hole is not scaled down  
and does not fit in  
The extruded face*

*JointPushPull v2.0  
Hole is adjusted to fit  
in the extruded face*

- 3) **Intersections:** Unlike the native Sketchup Push-Pull, JointPushPull does not create intersections allowing creating holes in back faces when applicable.

These limitations may be addressed in further versions.