

Tgi3D[®] Amorph/PhotoScan

Sketchup Plugin

User's Guide

(revision 1.5.4)

Tgi3D SU Amorph/PhotoScan v1.28

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1. Welcome to Tgi3D® SU Plugin Help

Tgi3D® SU (Tgi3D® SketchUp Plugin) is a plug-in for Google SketchUp that contains tools that supports:

- 1) Creating realistic 3D models from photographs by extending the matched-photo interface of SketchUp.
- 2) Creating 3D models with free-form surfaces by supplying various utilities for creating smooth meshes.

Initial sections of the Tgi3D® SU Help document provides step-by-step instructions on how to perform tasks specific to Tgi3D® SU plug-in. Sections following Section 14. contains all the reference material pertaining to Tgi3D® SU Plugin tools and commands.

This document assumes a basic knowledge of 3D modeling and familiarity with using Google SketchUp.

Note: The Tgi3D® CT (Tgi3D® SU PhotoScan Calibration Tool) is a photogrammetry software that facilitates an interface to mark matching points on multiple images for camera calibration and taking measurements between the marked points. Tgi3D CT is available only in the Tgi3D® SU PhotoScan package.

2. Tgi3D® SU Overview

Tgi3D® SU is a collection of interactive 3D drawing tools that extend SketchUp in two fundamental ways:

- 1) Tgi3D® SU support 3D modeling of real-world objects captured in the form of multiple images taken from different locations and angles. The plugin depends on the *Photo Match interface* of SketchUp for drawing models from photographs; but It provides a much more effective interface due to the patented *view-lock* drawing technique.
- 2) Tgi3D® SU contains various tools for creating and editing smooth meshes controlled by Bézier curves to enable creating 3D models with amorphous shapes.

2.1. View-locking

View-lock is a motion constraint that enables the user manipulate a 3D drawing primitive without changing its appearance on a selected input image (or on a desired camera view). Under the view-lock constraint you can move (using the *Tgi3D Move* tool) the primitive to align its appearance on another view, without changing its appearance on the locked view. In a typical project, you need to go through a number of *lock and align* operations to draw the primitive correctly in 3D.

Figure 1 is a step by step demonstration of the lock and align operation:

- a) Figure 1-a shows a line segment overlayed on the edge of the coffee table on a photo-match page. After the line is drawn correctly on this page, it is locked with “Lock selection” command from the context menu.
- b) Figure 1-b shows the same line on a different page. It does not coincide with the edge of the table. When you move the end of the line using the *Tgi3D Move* tool, a red line representing the lock or equivalently the motion constraint appears. As long as the vertex moves on the red-line (this constraint is enforced by the *Tgi3D Move* Tool only), its appearance won't change on the first page. It becomes possible to align the line segment with the edge of the table without affecting its appearance on the first page.
- c) Figure 1-c shows the same line segment after the alignment operation. Now the line coincides with the edge of the table on the second page as well.
- d) Figure 1-d shows the same line on a third page. It matches the edge of the table again. Actually we expect a match on an arbitrary page showing the edge of the table, which means that the line is reconstructed perfectly in 3D.

Theoretically having the line segment matching the image on two views guarantees its reconstruction; but in practice calibration errors and degenerate camera configurations such as narrow angle camera pairs require exercising the lock and align operations on other cameras as well.



(a)



(b)



(c)



(d)

Figure 1: The steps of lock and align operation

2.2. Tools and Commands

Apart from the lock and align mechanism, Tgi3D® SU comes with various utilities and tools for drawing complex objects including the ones with amorphous shapes. Some of these tools are limited to the photo-match pages as they operate on the images together with the model. The other s including the lock and align mechanism can be used on the fly from an arbitrary view as they only operate on the model. Without a photo-match page, the view-lock uses viewing camera of SketchUp, representing a particular view of the object just like its 2D drawing.

Tgi3D Toolbar, shown in Figure 2, contains seven tools, namely *Tgi3D Select*, *Tgi3D Move*, *Construction Point*, *Cross Section*, *Set World Coordinates*, *Warper* and *Image-Based Surface Modeler (PhotoScan only)* tools. The last icon in the toolbar pops up the *Tgi3D Settings* dialog box. Among these tools, *Tgi3D Select* tool makes *Tgi3D* specific selection of SketchUp entities easier, *Tgi3D Move* tool moves the entities under the *Tgi3D* specific constraints and creates and modifies Bézier curves, *Construction Point* tool creates construction points and *Cross Section* tool enables you to efficiently edit cross sections of extrusions. *Set World Coordinates* allows you to transform the whole model to align it with the world coordinate system of SketchUp, which determines the ground plane and the default light source. *Warper tool* creates a *Tgi3D* specific bounding box, which is used for warping (i.e changing the shape of) the selected surface. *Channel Extrude* tool extrudes selected edges along a preselected connected path of edges. Finally, *Image-Based Surface Modeler (PhotoScan only)* pops up another toolbar that contains commands for fitting surfaces to images. They are also located under Tools menu of SketchUp.



Figure 2: The *Tgi3D* Toolbar

There are also various commands distributed to File, Edit, Tools, Help menu and context menu of SketchUp mainly for mesh creation, warping and smoothing operations to shape surfaces, vertex operations to lock or fix vertices inside the *Tgi3D Move* tool, and creating and modifying Bézier curves.

3. Setting up the Matched Photo Pages

In order to be able to draw objects using photographs, first the images should be loaded to the matched-photo pages of SketchUp and the corresponding perspective camera parameters should be set correctly. There are two ways of calibrating the cameras of matched photo pages.

1. SketchUp itself provides a novel interface for the calibration of cameras (see the SketchUp documentation on matching photos). If high reconstruction accuracy or the lens distortion is not an issue, and the images have appropriate content (e.g. buildings) this interface can be easily used. The image matching utility in Tgi3D® SU does not work with this type of calibration.
2. Calibrate the cameras using Tgi3D® CT (Tgi3D® SU PhotoScan Calibration Tool) that comes with the Tgi3D® SU PhotoScan package. Tgi3D® CT calibrates the cameras using manually marked point matches and takes the lens distortion into account. It can provide highly accurate camera calibration results. The tool exports lens distortion wise corrected images, and the camera parameters with or without cloud of points used in calibration to a SketchUp file. Just use the exported file, which contains the calibrated matched-photo pages, as a start-up for your modeling project. We recommend using Tgi3D® CT for best results.

Note: Tgi3D CT versions prior to 1.16 do not export the calibration results as a Sketchup file; instead a folder containing the calibration data (model.t3f) and the lens distortion wise corrected images is generated. This folder should be imported to SketchUp using the “*Plugins > Tgi3D > Utils > Import Tgi3D Calibration...*” command in Tgi3D® SU Plugin.

4. World Coordinates and Drawing Axes

SketchUp has a fixed coordinate system with a fixed ground plane and a single light source, which is the Sun. The location of the Sun is determined with respect to ground plane using the time and date in shadow settings. Besides this fixed world coordinate axes it is possible to define drawing axes to change the red, green and blue axis used in inference of SketchUp while drawing.

If you use Tgi3D® CT export output as a starting point you may want to change the world coordinate system so that the cameras and the reconstructed objects lie over the ground plane and cast shadows correctly. You can use *Set World Coordinates* tool located on the Tgi3D Toolbar (see Section 2.2.) for this purpose. The tool works similar to the *Axes* tool of SketchUp.

Note: We strongly recommend to setup the world coordinates in Tgi3D® CT before export; because the axes information provided by the user is utilized to calibrate the cameras to satisfy the desired world coordinate system accurately.

When you change the drawing axes by some means in SketchUp, the change is not reflected automatically in Photo-match pages. When you switch to a photomatch page you lose the current drawing frame as the drawing axes in that page is activated. If you want to change the drawing frame axes in the pages as well, you can use the “Edit-->Update Tgi3D page axes” command, which sets the drawing axes of all Tgi3D photo-match pages to the current drawing axes.

5. View Locking

View locking (patent pending) is a central feature of Tgi3D® SU. View locking a vertex constrains the 3D position of that vertex in such a way that its appearance from the locked view is invariant (i.e. constant). That is, further edits to the vertex in other views do not affect its position in the locked view. You will notice that the movement of the view locked vertex is restricted on a line in other views (e.g. the red line in Figure 1-b). This line is the line that connects the original position of the vertex to the view's optic center. In its simplest usage, a vertex is locked from one view and then the vertex is moved to its correct 3D position in other views.

5.1. View locking vertices of a line

To view lock the vertices of a line:

1. If you are not already in *Tgi3D Move* mode, pick the *Tgi3D Move* tool
2. Right click to select the line
3. Select “Lock selection” command in the context (or pop-up) menu.

5.2. View locking a Bézier Curve

To view lock a Bézier curve

1. If you are not already in *Tgi3D Move* mode, pick the *Tgi3D Move* tool
2. Right click on the curve
3. Select “Lock curve” command in the context menu.

5.3. View locking a single vertex or construction point

To view lock a single vertex or a construction point:

1. If you are not already in *Tgi3D Move* mode, pick the *Tgi3D Move* tool
2. Place the cursor on the vertex
3. Right click on the vertex
4. Select “Lock single vertex” command in the context menu.

5.4. View locking vertices of a selection

To view lock the vertices of a selection:

1. If you are not already in *Tgi3D Move* mode, pick the *Tgi3D Move* tool
2. Right click on the selection
3. Select “Lock selection” command in the context menu.

Under *Tgi3D Move* tool, the vertex in focus appears highlighted in different colors and shapes depending on *lock* and *fix* status as shown in Table 1

Colors:

Blue: no lock

Red: locked from the current point of view

Orange: locked from some other point of view

Shapes:

Triangle: vertex is fixed (i.e. vertex is immovable) for smoothing and image matching operations.

Rectangle: vertex is not fixed (i.e. vertex is movable) for smoothing and image matching operations.







	No Lock	Locked in current View	Locked in another view
No fix			
Fixed			

Table 1: Lock and fix status under Tgi3D Move tool

Note: You can perform view lock to arbitrary cameras (photo associated or not, perspective or not).

6. Editing lines, Bézier curves and Construction Points

Lines are the basic geometric primitives of SketchUp that are enough to capture a wide range of shapes; on the other hand many objects in the photographs have smooth curvy boundaries and management of polyline representations of these boundaries gets very unpractical as the number of segments increases. Therefore Tgi3D® SU includes support for the manipulation of 3D Bézier curves, which are well behaved curves with the ability to capture a wide range of shapes with a few parameters. Tgi3D® SU does not include a tool to directly draw Bézier curves, instead the lines drawn by SketchUp line tool are converted to third order Bézier curves using *Tgi3D Move* tool or the context menu.

Construction points form another type of entity that can be processed by Tgi3D® SU. In Sketchup construction points are not part of the model but are used as guides while drawing. It is possible to create, lock, and move construction points using Tgi3D® SU plugin.

6.1. Converting a line to a Bézier curve

You can convert a line to a Bézier curve in two ways:

Either

1. Select the line
2. Click the right mouse button while the cursor is on the line
3. Select the *Convert to Bézier Curve* item in the context menu.

or

1. Make sure the *Tgi3D Move* tool is picked
2. (Windows) Press and hold the 'Ctrl' key on the keyboard
(Mac) Press and hold the 'option' (or 'alt') key on the keyboard
3. Press and hold the left mouse button on any point on the line and drag the mouse (just clicking without dragging is also enough for the conversion).

Figure 3 shows the initial and final states of the line for the second method.

6.2. Stretching and stressing a curve

To stretch or stress a curve:

1. If you are not already using the *Tgi3D Move* tool, click the *Tgi3D Move* tool icon from the Tgi3D toolbar.
2. Grab and pull from any point on the curve.

You will observe that as the grab point gets closer to one end of the curve that side of the curve is affected more by the motion.

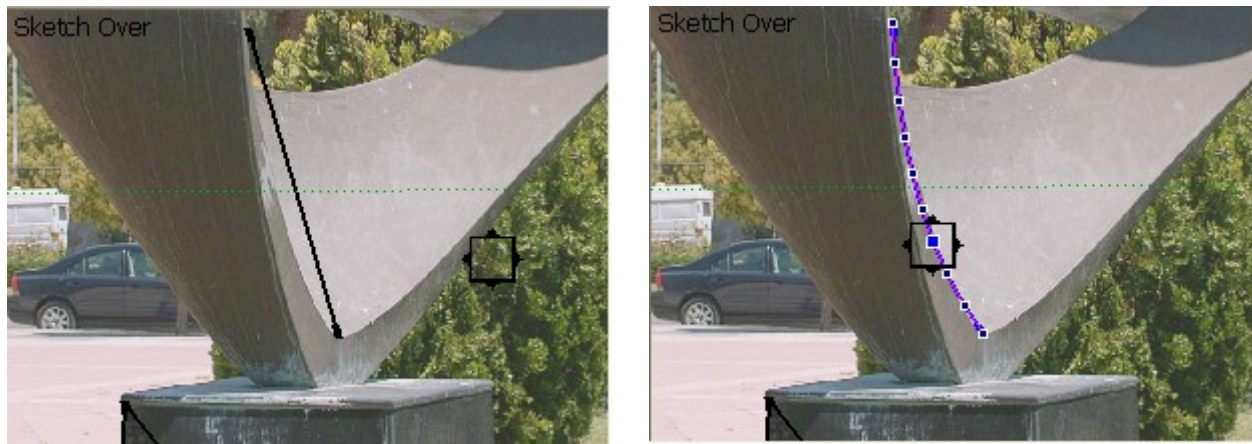
6.3. Exploding a Bézier curve

Ordinary SketchUp explode operation destroys the curves, but Tgi3D® SU will still recognize them as Bézier curves. If you want to completely explode a Bézier curve, you need to use the *Explode Bézier Curve* menu item in the context menu. To explode a single curve

1. Click the right mouse button while the cursor is on the line
2. Select the *Explode Bézier Curve* item in the context menu.

To explode multiple curves

1. Select the curves you want to explode. Exact selection is not needed, just make sure the selection includes all the Bézier curves to be exploded.
2. Click the right mouse button on the selection
3. Select the *Explode Bézier Curve* item in the context menu.



(a)

(b)

Figure 3: Converting a line to a Bézier curve

6.4. *Splitting a line or a curve*

To split a line or a curve:

1. If you are not already using the *Tgi3D Move* tool, click the *Tgi3D Move* tool icon from the Tgi3D toolbar.
2. Position the cursor at the point you want to split the line or curve.
3. Double click the left mouse button.

Note: Curves lying on or at the border of meshes attached to faces can not be split. Instead, new samples are added to the curve at the point specified by the mouse

6.5. *Changing sampling rate on the curve*

To change the sampling rate on a curve or multiple curves:

1. Select the curve(s). Exact selection is not needed, just make sure the selection includes all the Bézier curves to be resampled.
2. Right click on the selection
3. Select *Resample Bézier Curve...* item in the context menu.
4. Enter the desired number of vertices on the curve(s) in the *Bézier Curve Info* dialog box
5. Press “Enter” key or click “OK” button on the dialog box.

Hint: For reasonable model size and manipulation ease, use the fewest samples that meet your accuracy requirement.

Note: If the curve have attached faces, then resampling operation will not work. However you can explicitly insert a sample at a desired location by double clicking at that location on the desired edge.

6.6. Drawing a 3D line matching to the photographs

To draw a 3D line matching to the photographs:

1. Draw the line on a photograph to match the desired feature or edge of the object in the picture
2. Select the line
3. View lock the line in the current photo
4. Select *Tgi3D Move* tool (unless already selected)
5. Move the ends of the line to match the same feature in other photo(s).

6.7. Matching lines to image features automatically (PhotoScan Only)

With Tgi3D® SU you can adjust the position of lines to match the desired feature in a photograph. To use automatic adjustment:

1. Position the line close to the desired feature
2. Select the line (or move the cursor over the line if inside the *Tgi3D Move* tool)
3. Make sure *Tgi3D Move* (or *Tgi3D Select*) tool is on
4. Press and release key “K”, until you want to end the matching process.

Note: For the automatic vertex match operation to work properly, there needs to be enough contrast in the photograph. Sometimes there may be fake edges due to shadows etc. in the photograph which makes it impossible to perform automatic matching.

Caution: This feature is only available in Tgi3D® SU PhotoScan product and works with SketchUp files exported by Tgi3D® CT (Tgi3D® SU PhotoScan Calibration Tool).

6.8. Drawing a 3D curve matching to the photographs

To draw a 3D curve:

1. Select *Tgi3D Move* tool (unless already selected)
2. Draw the curve on a photograph to match the desired feature or edge of the object in the picture by stretching and stressing the curve
3. View lock the curve in the current photo
4. Modify the curve to match the same feature in other photo(s).

6.9. Matching curves to image features automatically (PhotoScan Only)

With Tgi3D® SU you can adjust the curves to match the desired feature in a photograph. To use automatic adjustment:

1. Position and adjust the shape of the curve close to the desired feature
2. Select the curve (or move the cursor over the curve if inside the *Tgi3D Move* tool)
3. Make sure *Tgi3D Move* (or *Tgi3D Select*) tool is on
4. Press and release keys “J” and “K” interchangeably, until you want to end the matching process.

Note: For the automatic vertex match operation to work properly, there needs to be enough contrast in the photograph. Sometimes there may be fake edges due to shadows etc. in the photograph which makes it impossible to perform automatic matching.

Caution: This feature is only available in Tgi3D® SU PhotoScan product and works with SketchUp

files exported by Tgi3D® CT (Tgi3D® SU PhotoScan Calibration Tool).

6.10. Drawing a 3D construction point matching to the photographs

To draw a 3D construction point

1. Choose *Tgi3D Construction Point* tool
2. Left click on the desired position. The depth will be assigned by SketchUp using coincident geometry (i.e. if there is a plane/face the point will be placed on the face, if it is close to an edge the point will be on that edge etc).
3. View lock the construction point
4. Edit the position of the construction point using the *Tgi3D Move* tool from other viewing-positions/photos if desired. If there are no locks, the *Tgi3D Move* tool will restrict construction point to a plane which is perpendicular to the present camera's viewing axis.

6.11. Moving lines and curves restricted to a face-plane

To move lines and curves restricted to a face plane, use *Tgi3D Move* tool simultaneously pressing and holding the 'Shift' key. The face closest to the cursor location determines the restriction plane.

For example, to convert a line in a plane to a curve in the same plane:

1. (Windows) Press and hold 'Ctrl' and 'Shift' keys
(Mac) Press and hold 'option' (or 'alt') and 'Shift' keys
2. Drag from any point on the line using the *Tgi3D Move* tool.

Note: If you have a view lock on a surface, the vertex that is restricted to the plane cannot be moved (intersection of a plane and a line is a point).

6.12. Snapping a vertex to another vertex

Similar to the “*Move Tool*” of SketchUp, it is possible to snap and merge the end-points of curves and line segments to other vertices under the *Tgi3D Move* Tool by simultaneously pressing and holding the 'Shift' key. If there is a face close to the cursor location the motion is restricted on that face as explained in Section 6.11.; otherwise a close enough vertex is chosen. Snap occurs when you release the mouse button after a green circle with an 'Endpoint' highlight is displayed. The point being moved is merged with the existing vertex.

6.13. Re-sampling Paths

Any smoothly connected set of edges, Bezier curves or Sketchup curves is called a path. The smoothness is determined by the “*Curve crease angle*” option in the Tgi3D settings (see Section 24.1.). Sometimes it may be desirable to get a uniformly sampled path that is made up of same length segments. “*Resample path*” command in the context menu is used for this purpose:

1. Select the curves edges etc to be re-sampled. Re-sampling will be applied to the paths made up of edges without any faces.
2. Right click on the selection select *Resample path* item from the context menu.
3. Enter the desired segment length in the dialog box that will pop-up and press enter.

6.14. Temporarily hiding the drawing

Action: Press and hold the 'W' key

While using the *Tgi3D Move* tool you can temporarily remove the drawing so that fine details are easier to observe in the underlying photo by clicking the 'W' key on the keyboard.

7. Creating and Editing Smooth Surfaces

The lines and curves capture the edges of the objects in the scene, smooth meshes are needed to represent the surfaces bounded by these edges. There also exist various objects corresponding to closed surfaces without any edge boundaries. Tgi3D® SU contains a number of utilities to create and modify meshes representing the surfaces of the objects.

In general, Tgi3D® SU surfaces are made up of smooth surface patches bounded by curves as shown by the blue dotted lines in Figure 4. The nature of the edges on the curves determine the continuity of the surface normals. The patches form smooth transitions across smooth, soft, or hidden curves. The surface can be reshaped by first modifying the control curves and then applying different types of smoothing operators. Depending on the Tgi3D settings the curves on or at the border are kept fixed in smoothing, therefore determine the shape of the surface.

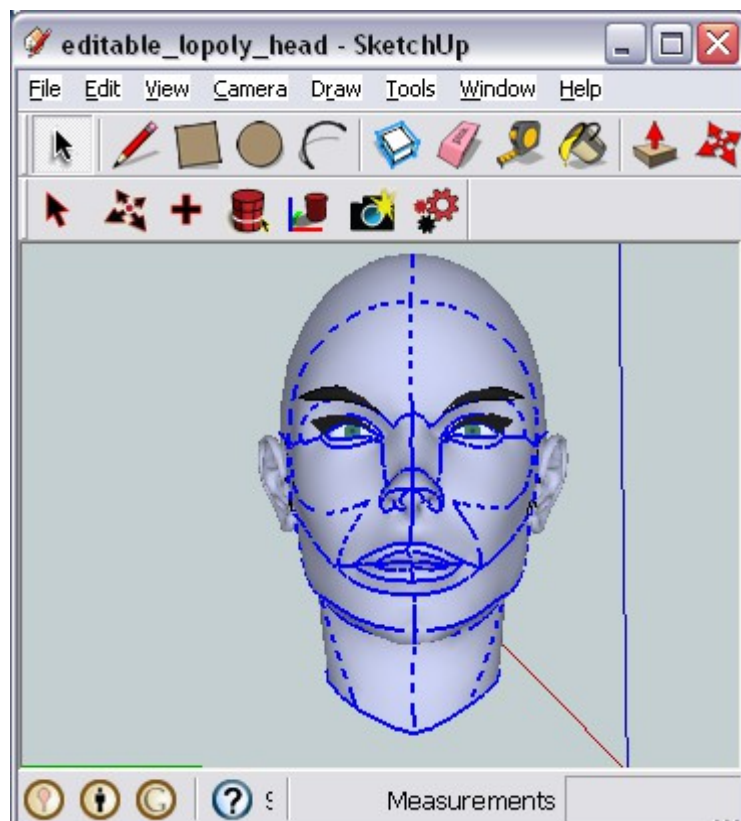


Figure 4: Smooth surfaces and control curves

An alternative method without the curves is employing fixed vertices as control points. The surface is forced to pass through the fixed vertices in smoothing. In mesh creation, the construction points serve the same purpose as there are no vertices to be fixed.

7.1. Creating a surface

To create a surface:

1. Select the boundaries of the surface you want to create. Use the *Tgi3D Select* tool for an easier and faster selection (i.e. Ctrl + Left click on Windows, or alt/option + Left click on Mac) of the boundary.
2. Include construction points, if any, indicating 3D locations from which the surface will pass.

3. Right click on the selection and select *Create Mesh* item from the context menu. Note that you can also access the context menu from the Edit menu of SketchUp.
4. Depending on the selected boundary “Create Mesh Options” dialog may show up to allow you choose the type of surface to be created (see Section 7.10.). Just select the surface type and click OK to continue.

If the boundary has an existing surface and the boundary edges on that surface are smooth, or hidden or softened then the new mesh will form a smooth transition from the existing surface. If the edges are visible edges representing hard boundaries, the smooth transition constraint will be dropped.

The resolution of the mesh is kept proportional to the number of line segments at the boundary.

7.2. Smoothing a surface

To smooth a surface

1. Select the surface to be smoothed. Use the *Tgi3D Select* tool for an easier and faster selection of connected surface regions.
2. Each time you press the 'U' key (*smooth* operation) on the keyboard the smoothness of the surface will be improved

Smoothing operation moves the vertices of the mesh such that the discontinuities or sharp features around the soft/hidden/smoothed edges are minimized. Smoothness optimization process does not try to smooth hard edges (i.e. the edges that are not soft, smooth or hidden). If there are locks on the vertices, those vertices are restricted to their locks. If a vertex is not locked it moves along the vertex normal. Also, fixed vertices are not affected by this operation (i.e. their location is kept constant). Vertices of edges with neighboring unselected faces are treated as fixed. Note if you want to reach to a steady state of the *smooth* surface quickly, you may choose to press 'Shift+U' instead.

Caution: If the selected surface has no constraints (no unselected neighboring faces or no fixed vertices) then the optimally smooth shape is a plane.

7.3. Redistributing the Vertices of a Mesh

Stretching and stressing the control curves or moving the vertices affects the distribution of triangular faces over the surface. It is best to have a close to uniform tiling over the surface. If you wish to redistribute the triangles, just make sure that the vertices in the selection do not have view locks and press 'Y' key (Redistribute and Smooth operation) after selection. This will in general generate a smooth surface with a close to uniform tiling. In this mode, the surface is assumed to be made up of either a stiff or elastic material depending on the option chosen in *Tgi3D Settings*. You can issue the command repeatedly by hitting the 'Y' key or press 'Shift+Y' instead to reach to the steady state of the *redistribution* quickly. The redistribute and smooth operation has a strong smoothing capability; it can iron out deep wrinkles and irregularities on the surface.

Note: In general, one needs to issue a sequence of “Redistribute and Smooth ('Y')” and pure “Smoothing ('U')” commands for shaping a surface.

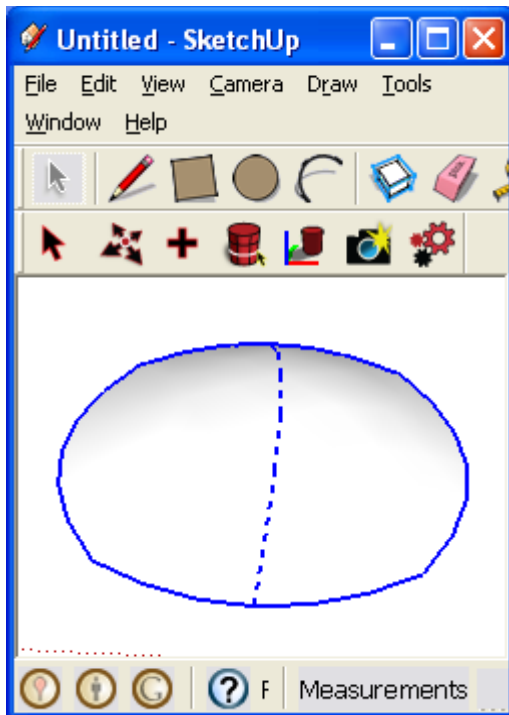
7.4. Changing Surface Shape using Control Curves

If you want to modify the shape of your surface with control curves

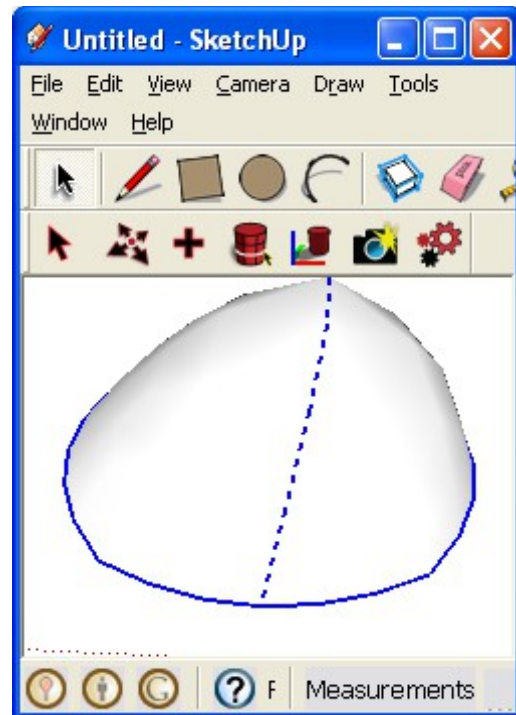
1. Use the *Tgi3D move* tool to edit the curves on or at the boundary of the surface.
2. Select the whole surface. Use the *Tgi3D Select* tool for an easier and faster selection of connected surface regions.
3. Use smoothing commands ('U' or 'Y') keys to get a smooth surface.

A sample surface before and after editing is shown in Figure 5-a and b respectively. The controls curves can be viewed using the *Edit → Select All Curves* command. The behavior of smoothing

depends on the “Assume Bézier curves as fixed” option in Tgi3D settings. If this option is turned off, you need to fix the vertices of your curves explicitly using the “Fix selection” command in the context menu; otherwise the smoothing operation will smooth out the soft curves as if they don't exist.



(a)



(b)

Figure 5: Editing a smooth surface

7.5. Increasing the resolution of a surface

The number of triangles in the mesh can be increased using the *Up-sample* operation.

1. Select the surface where you want to increase the resolution. Use the *Tgi3D Select* tool for an easier and faster selection of connected surface regions.
2. Right click on the selection and select *Upsample* from the context menu. Note that you can also access the context menu from the Edit menu of SketchUp.
3. Set the upsample options in the dialog box (see Section) that will show up and click OK.

Up-sampling basically increases the resolution of the surface by splitting each face in the selection and interpolating the location of new vertices to get a smoother looking surface.

An important feature of the up-sampling operation is the preservation of surface discontinuities marked by hard edges. The hard edges are treated as smooth curves whenever possible during the up-sampling process. The curve crease angle parameter in Tgi3D settings is used to determine the curve the hard edge resides on, if it is not already specified as a Bézier curve.

7.6. Decreasing the resolution of a surface

It is often desirable to minimize the number of faces, vertices and edges on a mesh to save memory and increase processing speed. Tgi3D® SU Plugin comes with a down-sampling utility to decrease the resolution of the mesh surfaces down to a desired quality level. To down-sample

1. Select the surface where you want to decrease the resolution.

2. Right click on the selection and select *Downsample* from the context menu. Note that you can also access the context menu from the Edit menu of SketchUp.
3. Set the downsample options in the dialog box (see Section 7.11.) that will show up and click OK.

7.7. Image-Based Surface Modeling (PhotoScan Only)

Given the photographs and the parameters of the corresponding cameras, it is possible to reconstruct an object using image matching techniques. The basic rule is that the projections of the surface points should match on the corresponding photographs. *Image-Based Surface Modeler* in Tgi3D® SU PhotoScan activates a set of commands for the color matching based reconstruction rule to find the real shape of the surface. To shape surfaces using image content:

1. Create a surface as described in Section 7.1. and select it.
2. Lock vertices of the surface on a photograph where the surface has good visibility (i.e. all selected faces are visible directly).
3. Switch to another photograph with a good view of the surface
4. Activate the Image-Based Surface Modeler tool that will pop-up a new tool bar containing various commands
5. Issue the image matching commands that cause to selected surface to evolve to match the current and locked photograph.

See Section 9. for a detailed guide to using the image-based surface modeler.

Caution: This feature is available in Tgi3D® SU PhotoScan product and only works with the SketchUp files exported by Tgi3D® CT (Tgi3D® SU PhotoScan Calibration Tool).

7.8. Smart surface matching to photographs (i.e. image matching) (PhotoScan Only)

Apart from the Image-Based surface modeler described in Section 7.7. there is also a more primitive image matching utility that works with surfaces close to their real shape in the photographs. To create a surface in 3D to match the photographs:

1. Create a surface as described in Section 7.1.
2. Lock vertices of the surface on a photograph where the surface has good visibility (i.e. all selected faces are visible directly).
3. Select the surface.
4. Switch to another photograph with a good view of the surface
5. Use the Tgi3D Move tool to deform the surface, especially its boundary so that it appears close to its view on the photograph.
6. Make sure *Tgi3D Select* (or *Tgi3D Move*) tool is on
7. Each time you press 'N' key on the keyboard the surface will evolve to match both the the current and locked photograph

Note: If the surface on the current photograph does not improve (i.e. initial surface was not close enough to the final surface), then you can reinitialize the surface with a better match to the photographs (current and locked photographs) by pressing 'Shift+N' on the keyboard.

Note: This is a time consuming operation; too big an area or too many vertices will take a long time to optimize. Soft edges, will resist buckling in this operation so that the final surface is smooth. If you want sharp corners you must leave those edges as hard edges (i.e. no hiding, smoothing, or softening).

Caution: This feature is available in Tgi3D® SU PhotoScan product and only works with SketchUp files exported by Tgi3D® CT (Tgi3D® SU PhotoScan Calibration Tool).

7.9. Entering Angular Constraints

Angular constraint is the desired angle between two face normals connected to a hard edge (no hiding, smoothing, or softening). These constraints are used (and satisfied) in *surface smoothing*, *redistribution* and especially in *Plane Optimization* operations (accessed via 'D' and 'Shift+D' shortcuts). *Plane optimization* operation is used especially when you want to create objects whose faces are all planes, e.g. cubes, cuboids, hexahedrons, tetrahedrons etc. In *plane optimization*, it is advised that you fix a vertex and the other vertices are aligned relative to this vertex.

Move the cursor over an edge that can accept angular constraint (only hard edges with two faces can have angular constraints). To enter an angular constraint:

1. Right click on the highlighted edge to access the context menu
2. Choose change *Angular Constraint...* item in the context menu
3. Enter the desired angle in degrees in the dialog box that shows up and click OK.

Entering '-1' degrees as angular constraint removes existing constraint on the edge.

7.10. Create Mesh Options Dialog Box

If the boundary of the mesh to be created consists of three or four different Bézier curves (see Section 6.), all having compatible number of samples, the “Create Mesh Options” dialog box will show up to allow the user to select the type of surface to be created as shown in Figure 6. You can either choose to create a Bézier surface or just a smooth surface, which is the default type of surface when the Bézier surface creation conditions are not met.

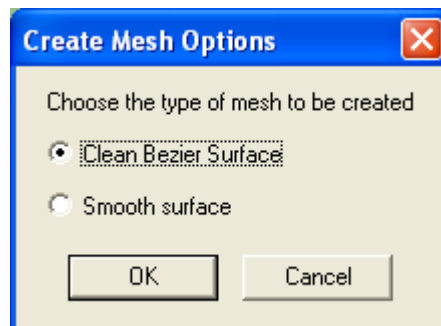


Figure 6: Create mesh options

7.11. Downsample Options Dialog Box

The downsample options determine the visual quality of the output of mesh reduction process. High quality means an output that looks just like the original mesh; however depending on the geometry of the object the reduction in memory requirement of the mesh may not be as low as desired. In that case the quality should be decreased.

The desired output quality can be set directly using the basic downsample options as shown in Figure 7. The desired *quality level* can be set as a number between 0 and 100 using the slider control.

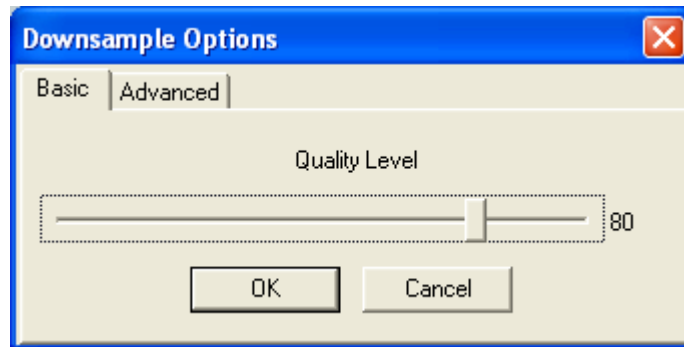


Figure 7: Basic downsample options

In advanced downsample options, the mesh reduction is controlled by setting the maximum allowable surface rotation and displacement as shown in Figure 8. In mesh reduction some of the vertices and the corresponding faces and edges on the mesh are removed. *Allowable surface normal rotation* limits the rotation in face normals after removal. Similarly, *allowable surface displacement* limits the translation in faces.

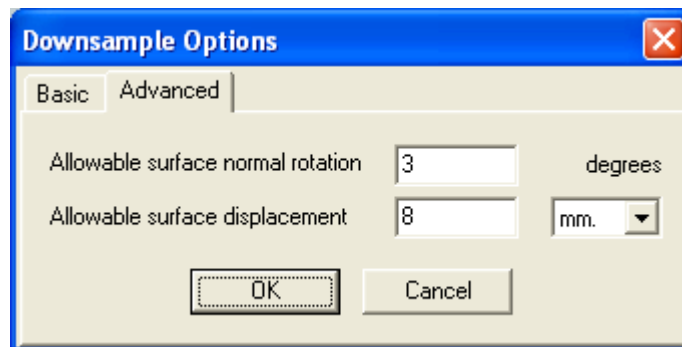


Figure 8: Advanced downsample options

7.12. Upsample Options Dialog Box

Downsample options determine the smoothness of the resulting mesh after upsampling as shown in Figure 9. The upsampling creates a smoother mesh if *extra smoothing* is desired; however depending on the size of the mesh it may take a very long time to smooth the surface.

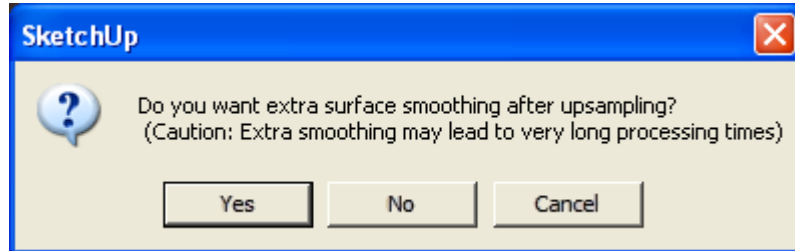


Figure 9: Upsample options

8. Warping Objects

Menu: Tools > Warper

Toolbar icon:



Warper is a Tgi3D tool that help modelers deform the selected surfaces including the ones inside the selected groups and components. Using the warper tool consists of three basic steps:

1. Create a warper, which is basically a bounding box of your selection placed in a new group as shown in Figure 10-(a). The warper group has a default orientation (bounding box in the world coordinates). But you can rotate scale translate and shear (guess using warper or scale tools) it as an ordinary component instance, it will be as if the warper was created in the orientation after the edit.
2. Edit bounding box inside the group as shown in Figure 10-(b) to modify the bounding box. All your edits including scale, rotate, translate etc done inside the component will be reflected to the output. If you use Tgi3D tools in modification a preview of the deformation result is displayed.
3. Finally issue the *Warp* command to apply the transformation of the warper on the corresponding object as shown in Figure 10-(c)

8.1. Creating the Warper

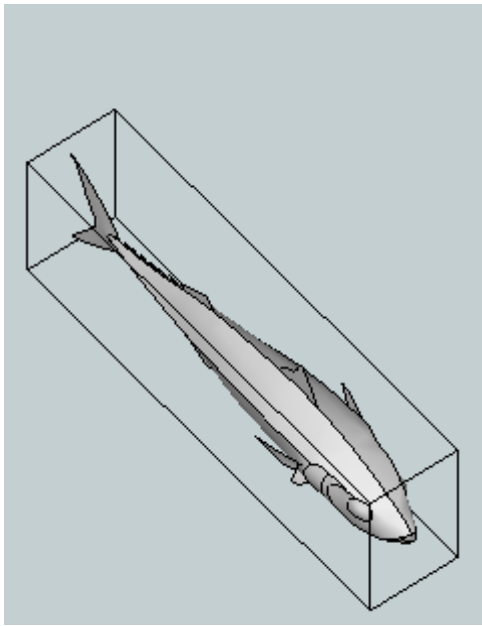
To create a warper

1. Select the surfaces you want to reshape and either
 - a) click on the *Warper* icon in the Tgi3D toolbar, or
 - b) choose the “Create warper” command in the context menu that pops up after right clicking on the selection.
2. Set options for the warper to be created in the dialog box that pops up (see Section 8.4.), then a bounding box will be created around your selection as a new group.
3. Optionally you may want to change the alignment of the bounding box with respect to the selection by rotating, translating or scaling the group.

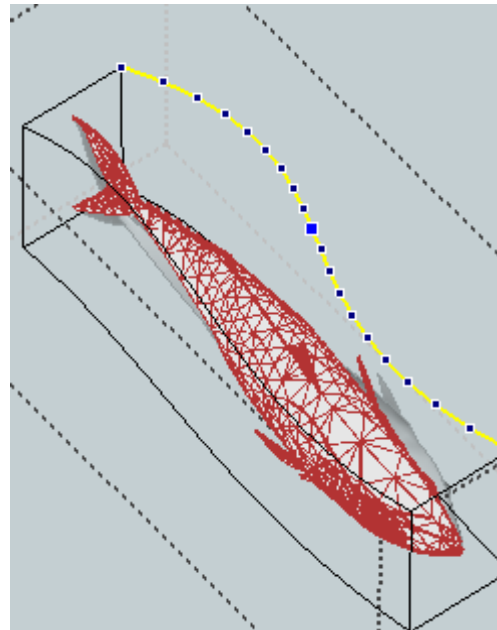
8.2. Editing the Warper

In order to edit the warper

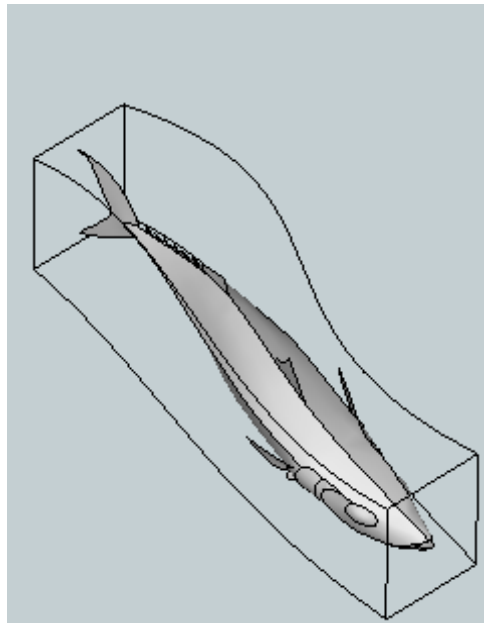
1. Double click or use the “*Edit Group*” command in the context menu to edit the bounding box itself.
2. Edit the edges and vertices of the bounding box using any tool you want. If you use Tgi3D tools and if the *transform* preview option was selected to be on in the warper creation process, you can preview the result of your transformation while editing. **Do not change the connectivity of the bounding box by deleting edges or creating extra connections between the edges or vertices.**
3. Click outside the group or choose the “*Close Group*” command in the context menu when you are finished with editing.



(a)



(b)



(c)

Figure 10: Basic steps of using the warper

8.3. Transforming the object

1. To modify the shape of object(s) corresponding to the warper, select the group and either
 - a) click on the *Warper* icon in the Tgi3D toolbar, or
 - b) choose the *Warp* command in the context menu that pops up after right clicking on the selection.
2. If you want to modify the object(s) further just go on with editing the bounding box. Otherwise you can simply delete it, because the bounding box is valid only for the current

editing session of SketchUp. Even if you save it, it won't be active next time you open the file.

8.4. Warper Options

Warper Options dialog box shows up when the “Create warper” command is issued. It is possible to set the type of transformation to be applied on the SketchUp groups and components in the selection and turn on/off the preview mode as shown in Figure 11.

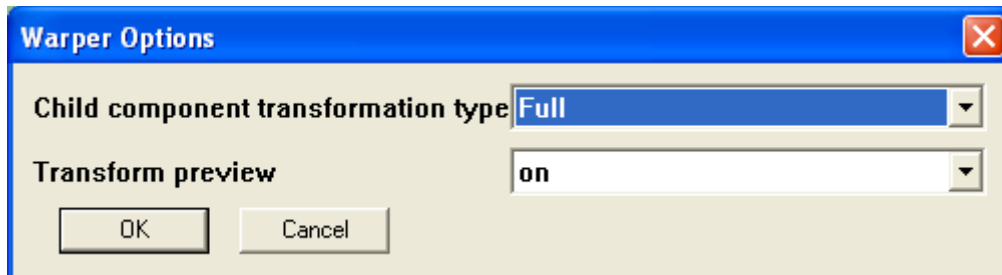


Figure 11: The warper options dialog box

The dialog box contains the following options:

- **Child component transformation type:** These options determine the type of transformation to be applied on the selected components and groups. There are six different options:
 - a. **Full:** The given transformation is applied to the whole hierarchy as if the whole selection were flat. In the process it may have to uniquify instances with more than one instances. This mode is interesting because it leaves the instances intact, enabling smooth edits on large designs despite sketchup performance issue. You can easily warp large designs where you can not even hope to explode and flatten the whole thing. For the other options the hierarchy is preserved.
 - b. **Nothing:** The component (group) instances in the selection are ignored, they are left untouched.
 - c. **Translation:** The instances are translated only with an average amount (as determined from the transformation on the warper)
 - d. **Rigid:** Rotation and translation only (the amounts are approximated to be optimally matching the transformation)
 - e. **Similarity:** Rotation, Translation, and uniform scaling.
 - f. **Affine:** Rotation, Translation, arbitrary scaling, and shear (this is equivalent to the SketchUp component instance transformation matrix).
- **Transform preview:** When the transform preview is turned on and one of the Tgi3D tools are used for editing, the result of the transformation can be previewed instantly. You may want to turn preview off for very large meshes as it may slow down editing.

9. Image-Based Surface Modeling (PhotoScan Only)








Menu: **Tools > Image-Based Surface Modeler**

Toolbar icon: 

Image based surface modeler is a Tgi3D tool that help modelers create free form surfaces that match the images on photomatch-pages. The basic image based surface modeling process consists of the following steps:

1. Create a mesh on one of the photomatch pages facing the surface you want to draw at a right angle. Do not bother about the 3D shape of the mesh, just assume you are creating a 2D mesh over the photograph on the page.
2. Lock the mesh on the current view using the Tgi3D “Lock selection” command.
3. Switch to another photograph facing the surface from a different angle.
4. Choose the Tgi3D image based surface modeler tool, which will pop-up a new toolbar.
5. Use the command buttons on the toolbar for shaping the surface.
6. Check the markers appearing on the mesh that you created. Pure green plus signs indicate successfully matched triangles on the mesh, while red minus signs indicate bad matches. The ones without any signs are neutral. You can also check the quality of the surface from other views. Do not expect to get a good match all over the surface.
7. Depending on your evaluation in Step 6, you can go to Step 5 to issue another match command or stop if you are satisfied with the result. If your previous command resulted in a very low quality surface you can issue an undo command and go to Step 5 to issue another one.

The *Image-Based Surface Modeler Toolbar* contains the following commands:

Toolbar Icon	Menu command
	Tools → Initial Estimate
	Tools → Single-Segment Surface
	Tools → Multi-Segment Surface
	Tools → Refine Estimate
	Tools → Upsample Mesh
	Tools → Flip if necessary
	Tools → Image-Based Surface Modeler Help

9.1. Initial Estimate

Initial estimate is used for reshaping surfaces that are far away from the target surface. You can determine such surfaces by checking the markers on it and its appearance on a view other than the locked one.

If the surface

- a) have all negative (i.e. red) markers on it, or
- b) appears off the target surface on any of the available images, or**
- c) is not connected to another surface that is already shaped correctly,**

you may want to use initial estimate command

Initial estimate command corresponds to a long range search targeting multiple surfaces.

9.2. Single-Segment Surface

Single-segment surface is a smooth surface that you can unfurl using a single sheet of a soft material without any tears; otherwise the surface is called a multi-segment surface. *Single-segment surfaces* do not contain any creases or breaks. A ball or the torso of human body can be considered as a *single-segment surface*, while the whole surface of a cube is a *multi-segment surface* due to vertical creases at the edges of the cube. The total visible surface of an object and another object partially occluding it should also be considered as a *multi-segment surface* due to the breaks, which are discontinuities in space. It is impossible to unfurl two different objects with a single sheet.

Use the single-segment surface command for a surface

- a) that does not contain very sharp creases, an**
- b) that does not contain breaks as in the case of multiple objects.**

Single-segment surface command corresponds to a medium range search targeting a single smooth surface.

9.3. Multi-Segment Surface

Single-segment surface is a smooth surface that you can unfurl using a single sheet of a soft material without any tears; otherwise the surface is called a multi-segment surface. *Single-segment surfaces* do not contain any creases or breaks. A ball or the torso of human body can be considered as a *single-segment surface*, while the whole surface of a cube is a *multi-segment surface* due to vertical creases at the edges of the cube. The total visible surface of an object and another object partially occluding it should also be considered as a *multi-segment surface* due to the breaks, which are discontinuities in space. It is impossible to unfurl two different objects with a single sheet.

Use the multi-segment surface command for a surface

- a) that contains very sharp creases, or**
- b) that contains breaks as in the case of multiple objects.**

Multi-segment surface command corresponds to a medium range search targeting multiple smooth surfaces.

9.4. Refine Estimate

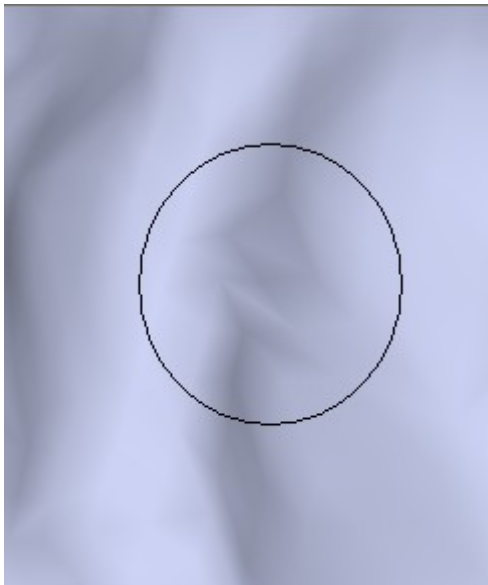
Refine estimate command improves the quality of matching regions on the mesh. It can be used to after obtaining a fairly good estimate of the target surface. It corresponds to a narrow range search to let the mesh adapt to the fine details of the target surface.

9.5. Upsample Mesh

Upsampling increases the resolution of the mesh. It is best to start image-based modeling with low-resolution meshes. Once you get a good estimate of the surface at a low resolution use the *upsample mesh* and *refine estimate* command to obtain a more detailed mesh to represent the target surface.

9.6. Flip if necessary

This command changes the topology of the mesh to capture sharp discontinuities in the surface. The edges are flipped as in the “*Flip Edge*” tool of the *Sandbox Plugin* based on the image matching quality. The effect of flipping is demonstrated in Figure 12. The distortion indicated by the circle in Figure 12-a is removed after executing the *Flip if necessary* command as shown in Figure 12-b.



(a)



(b)

Figure 12: The effect of flipping on the quality of the model

9.7. Image-Based Surface Modeler Help

This command pops up a window that displays detailed information about the image-based surface modeler.

10. Editing Extrusions

The Push/Pull tool in SketchUp help creating solid objects instantly from planar faces. Tgi3D® SU includes a “Cross Section” tool for scaling and translating the cross sections of these extrusions. It becomes possible to model a wide range of objects (e.g. wine glass, pipes, trees ... etc.) using cross section editing.

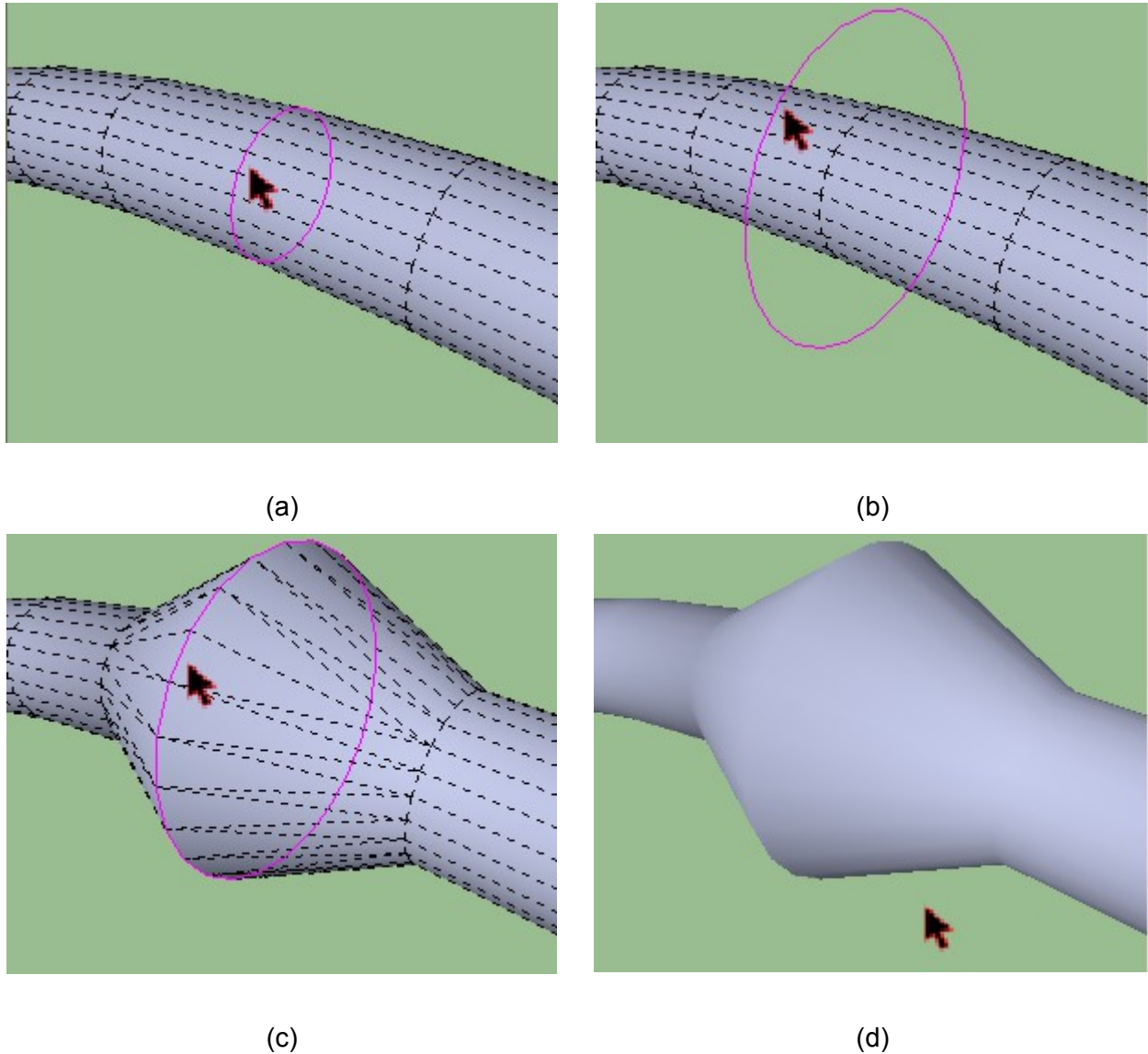


Figure 13: Cross section tool in action

The operation of Cross Section Tool is demonstrated in Figure 13. Inside this tool when you move the cursor on a cross section of an extrusion, the cross section that will be affected will be highlighted (see Figure 13-a) (it is strongly advised that *View > Hidden Geometry* option of SketchUp is checked). If you perform a drag operation (hold the left mouse button and move the cursor) the cross section expands or contracts, following the cursor (see Figure 13-b). When the dragging is finished the extrusion is reshaped to fit the new cross section (see Figure 13-c). Figure 13-d shows the result with the *View > Hidden Geometry* option of SketchUp is unchecked.

10.1. Types of Cross Section transformations

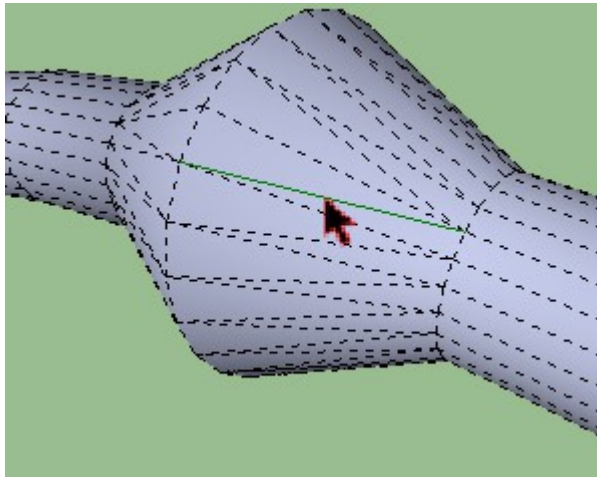
Depending on the key modifier there three types of transformations applied on the cross section:

1. **No Modifier:** The cross section is expanded or shrunk. The expand and shrink method can be chosen from *Tgi3D Settings* between scale and offset (default is scale).
2. **Shift Modifier:** Translate the selected cross section longitudinally.
3. **Ctrl Modifier:** Translate the selected cross section transversely. (**Windows**)
alt/option Modifier: Translate the selected cross section transversely. (**Mac**)

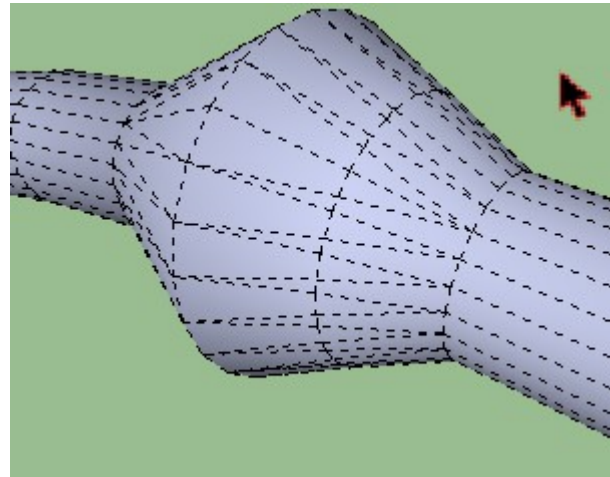
10.2. Creating a cross section

Action: Double click with left mouse button

When this tool is selected as you move the cursor on an edge, it is highlighted in green (see Figure 14-a) if it is possible to create a cross section crossing that edge. Than you can create a new cross section crossing the highlighted edge at the cursor location by a left double-click (see Figure 14-b).



(a)

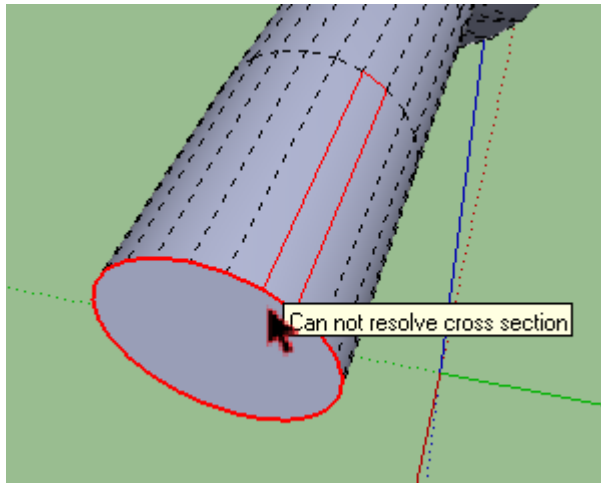


(b)

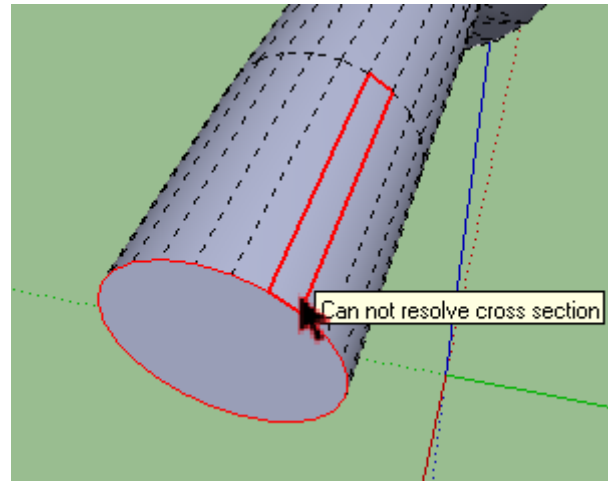
Figure 14: Creating a new cross section

10.3. Confusions in cross section resolution

The *Cross Section* tool resolves the cross section automatically. A cross section should be a closed planar contour passing through the edge pointed by the cursor. When the tool can not resolve the cross section uniquely, it highlights the possibilities in red as shown Figures 15-a and 15-b. Depending on the mouse cursor location one them will be selected and displayed with a thicker highlight. For example in Figure 15-a the circular cross section is selected as the mouse cursor points to its face. In case of confusions, just hover the mouse over the sides of highlighted cross sections to select the correct one and go on with the operation as if a single cross section is highlighted.



(a)



(b)

Figure 15: Confusions in cross-section resolution

11. Creating and Mapping Textures

SketchUp has a number of utilities such as “*Project photo*”, “*Position Texture Tool*”, and “*Make Unique Texture*” commands to apply textures on surfaces; but they are not practical or satisfactory to be used on smooth organic shapes made up of large number of faces. Tgi3D® SU Plugin comes with a much more practical “*Create Texture...*” utility to apply texture over smooth surfaces.

Given a selection of faces, “*Create Texture...*” utility creates a texture map and a texture image. If there is already a texture applied on any part of the selection, it is preserved in the new texture image. Preserving the existing texture helps avoid discontinuities in the texture. Once the texture image is created one can edit the image using the “*Edit Texture Image*” command in SketchUp.

11.1. Applying texture on a selected region

In order to apply texture on a selected region

1. Select the surface to be textured. Use the *Tgi3D Select* tool for an easier and faster selection of connected surface regions.
2. Right click on the selection.
3. Select “Create Texture...” command in the context menu.
4. Set the desired “Create Texture Options” in the dialog box (see Section 11.4. for details) that shows up and press OK.

The create texture command will create a material with a texture image and apply it on the selection. You may assign a name to the material in the Create Texture Options dialog box (see Section 11.4. for details) to find and edit the material later in the “*Material Browser*” window of SketchUp.

The crucial parameter of texture creation is the texture mapping method. You may choose the method by trial and error. If none of the texture mapping methods produce satisfactory results, narrow down your selection and try again. There are currently three methods of texture mapping: Unwrap, Spherical and Planar.

- 1) **Unwrap** method tries to map the geometry with no distortion. Unwrap method works best when you can flatten the selected surface without any tears. If it has to place tears, it does not quite know where best to place them. You can indeed select chunks of mesh and texture piece by piece.
- 2) **Spherical** mapping on the other hand may introduce stretching distortions due to the non-linearity of the transformation. Similar to the unwrapping method the only way to minimize the distortions is to manually tear the surface and texture it piece by piece.
- 3) **Planar** method maps the selected faces to the most common plane in the selection (i.e., the plane with the largest total area). This feature is especially useful for architectural applications. If the faces already have mapped textures (e.g. via “Project photo”), then this feature basically provides a rectified photograph (or orthophoto feature) without perspective distortion.

We would like to point out here that in either spherical or unwrap mode, the selected part of the mesh can be already textured, then the newly created texture will seamlessly merge with the existing texture. This is especially useful when you have to texture the whole mesh in chunks. This way you can edit your textures to be seamless between chunks. You can even repair existing texture seams using this feature

11.2. Editing the created texture

In order to edit the texture that is created by the “*Create Texture...*” command

1. Go to the “*Material Browser*” of SketchUp. You can use the “*Paint Bucket Tool*” (Press B as a short cut) to easily access the *Material Browser*. In order to view the textures available in the model, you need to
(Windows) Click on the “Select” tab and select “In Model” item from the listbox menu.
(Mac) Click on the “Texture Palettes” icon (top rightmost icon) and select “Colors In Model” item from the listbox menu.
2. Find the material that is just created by the create texture command. Assigning a name to the material in the Create Texture Options dialog box (see Section 11.4. for details) may help you to find the material easily.
3. Use the “Edit Texture” command as shown in Figure 16 to load and edit the texture image in your image editor. The default image editor can be set in the SketchUp's “*System Preferences*” dialog (can be accessed via Window > Preferences menu item) as shown in Figure 17 (Note: we recommend you to use layer based image editors).
4. When you close the editor SketchUp automatically refreshes the material using the edited texture image (Note: SketchUp's automatically refreshing of the texture may take a long time on Mac OS X systems).

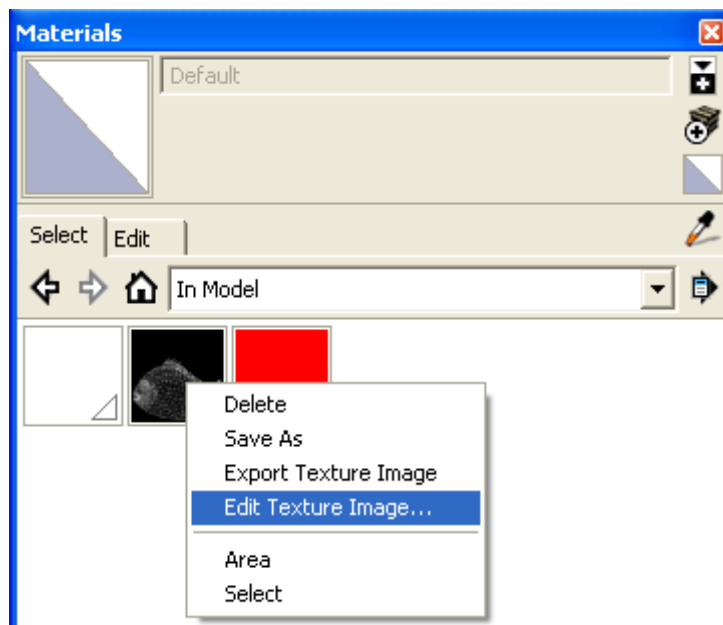


Figure 16: Editing texture image in SketchUp

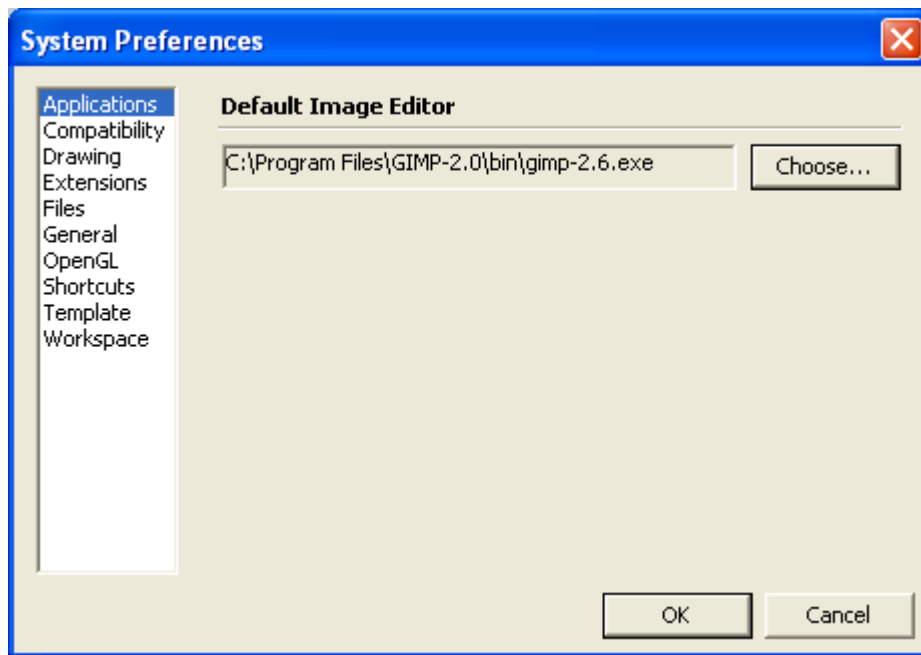


Figure 17: The SketchUp preferences window for setting the default image editor

11.3. Applying texture on the whole surface of an object

In order to apply texture to the whole surface an object you need to

1. Select a region to be textured on the object surface. If the region has already textured neighbors, include those faces in your selection.
2. Create a texture using the procedure given in Section 11.1.
3. Edit the texture using the procedure given in Section 11.2. As the neighboring textures are preserved in the new texture it becomes possible to preserve continuity in editing.
4. Go to Step 1 if there is an untextured region on the object.

11.4. Create Texture Options Dialog Box

Create Texture Options dialog box shows up when the “Create Texture...” command is issued. It is possible to set the image attributes, texture mapping method, and the target of the texture in this dialog box as shown in Figure 18.

The dialog box contains the following options:

- **Material Name:** This field determines the name of the material that will be created. If it is left blank, a random material name is assigned.
- **Image width:** The width of the texture image in pixels
- **Image height:** The height of the texture image in pixels
- **Apply to:** The texture material is applied on the front, back or both sides of the selected surface depending on the value of this option.
- **Mapping method:** This options determines the texture coordinates of the surface elements in the image. Texture mapping requires mapping the selected surface to a 2D plane without any overlaps, which can be a very complex even an impossible process depending on the topology of the selected surface. There are two choices for the mapping:

- **Unwrap:** The surface is unwrapped (or ironed out) to a plane. The surface can be torn if necessary to avoid faces having overlapping mapping regions on the texture image. Tearing the surface creates discontinuities, which may be undesirable. The surface should be a single connected region for the unwrapping method to work.
- **Spherical:** The selection is first mapped to a sphere. It is guaranteed to be a continuous mapping without any tearing but depending on the coverage of the sphere the mapping can produce highly stretched texture maps.
- **Planar:** The selection is mapped to the most common plane in the selection (i.e., the plane with the largest total area). This feature is especially useful for architectural applications.

The methods are not guaranteed to work on an arbitrary selection. If none of the methods produce satisfactory results you need to narrow down your selection and try again.

- **Output format:** This option determined the format of the texture image. You can choose JPEG image (jpg) or PNG image (png) as the output format. The PNG format is required if you want to assign variable transparency over the texture image.
- **Create UV Map:** The texture mapping itself is saved as a separate material if this options is set to “yes”. The mapping is represented with an image made up of the boundaries of faces in the selection. It can be used as a guiding layer in drawing your texture image.

Note: Selecting “no” will not have any effect if there is no existing image texture on the selected faces. In that case, the UV map will be always drawn on the created texture image.

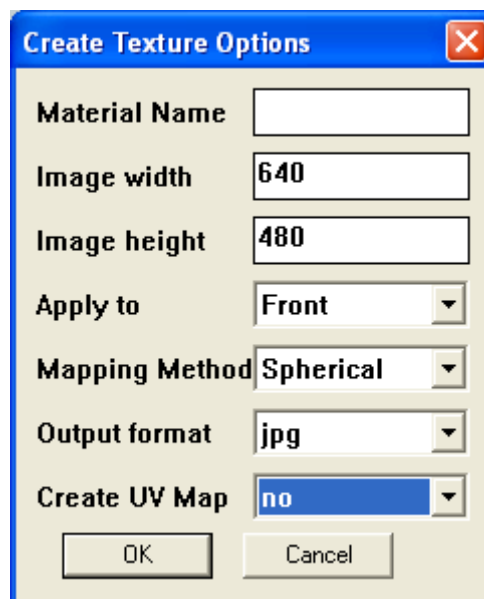


Figure 18: The Create Texture Options dialog box.

11.5. Safeguarding texture maps

When applied to a textured surface, many tools of SketchUp such as the Move or Scale tools distort the texture map in an unpredictable way. It becomes difficult to edit already textured images under SketchUp. Therefore Tgi3D provides safeguard and restore utilities to preserve the texture maps. In order to safeguard texture maps:

1. Select the textured faces to be safeguarded. Use the *Tgi3D Select* tool for an easier and faster selection of connected surface regions.
2. Right click on the selection.
3. Select “Safeguard Texture map” command in the context menu.

In order to restore texture maps:

1. Right click on any part of the model to access the context menu.
2. Select “Restore texture map” command to restore all of the safeguarded texture maps.

When the safeguarded texture maps are restored the safeguarding is removed as well.

12. Transporting Model to a New Calibration (PhotoScan Only)

In general, camera calibration is an iterative process and the camera calibrations are improved either by adding more calibration points and/or adding new cameras. Suppose that you improved your previous camera calibrations using Tgi3D CT and export the new calibrations to a new SketchUp (SKP) file. In order to transport your previous drawings to the new Sketchup file with the improved camera calibrations, please follow the following six steps.

1. Open both the old SKP file which contains your previous drawings and the new SKP file with the new camera calibrations in Sketchup.
2. In the old SKP file, select the drawings you want to transport to the new SKP file and activate the "Group to transport" command via the context menu, "*Other Tgi3D Utilities > Group to transport*" or the "*Plugins*" menu, "*Plugins > Tgi3D > Transport > Group to transport*". This command will produce a selected group from the selected entities, which is ready for transportation.
3. In the old SKP file, copy the selected group, which is created in Step 2, via the "*Edit*" menu, "*Edit > Copy*".
4. Switch to the new SKP file and paste the copied group in place, via the "*Edit*" menu, "*Edit > Paste In Place*".
5. In the new SKP file, select the newly transported group and activate the "Ungroup from transport" command via the context menu, "*Other Tgi3D Utilities > Ungroup from transport*" or the "*Plugins*" menu, "*Plugins > Tgi3D > Transport > Ungroup from transport*". This command will transform the selected group to fit into the new calibration and explode the group making the entities available to the user. You can now save the new SKP file to contain the previous drawings.
6. Close the old SKP file (preferably without saving).

At the end of this six-step process the previous drawings should have been transported to the new calibration successfully and are ready for further modifications.

13. Terrain Operations

Tgi3D SU plugin includes a number of helper features that can be used in terrain-based designs.

13.1. Terrain Mapping

It is sometimes desirable to build complex models such as cities or parks over terrains; however building the model directly on the terrain can be very difficult due to its non-planar nature. Terrain mapping allows one to build the model over the ground plane then map it to the terrain.

In order to use the terrain mapping functionality first you need to mark the terrain to be used in mapping:

1. Select the mesh representing the terrain.
2. Right click on the selection.
3. Select “Set Target Terrain” command in the context menu.

The target terrain will be hold fixed for the following mapping operations. To map your model to the target terrain;

After building your model over the ground plane

1. Select your model.
2. Right click on the selection.
3. Select “Map to terrain command” command in the context menu.
4. Set the options in the terrain mapping options dialog box shown below in Figure 19 and press the “OK” button.

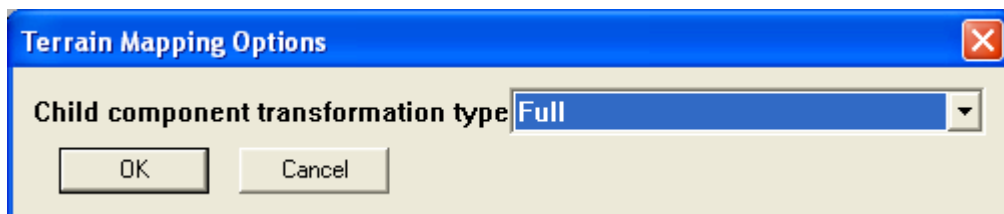


Figure 19: Terrain mapping options dialog-box.

The terrain Mapping Options dialog box contains a “Child component transformation type” option that determines the type of mapping transformation to be applied on the selected components and groups. There are four different options:

- a. **Full:** The mapping is applied to the whole hierarchy as if the whole selection were flat. In the process it may have to unquify group or components with more than one instance. For the other options the hierarchy is preserved.
- b. **Translation:** The instances are translated only with an average amount (as determined from mapping)
- c. **Rigid:** Rotation and translation only (the amounts are approximated to be optimally matching the mapping transformation)
- d. **Affine:** Rotation, Translation, arbitrary scaling, and shear (this is equivalent to the SketchUp component instance transformation matrix).

13.2. Channel Extrusion

Extrusion operation is a powerful tool for creating 3D objects. There are various forms of extrusions available in SketchUp or in other SketchUp plugins. Channel extrusion refers to a special type of extrusion that can be used in terrain operations such as road or channel creation over the terrain. Channel extrusion extrudes a set of edges or curves over a preselected path of edges without changing their alignment with respect to ground plane (i.e. red-green plane) of SketchUp.

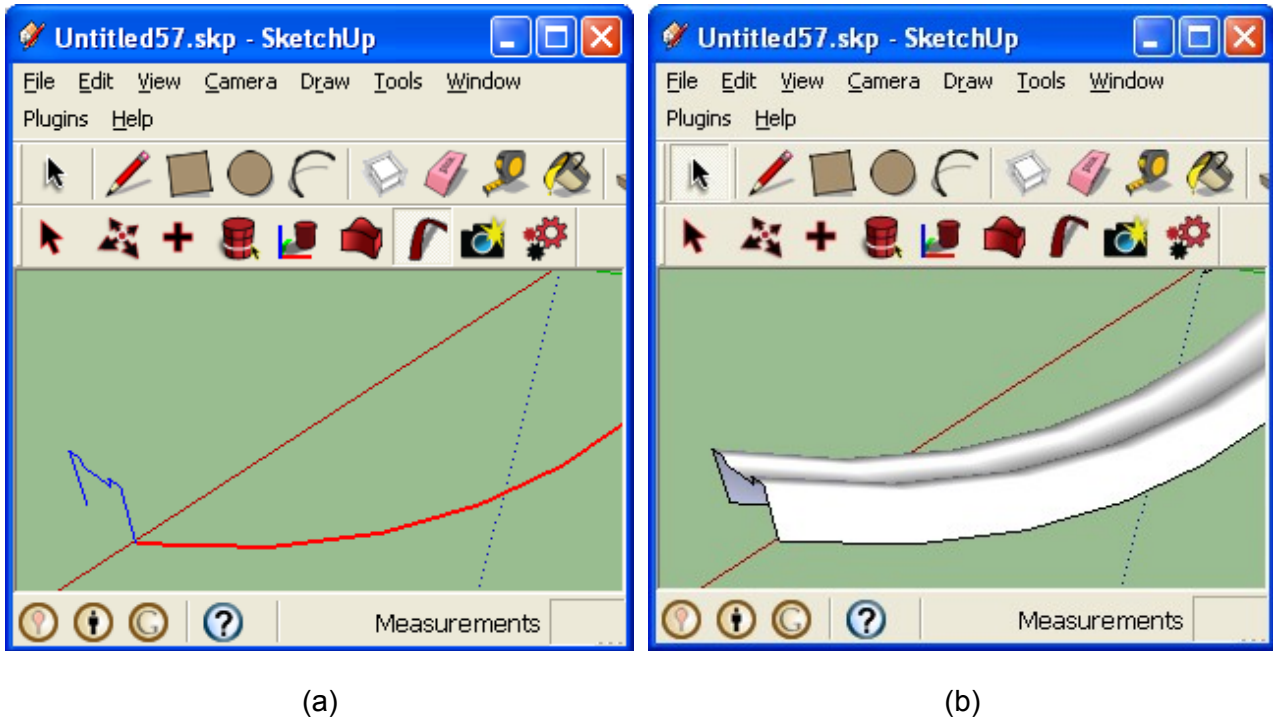


Figure 20: Operation of channel extrusion tool

To use the channel extrusion tool

1. Select the path along which the extrusion will be performed. A singly connected set of edges should be selected.
2. Click the “Channel Extrude” icon on the toolbar (see Section 2.2. and 20.) The selected path will turn red when the tool is activated as shown in Figure 20-a.
3. Select the profile to be extruded by clicking on it. To make multiple selections, press the Shift key before selection and do not release it until all the edges to be extruded are selected.
4. The result of extruding the selected profile shown in Figure 20-a along the preselected path in red color is shown in Figure 20-b.

14. Tgi3D Select Tool

Menu: Tools > Tgi3D Select

Toolbar icon:



This tool provides additional selection capabilities for mesh based operations to SketchUp's own select tool.

14.1. *Selecting a face and its edges*

Action: Click left mouse button

Position the cursor over the face to be selected and click the left mouse button.

14.2. *Selecting multiple faces*

You can select multiple faces in two ways using *Tgi3D Select* tool:

1. Position the cursor over each face and click the left mouse button one by one

or,

2. Drag the mouse over multiple faces while holding down the left mouse button.

14.3. *Tagging faces*

Tgi3D® SU Plugin allows the user assign tags to the faces. The faces with the same tag can be selected with a single double-click by the Tgi3D selection tool.

To assign tags to the faces:

1. Select the faces to be tagged
2. Right click on the selection
3. Choose "Tag faces" command in the context menu

To clear tags of the faces:

1. Select the faces to be untagged
2. Right click on the selection
3. Choose "Untag faces" command in the context menu

14.4. *Bounded selection*

Action: Left mouse double click (on a face)

Double clicking the left mouse button on a face without a tag, starts selecting all the faces (and edges) physically connected to that face until a boundary (e.g. hard edge) is reached.

If the first face is tagged, all the neighboring faces with the same tag are selected.

14.5. Incremental Bounded selection

Action: (Windows) Ctrl + Left mouse double click (on a face)

(Mac) alt/option + Left mouse double click (on a face)

The operation is similar to bounded selection (see Section 14.4.). The difference is the behavior on an existing selection. The existing selection is not cleared. If the first face does not have a tag the new selection stops at a previously selected face or edge or a boundary edge for faces.

If the first face is tagged, all the neighboring faces with the same tag are selected.

14.6. Selecting the boundaries and curves on a surface

Action: (Windows) Ctrl + Left mouse click (on an edge)

(Mac) alt/option + Left mouse click (on an edge)

If you press and hold the 'Ctrl' key ('alt/option' key on Mac) and click the left mouse button

1. **On a boundary edge:** The selection expands until a bifurcation (of boundary edges) is encountered.
2. **On a hard edge inside surface:** The selection expands until a boundary or a bifurcation (of hard edges) is encountered.
3. **On a curve edge inside surface:** The selection expands until the whole curve is selected. A curve edge will be highlighted in yellow color when the cursor is over it.
4. **On a soft edge inside surface:** The selection expands until a boundary, a hard edge or a bifurcation (when all crease angles are higher than 33° degrees) is encountered.

Note: A boundary edge is defined as edge with less than two faces.

14.7. De-selecting faces and their edges

Action: Shift + Left mouse click (on a face)

To deselect a face that has already been selected:

1. Position the cursor over a face that has already been selected
2. Press and hold the 'Shift' key and click the left mouse button

To deselect multiple faces:

1. Press and hold the 'Shift' key and the left mouse button while dragging the cursor over the faces to be deselected.

14.8. Bounded deselection

Action: Shift + Left mouse double click (on a face)

Holding the 'Shift' key and double clicking the left mouse button on a selecting face without a tag, starts deselecting all the faces (and edges) physically connected to that face until a boundary (e.g. hard edge or a unselected face) is reached.

If the first face is tagged, all the neighboring faces with the same tag are deselected.

14.9. Deselecting the boundaries and curves on a surface

Action: (Windows) Ctrl + Shift + Left mouse click (or Shift + Left mouse click)

(Mac) alt/option + Shift + Left mouse click (or Shift + Left mouse click)

If you press and hold the 'Ctrl+Shift' key ('alt/option'+Shift key on Mac) and click the left mouse button on a selected edge on a surface, the de-selection expands until a bifurcation inside selection is encountered as explained in Section 14.6.

Deselection also works with a 'Shift + Left mouse click' combination if there is no selected face on that edge, otherwise selected face will be deselected.

Note: A boundary edge is defined as edge with less than two faces.

15. Tgi3D Move Tool

Menu: Tools > Tgi3D Move

Toolbar icon:



Tgi3D Move tool allows you to move the vertices of a line or curve under the view-lock constraint, or on a face or along the image plane of the active view. This way you can stress or stretch curves as desired or to fit the underlying photograph. It has a different behavior than the SketchUp move tool.

Tgi3D Move tool applies Tgi3D specific constraints to the motion of the entity begin moved:

1. If the entity has a view-lock, the tool applies the view-lock constraints in motion so that its appearance on the locked view does not change.
2. If there is no view-lock constraint on the entity begin moved and the 'Shift' key is not pressed then it is moved freely on a plane parallel to the current view and passes through the entity. This motion helps alignment over an image.
3. The 'Shift' modifier restrains the motion to the face-plane close to the entity being moved (see Section 6.11. for an example).
4. The 'Ctrl' modifier causes the entities being moved to be converted to a Bézier curve if possible before motion (see Section 6.1.).

When you move the cursor over to a vertex in Tgi3D move tool, the vertex changes color and shape to show its lock and fix status (see Section 5.and Table 1).

16. Construction Point Tool

Menu: Tools > Construction Point

Toolbar icon:



Construction points are SketchUp entities that provide guidance in drawing. *Tgi3D Move* tool and the locking mechanism applies to these points as well. The calibration points used in Tgi3D® CT are exported as construction points to help drawing already aligned boundaries using SketchUp tools. As there is no tool to directly create construction points in SketchUp, Tgi3D® SU has a simple tool for creating construction points.

To draw a construction point

1. Choose *Tgi3D Construction Point* tool from the tools menu or the toolbar.
2. Left click on the desired position. The depth will be assigned by SketchUp using coincident geometry (i.e. if there is a plane/face the point will be placed on the face, if it is close to an edge the point will be on that edge etc).

17. Cross Section Tool

Menu: Tools > Cross Section

Toolbar icon:



Cross section editing tool enables you to efficiently edit cross sections of extrusions (see Section 9. for details). Inside this tool when you move the cursor on a cross section of an extrusion, the cross section that will be affected will be highlighted in magenta. When the left mouse button is clicked down and dragged the cross section is transformed in a way determined by the key modifier.

There are three types of transformations applied on the cross section, depending on the key modifier

1. **No Modifier:** The cross section is expanded or shrinked. The expand and shrink method can be chosen from *Tgi3D Settings* dialog (see Section 24.) as scale or offset (default is scale).
2. **Shift Modifier:** Translate the selected cross section longitudinally.
3. **Ctrl Modifier:** Translate the selected cross section transversely. (**Windows**)
alt/option Modifier: Translate the selected cross section transversely. (**Mac**)

Double clicking with left mouse button on an edge highlighted in green, creates a new cross section on the extrusion passing through the point specified by the mouse cursor.

18. Set World Coordinates Tool

Menu: Tools > Set World Coordinates

Toolbar icon:



You can use *Set World Coordinates* tool to change the world coordinate system so that the cameras and the reconstructed objects lie over the ground plane and cast shadows correctly (see Section 4.). The tool works similar to the *Axes* tool of SkeethUp.

19. Warper Tool

Menu: Tools > Warper

Toolbar icon:



Warper is a Tgi3D tool that help modelers deform the selected surfaces including the ones inside the selected groups and components. See Section 8. for details.

20. Channel Extrude Tool

Menu: Tools > Channel Extrude

Toolbar icon:



Channel Extrude tool extrudes selected edges along a preselected connected path of edges. The extrusion is constrained so that the alignment of the extruded edges with respect to the ground plane does not change. See Section 13.2. for details.

21. Image-Based Surface Modeler Tool (PhotoScan Only)








Menu: Tools > Image-Based Surface Modeler

Toolbar icon: 

Image based surface modeler is a Tgi3D tool that help modelers create free form surfaces that match the images on photomatch-pages. (see Section 9. for details of image-based surface modeling). The tool pops up *Image-Based Surface Modeler* toolbar shown below:



The *Image-Based Surface Modeler* toolbar contains the following commands:

Toolbar Icon	Menu command
	Tools > Initial Estimate
	Tools > Single-Segment Surface
	Tools > Multi-Segment Surface
	Tools > Refine Estimate
	Tools > Upsample Mesh
	Tools > Flip if necessary
	Tools > Image-Based Surface Modeler Help

22. Tgi3D® SU Menu Items

The Tgi3D® SU menu items appear within the related Google SketchUp menus and the Tgi3D® SU tools appear as a group on the Tgi3D toolbar (see Figure 1).

22.1. *Select all Curves*

Navigation: Edit > Select all Curves

This menu item selects all the Bézier curves created by Tgi3D® SU in the model. It is useful for viewing the curves on a surface.

22.2. *Update Tgi3D page axes*

Navigation: Tools > Update Tgi3D page axes

This menu item sets the world coordinate axes (The red, green, blue axes of SketchUp) of the photo match pages to the current one.

22.3. *Purge Photos and Locks*

Navigation: Edit > Purge Photos and Locks

This menu item removes the photographs and locks from the current project to reduce the file size after the 3D model has been built to desired specifications.

22.4. *Tgi3D Settings*

Navigation: Edit > Tgi3D Settings

This menu item launches the *Tgi3D Settings* dialog box (see Section 24.)

22.5. *Tgi3D Select*

Navigation: Tools > Tgi3D Select

This menu item activates the *Tgi3D Select* tool. The *Tgi3D Select* tool icon on the toolbar will appear as pressed when this menu item is clicked.

22.6. *Tgi3D Move*

Navigation: Tools > Tgi3D Move

This menu item activates the *Tgi3D Move* tool. The *Tgi3D Move* tool icon on the toolbar will appear as pressed when this menu item is clicked.

22.7. *Construction point*

Navigation: Tools > Construction point

This menu item activates the Tgi3D Construction point Tool. The Tgi3D Construction point tool icon on the toolbar will appear as pressed when this menu item is clicked.

22.8. *Cross Section*

Navigation: Tools > Cross Section

This menu item activates the *Tgi3D Cross Section* tool. The *Tgi3D Cross Section* tool icon on the toolbar will appear as pressed when this menu item is clicked.

22.9. Set World Coordinates

Navigation: *Tools > Set World Coordinates*

This menu item activates the *Tgi3D Set world coordinates* tool. The *Set world coordinates* tool icon on the toolbar will appear as pressed when this menu item is clicked. See Section 4. for details.

22.10. Warper

Navigation: *Tools > Warper*

This menu item issues *Create warper* or *Warp* commands depending on the selection. See Section 8. for details.

22.11. Image-Based Surface Modeler

Navigation: *Tools > Image-Based Surface Modeler*

This menu item activates the *Image-Based Surface Modeler tool* (see Section 9.). The *Image-Based Surface Modeler* tool icon on the toolbar will appear as pressed when this menu item is clicked.

22.12. Initial Estimate

Navigation: *Tools > Initial Estimate*

This menu item issues the *Initial Estimate* command of *Image-Based Surface Modeler* tool (see Section 9.). The *Image-Based Surface Modeler* tool icon on the toolbar will appear as pressed when this menu item is clicked.

22.13. Single-Segment Surface

Navigation: *Tools > Single-Segment Surface*

This menu item issues the *Single-Segment Surface* command of *Image-Based Surface Modeler* tool (see Section 9.). The *Image-Based Surface Modeler* tool icon on the toolbar will appear as pressed when this menu item is clicked.

22.14. Multi-Segment Surface

Navigation: *Tools > Multi-Segment Surface*

This menu item issues the *Multi-Segment Surface* command of *Image-Based Surface Modeler* tool (see Section 9.). The *Image-Based Surface Modeler* tool icon on the toolbar will appear as pressed when this menu item is clicked.

22.15. Refine Estimate

Navigation: *Tools > Refine Estimate*

This menu item issues the *Refine Estimate* command of *Image-Based Surface Modeler* tool (see Section 9.). The *Image-Based Surface Modeler* tool icon on the toolbar will appear as pressed when this menu item is clicked.

22.16. Upsample Mesh

Navigation: *Tools > Upsample Mesh*

This menu item issues the *Upsample Mesh* command of the *Image-Based Surface Modeler* tool (see Section 9.). The *Image-Based Surface Modeler* tool icon on the toolbar will appear as pressed when this menu item is clicked.

22.17. Flip if necessary

Navigation: *Tools > Flip if necessary*

This menu item issues the *Flip idf necessary* command of the *Image-Based Surface Modeler* tool (see Section 9.). The *Image-Based Surface Modeler* tool icon on the toolbar will appear as pressed when this menu item is clicked.

22.18. Image-Based Surface Modeler Help

Navigation: *Tools > Image-Based Surface Modeler Help*

This menu item pops up a window that displays detailed information about the *Image-Based Surface Modeler* tool (see Section 9.). The *Image-Based Surface Modeler* tool icon on the toolbar will appear as pressed when this menu item is clicked.

22.19. Check for Tgi3D Updates

Navigation: *Help > Check for Tgi3D updates*

This menu item checks the Tgi3D servers to see if there is an update of the product.

22.20. About Tgi3D

Navigation: *Help > About Tgi3D*

The *About Tgi3D* menu item launches the Tgi3D splash screen, which displays information about the version of the program, licensing and copyrights.

22.21. Import Tgi3D Calibration...

Navigation: *Plugins > Tgi3D > Utils > Import Tgi3D Calibration...*

This menu item imports the files exported by Tgi3D® CT prior to version 1.16. You do not need this menu item if you have Tgi3D CT version 1.16 or higher.

22.22. Group to transport

Navigation: *Plugins > Tgi3D > Transport > Group to transport*

See Section 12. for more details.

22.23. Ungroup to transport

Navigation: *Plugins > Tgi3D > Transport > Ungroup from transport*

See Section 12. for more details.

23. Context Menu Items

The following are the list of Tgi3D items that appear in the context menu when you right click on a selected entity. The context menu contains all of the commands available to manipulate the currently selected entity. The contents of the context menu changes depending on the entity that has been selected.

You can also access the context menu via the entity commands sub menu (which changes its name depending on the entity that has been selected) under SketchUp's Edit menu.

23.1. Lock selection

This item locks all the vertices in the selection set with respect to the current view. A view-lock ensures that the locked vertex can be moved in other views only in such a way that its position in the original view does not change. See Sections 2., 5. and 15. for more information on view-locking.

23.2. Unlock selection

This item unlocks all the entities in the selection set.

23.3. Lock curve

This item locks the Bézier curve (see sections 6. and 5.2.) highlighted by the Tgi3D move tool with respect to the current view. A view-lock ensures that the locked vertex can be moved in other views only in such a way that its position in the original view does not change. See Sections 2., 5. and 15. for more information on view-locking.

23.4. Unlock curve

This item unlocks the curve highlighted by the Tgi3D move tool.

23.5. Lock single vertex

This item locks the vertex highlighted by the Tgi3D move tool with respect to the current view. A view-lock ensures that the locked vertex can be moved in other views only in such a way that its position in the original view does not change. See Sections 2., 5. and 15. for more information on view-locking.

23.6. Unlock single vertex

This item unlocks the vertex highlighted by the Tgi3D move tool.

23.7. Fix selection

This item marks all the vertices in the selection set as fixed so that the surface smoothing operation does not move these vertices. Fixed vertices are displayed as triangles under the focus of the Tgi3D Move Tool cursor.

23.8. Unfix selection

This item removes the fix on all the vertices in the selection set.

23.9. Convert to Bézier curve

Convert the polylines (including a single line segment) in the selection to Bézier curves.

23.10. Resample Bézier curve...

When this item is clicked, the *Bézier Curve Info* pop-up dialog appears allowing you to change the

sampling rate on selected curve(s) by entering the desired number of vertices on each curve.

Hint: For reasonable model size and manipulation ease, use the fewest samples that meet your accuracy requirement.

23.11. Resample Paths

When this item is clicked, the singly connected paths in selection are resampled using the segment length provided in the dialog box that show up (see Section 6.13. for details)

23.12. Create mesh

This item creates a mesh from the selected boundary. You can ensure smooth transition from existing meshes by marking border edges as hidden (see Section 7.1. for details).

23.13. Create texture...

This item creates a textured material and maps it on the selected faces (see Section 11. for details).

23.14. Tag faces

This item lets you tag faces to help selecting the group of faces using the Tgi3D selection tool (see Section 14.3. for details).

23.15. Untag faces

This item lets you untag the tagged faces that help selecting the group of faces using the Tgi3D selection tool (see Section 14.3. for details).

23.16. Upsample

This item is used to increase resolution of an existing mesh (see Section 7.5. for details).

23.17. Downsample

This item is used to decrease the resolution of an existing mesh (see Section 7.6. for details).

23.18. Create Warper

This item lets you create a warper for the current selection. See Sections 8. and 8.1. for details

23.19. Warp

This item lets you apply the transformation of the warper to the corresponding objects. See Sections 8. and 8.3. for details.

23.20. Set warper options

This item lets you set warper options if the selection is a warper group. See Sections 8. and 8.4. for details.

23.21. Set Target Terrain

This item lets you set selected mesh as the target of map to terrain command. See Section 13.1. for details.

23.22. Map to Terrain

This item lets you map the selection model to the target terrain. See Section 13.1. for details.

23.23. Safeguard texture map

This item is used for safeguarding the texture maps of selected vertices (see Section 11.5. for details)

23.24. Restore texture map

This item is used for restoring all of safeguarded texture maps (see Section 11.5. for details)

23.25. Collapse

This item is used for manual downsampling (or mesh reduction). Selected faces, edges and vertices can be collapsed to a single point with this command.

23.26. Move vertices to camera plane

Navigation: *Other Tgi3D Utilities > Move vertices to camera plane*

While drawing in SketchUp the vertices or construction points can be assigned to coordinates far away from the scene especially at the beginning when the ground plane is the only coincident geometry. This item just moves the selected vertices closer to the scene by mapping them to a plane parallel to the camera plane and passing through the scene.

23.27. Fit plane

Navigation: *Other Tgi3D Utilities > Fit plane*

Find the best fit plane for the selected vertices and project them on that plane so that in the end all the selected items lie on a single plane.

23.28. Change angular constraints

Navigation: *Other Tgi3D Utilities > Change angular constraints*

This menu item launches the dialog box for entering an angular constraint (see Section 7.9. for details).

23.29. Slice

Navigation: *Other Tgi3D Utilities > Slice*

Slice command creates the visual cone of the selected entity. The visual cone of an edge is the triangle made up of the two vertices of the edge and the current viewing camera location. The visual cone of the selection is the union of the visual cone of all the edges.

23.30. Fit curve to edge (J) (PhotoScan only)

Navigation: *Other Tgi3D Utilities > Fit curve to edge (J)*

Action: Press and release 'J' key

The *Fit Curve to Edge* menu item aligns the curve over the edges on the image. The end points of the curve are not moved in the alignment process (see Section 6.9.).

Note: This menu item applies only to Bézier curves.

23.31. *Fit end points to edge (K) (PhotoScan only)*

Navigation: *Other Tgi3D Utilities > Fit end points to edge (K)*

Action: Press and release 'K' key

The *Fit End Points to Edge* menu item aligns a curve over the edges on the image by moving the end-points of the curve only (see Sections 6.7. and 6.9.).

Note: Key 'K' is mapped internally to another command on Google Sketchup 8. In order to use this shortcut, you have to clear the Sketchup shortcut via “Window > Preferences > Shortcuts” (“Sketchup > Preferences... > Shortcuts” on Mac).

23.32. *Match images (N) (PhotoScan only)*

Navigation: *Other Tgi3D Utilities > Match images (N)*

Action: Press and release 'N' key use Shift + N for automatic long range search

If the selection is view locked to a matched photo and the current camera is on another matched photo than this operation perform a color distance based shape optimization so that the projection of selected surface patches match in color (see Section 7.8. for more information).

If you start from a surface too far from the real one, you may have to repeatedly perform this operation. If you use the Shift key modifier the surface fitting is re-initialized through a search on a larger area on the images.

23.33. *Smooth (U)*

Navigation: *Other Tgi3D Utilities > Smooth (U)*

Action: Press and release 'U' key. Use Shift + U for automatic smoothing

Smoothing operation moves the vertices of the mesh such that the discontinuities or sharp features around the soft/hidden/smoothed edges are minimized. In this type of smoothing the mesh vertices are not allowed to move along the surface to preserve mesh topology. See Section 7.2. for more information.

You can issue the command repeatedly by hitting the 'U' key or press 'Shift+U' instead to reach to the steady state of the smoothing quickly.

23.34. *Redistribute and Smooth (Y)*

Navigation: *Other Tgi3D Utilities > Redistribute and Smooth (Y)*

Action: Press and release 'Y' key. Use Shift + Y for automatic redistribution and smoothing

In redistribute and smooth the mesh vertices are left completely free to get a smooth surface with close to uniform vertex distribution. The surface is assumed to be made up of either a stiff or elastic material depending on the option selected in the *Tgi3D Settings* dialog shown in Figure 21. See Section 7.3. for more information.

You can issue the command repeatedly by hitting the 'Y' key or press 'Shift+Y' instead to reach to the steady state of the redistribution quickly.

23.35. *Plane Optimization (D) (advanced)*

Navigation: *Other Tgi3D Utilities > Plane Optimization (D)*

Action: Press and release 'D' key. Use Shift + D for automatic plane optimization

The purpose of plane optimization is to completely planarize an almost planar surface to be able to

drop smooth/soft/hidden edges inside the surface. *Plane optimization* operation is used especially when you want to create objects whose faces are all planes, e.g. cubes, cuboids, hexahedrons, tetrahedrons etc. Also see Section 7.9. for related information.

You can issue the command repeatedly by hitting the 'U' key or press 'Shift+U' instead to reach to the steady state of the planarization quickly.

23.36. Remove Unnecessary Edges

Navigation: *Other Tgi3D Utilities > Remove Unnecessary Edges*

An edge is unnecessary if the faces on its two sides are almost coplanar. This command removes such edges in the selection.

23.37. Triangulate Faces

Navigation: *Other Tgi3D Utilities > Triangulate Faces*

Triangulate faces command triangulates non-triangular faces in the selection.

23.38. Element Count

Navigation: *Other Tgi3D Utilities > Element count*

Report number of vertices, edges and faces in selection.

23.39. Group to transport

Navigation: *Other Tgi3D Utilities > Group to transport*

See Section 12. for more details.

23.40. Ungroup to transport

Navigation: *Other Tgi3D Utilities > Ungroup from transport*

See Section 12. for more details.

24. Tgi3D Settings Dialog Box

Menu: Tools > Tgi3D Settings

Toolbar icon: 

Tgi3D Settings dialog box contains a number of options affecting the surface smoothing, mesh creation, image matching and cross section editing processes. There are two types of options: 1) *Model Specific Settings* that only affect the current model and are saved with it, and 2) *Global Settings* that affect all the instances of the Tgi3D® SU as shown in Figure 21.

24.1. Model Specific Settings

a) Surface Smoothing Optimizations Options

- **Assume Bézier curves as fixed:** When this option is checked, Bézier curve vertices inside the selected region are assumed to be fixed by default for the smoothing operations. Otherwise these Bézier curve vertices (unless explicitly marked as fixed) are also moved during smoothing.
- **Redistribute and smooth** In redistribute and smooth operation the surface is assumed to be made up of either one of the two types of materials.
 1. **Stiff material:** It is difficult to bend stiff materials
 2. **Elastic material:** Elastic material bends very easily.

b) Mesh Operations (Create/Upsample) Options

- **Curve crease angle:** Sets the maximum crease angle (in degrees) for noncurve hard edges (and boundaries) where the connected edges with a crease angles less than then the set value are assumed to be continuing during upsample operation.

This crease angle value is also used for the boundary edges during the smoothing optimizations to split the perimeter boundary into connected segments. If unexpected behaviour is observed during smoothing optimization, you can try changing this value.
- **Split boundary edges:** If this option is checked, very long boundary edges of the mesh to be created are split to smaller pieces to avoid skinny triangulations.

c) Image Matching Options

- **Surface stiffness:** Sets the stiffness of the surface to be used in image matching.

24.2. Global Settings

- **Split Selection boundary in upsample:** When this options is checked the edges and faces at the boundary of the selection are split and triangulated otherwise no splitting is performed.
- **Use SketchUp groups in mesh editing:** When this options is checked, the results of some mesh editing operations (up-sampling and down-sampling) are placed in a new group. If you want to merge the result with the rest of the scene, you need to explode the group. Using the SketchUp groups results in faster processing in mesh editing.
- **Direct context menu access to Tgi3D commands:** When this option is checked the Tgi3D menu items are placed directly under the context menu of SketchUp otherwise the

commands can be accessed through the “Tgi3D Commands” sub-menu.

- **Cross section edit method:** Determines the expand / shrink method of cross sections. One method is the 'offsetting' as in the *Offset* tool of SketchUp, the other one is scaling, that avoids topological changes in the cross section.
- **Language:** Set the language of the menu item names and help content for Tgi3D® SU plug-in.

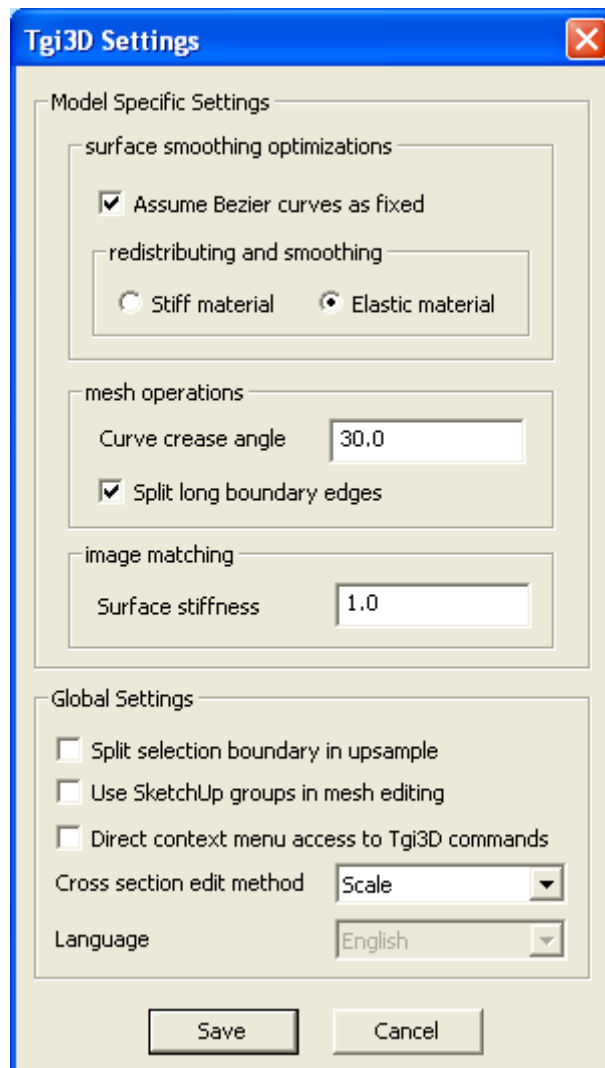


Figure 21: The Tgi3D Settings dialog box