TOPOSHAPER::CLOUDPOINTS

Generation of Terrain from a Cloud of Points
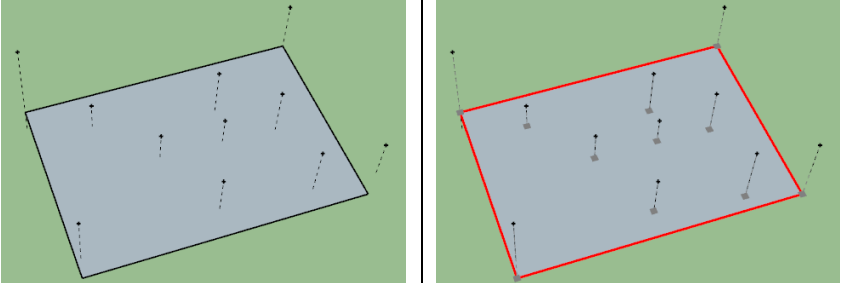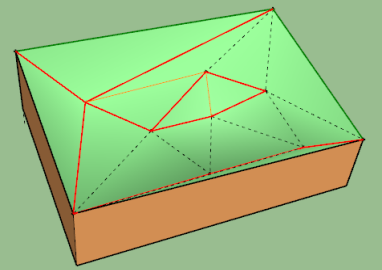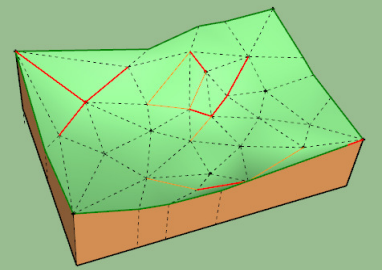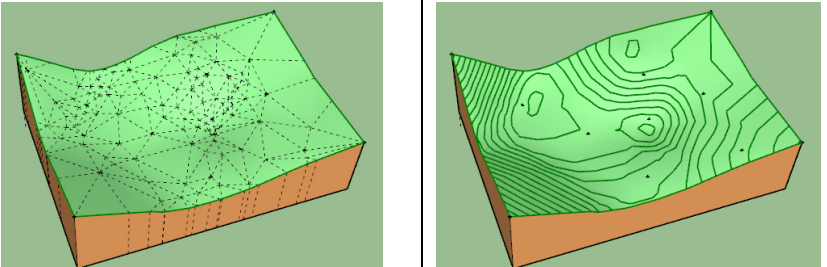
VERSION 2.0 – 22 DEC 2014

by Fredo6

1. Overview

TopoShaper::CloudPoints **creates a terrain from a limited number of points**, given as a set of Guide points enclosed within a group, with a set of contours (specified as faces) to clip the mesh. The terrain surface is generated as a **Triangular mesh**. Points are strictly on the terrain (i.e. part of the mesh).

TopoShaper uses **an iterative algorithm**, where it generates a triangulation of the points and refines it progressively by interpolation. The refinement ends when the sharpness of all edges of the terrain surface respects the specified **smoothing factor** or the number of triangles has reached a specified maximum.

Step 0 **Group of Cloud of Points**: The clipping contour, specified from a face, is highlighted in red.	
Step 1 **Simple Triangulation**: Original points are joined to form triangles (Delaunay triangulation). Sharp and very sharp edges are highlighted in red and orange.	
Step 2 **Refinement / Interpolation**: There are still some sharp and very sharp edges.	
Step 6 **Final Terrain**: After 4 more refinements, all edges are smoothed under the specified value (20°). Once the terrain is generated, you can add/remove the **Skirt** and **Iso-Contours**.	

2. Installation

- ➤ **Sketchup Versions**: **6 and above** (Free and Pro), including SU2015 32bits and 64 bits. Works better with **v8 M2 and above**

- ➤ **Platforms**: Windows XP, Vista, 7, 8, 10 and Mac OSX all versions

- ➤ **IMPORTANT:** TopoShaper 2.x requires the Shared Library **LibFredo6 v6.5 or higher**.

Since SU8 M2 and SU 2013, there are now several ways to install a plugin.
- − **SCF Plugin Store**, <u>recommended method</u>
- − **Extension WareHouse** (when published there)
- − SU Extension Manager to install a **.rbz file**
- − Unzipping into the SU Plugins directory from a .zip file (see details below)

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

- • **one script file** *Fredo6_TopoShaper.rb*
- • **one subfolder** *Fredo6_TopoShaper*. This subfolder contains the library files, the icons, cursor files, language files (please do not alter, rename or move files there).

Name	Type
SU Plugins root directory	Plugins Root Folder
Fredo6_TopoShaper	Folder
Fredo6_TopoShaper.rb	Ruby file
Fredo6_!LibFredo6	Folder
Fredo6_!LibFredo6.rb	Ruby file

The Sketchup standard Plugins directory is:

Windows	
Sketchup 8	**C:\program files\google\google Sketchup 8\plugins**
Sketchup 2013	**C:\program files\SketchUp\SketchUp 2013\Plugins**
Sketchup 2014	**C:\Users\<username>\AppData\Roaming\SketchUp\SketchUp 2014\SketchUp\Plugins**
Sketchup 2015	**C:\Users\<username>\AppData\Roaming\SketchUp\SketchUp 2015\SketchUp\Plugins**
Mac OSX	
Sketchup 8	**Macintosh HD/Library/Application Support/Google SketchUp 8/SketchUp/Plugins**
Sketchup 2013	**~/Library/Application Support/ SketchUp 2013/SketchUp/Plugins**
Sketchup 2014	**~/Library/Application Support/SketchUp 2014/SketchUp/Plugins**
Sketchup 2015	**~/Library/Application Support/SketchUp 2015/SketchUp/Plugins**

Note for SU6 and SU7 users: download the rbz file from the plugin store page at **http://sketchucation.com/pluginstore?pln=TopoShaper**, and change its extension from **.rbz to .zip. Then:**

      1) Open the zip archive

      2) Select All (Ctrl A)

      3) Extract into the Sketchup Plugin Directory

      4) Answer YES to OVERWRITE all existing files if any

      5) Make sure you get the correct footprint (one rb file and one folder)

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

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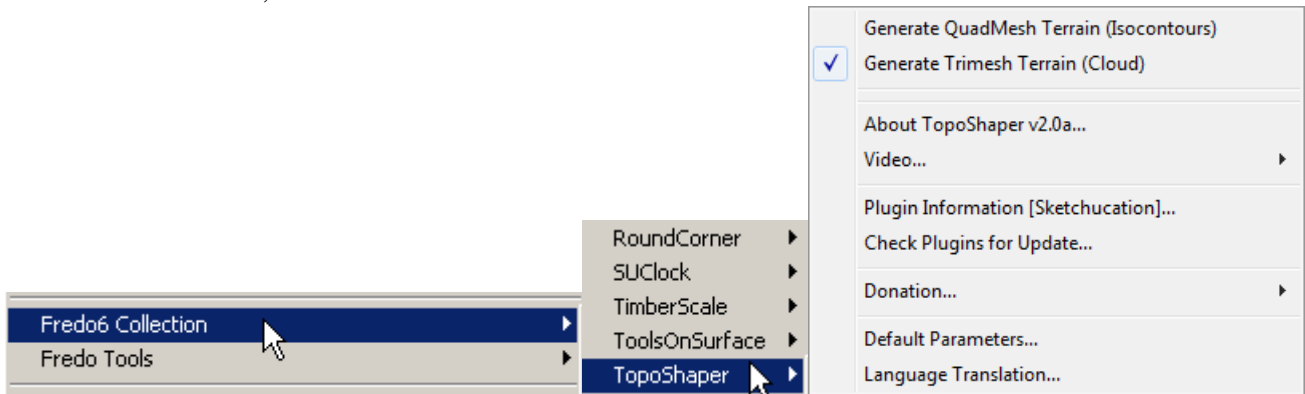
3. Menus, Toolbar and Configuration

TopoShaper 2.0 includes 2 methods for generating terrain
- **As a QuadMesh from iso-contours** (separate user manual)
- **As a Triangular Mesh from a Cloud of Points** (this user manual)

Main menu:

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

	Generate QuadMesh Terrain (Isocontours)
✓	Generate Trimesh Terrain (Cloud)
	About TopoShaper v2.0a...
	Video... ▶
	Plugin Information [Sketchucation]...
	Check Plugins for Update...
	Donation... ▶
	Default Parameters...
	Language Translation...

RoundCorner ▶
SUClock ▶
TimberScale ▶
ToolsOnSurface ▶
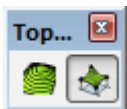TopoShaper ▶

Fredo6 Collection ▶
Fredo Tools ▶

Contextual menu

When selection contains at least 3 Guide Points → *"TopoShaper > Generate TriMesh Terrain (Cloud)"*

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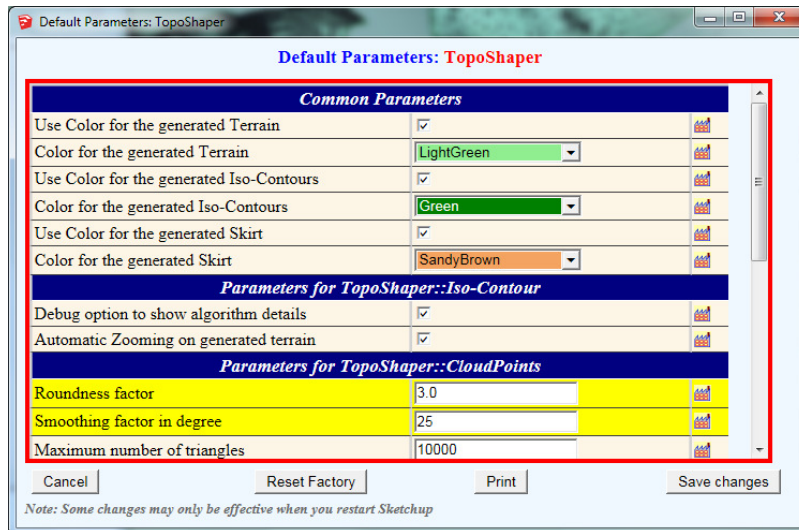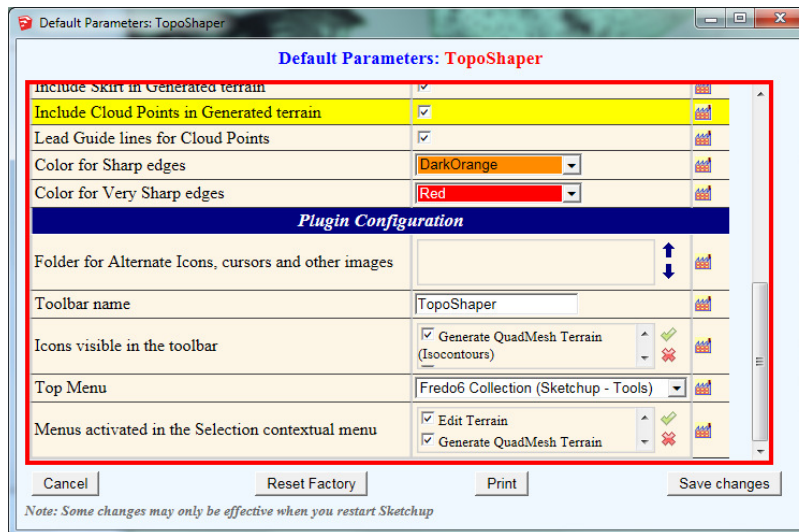
Toolbar

Top... ☒

Toolbar name is **TopoShaper** by default (you can change it). In version 2.0, the icon dedicated to the generation of terrain from Cloud Points is the one shown below.

Default Parameters

Default Parameters: TopoShaper		
Default Parameters: TopoShaper		
Common Parameters		
Use Color for the generated Terrain	☑	
Color for the generated Terrain	LightGreen ▼	
Use Color for the generated Iso-Contours	☑	
Color for the generated Iso-Contours	Green ▼	
Use Color for the generated Skirt	☑	
Color for the generated Skirt	SandyBrown ▼	
Parameters for TopoShaper::Iso-Contour		
Debug option to show algorithm details	☑	
Automatic Zooming on generated terrain	☑	
Parameters for TopoShaper::CloudPoints		
Roundness factor	3.0	
Smoothing factor in degree	25	
Maximum number of triangles	10000	

Cancel   Reset Factory   Print   Save changes

Note: Some changes may only be effective when you restart Sketchup

Some parameters like colors for the generated elements are common to the Iso-Contour and Cloud Points scripts

Default Parameters: TopoShaper		
Default Parameters: TopoShaper		
Include Skirt in Generated terrain	☑	
Include Cloud Points in Generated terrain	☑	
Lead Guide lines for Cloud Points	☑	
Color for Sharp edges	DarkOrange ▼	
Color for Very Sharp edges	Red ▼	
Plugin Configuration		
Folder for Alternate Icons, cursors and other images		↑ ↓
Toolbar name	TopoShaper	
Icons visible in the toolbar	☑ Generate QuadMesh Terrain (Isocontours)	✔ ✖
Top Menu	Fredo6 Collection (Sketchup - Tools) ▼	
Menus activated in the Selection contextual menu	☑ Edit Terrain ☑ Generate QuadMesh Terrain	✔ ✖

Cancel   Reset Factory   Print   Save changes

*Note: Some changes may only be effective when you restart Sketchup*

You can adjust which icon are visible in the toolbar and which commands are available in the contextual menu
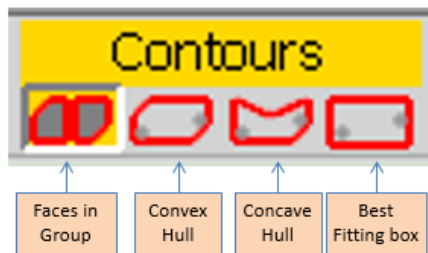
Buttons Palettes

The buttons palette is fixed for all operations:
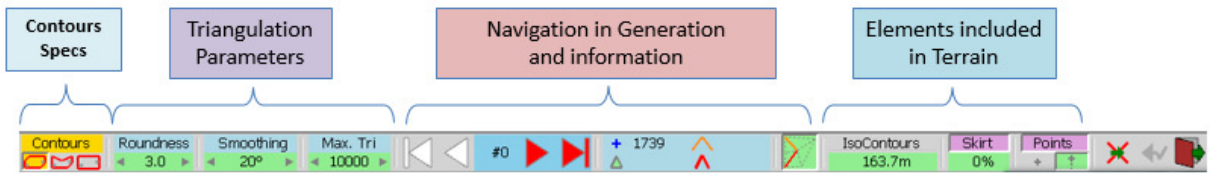
The navigation in the iterative algorithm is controlled by the navigation buttons, which also displays some information on the triangulation:
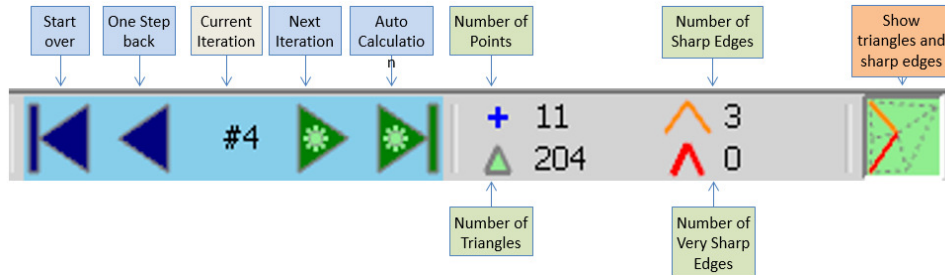
Options for Clipping Contours can be specified via the palette buttons:

Other standard buttons:

- **Abort and exiting** will exit and leave your model untouched:

- **Rollback to previous step** is shown as a backward arrow in orange:

- **Exit** will exit the script (whether terrain was generated or not):

Error Handling

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

If this happens, you may get an error message as shown as the dialog box below:
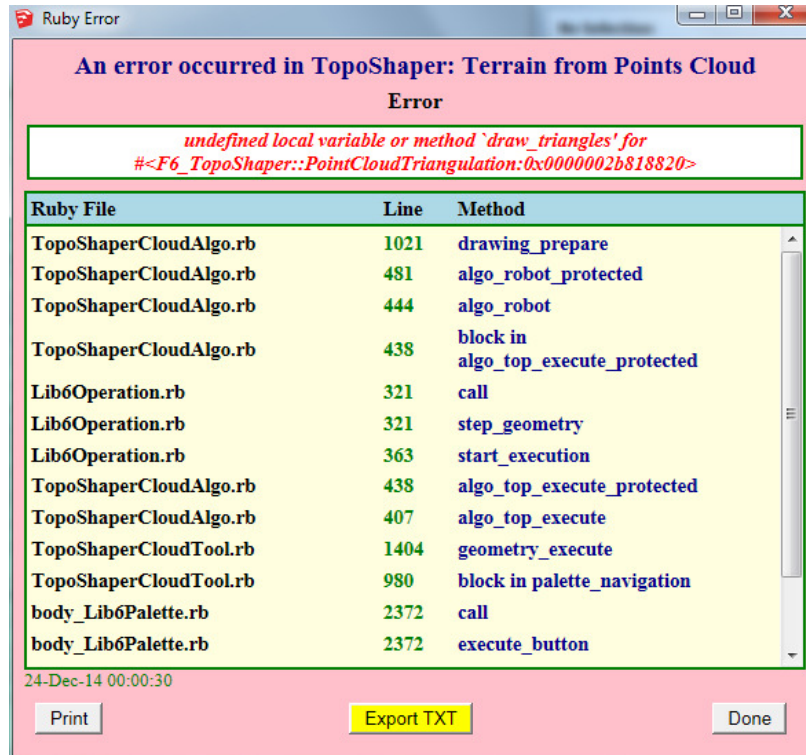
Although this is purely technical information related to the Ruby script, it can be helpful to the author in order to trace the cause of error. So you may want to export the information as a text file (or simply copy / paste it) and post it on Sketchucation.

1 – Points Cloud Selection

Points must be enclosed within a Group as Guide Points. Optionally, the Group may enclose faces which will indicate the contours to clip the generated mesh. Contours can be arbitrary and include holes. If there are no specified contours, a default contour is taken as the **convex hull** of the points. You can change this option via the palette buttons.
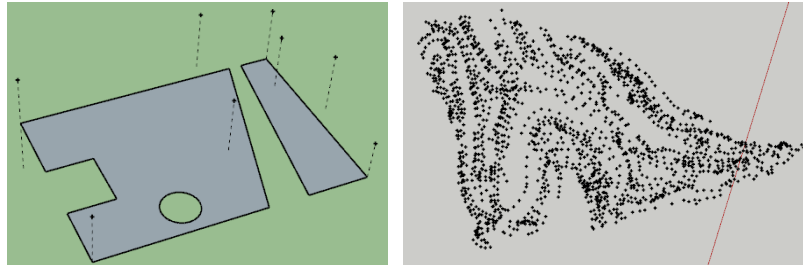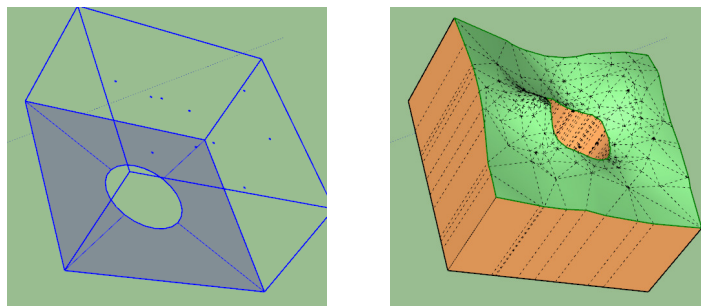

To start the script, **select the Group and launch the script** via the toolbar or menu or contextual menu.
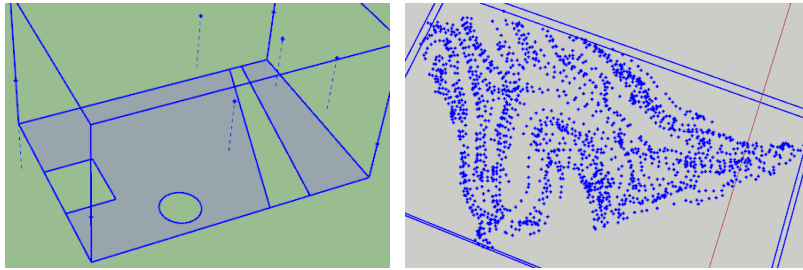
The contours and holes are highlighted in red and the points in gray.
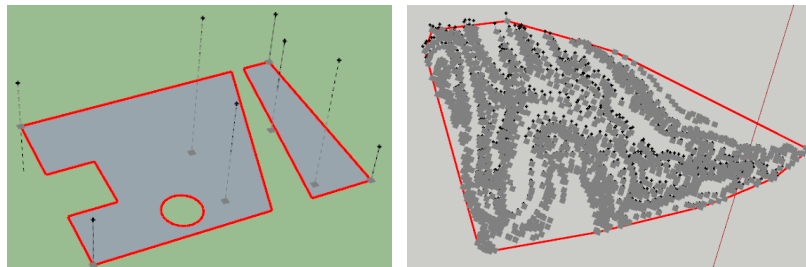
Note that the points and contours do not need to be in the horizontal plane, as long as it is possible to retrieve the relevant Z Axis (either from contour faces or Z axis of the group).

2 – Clipping Contours

Clipping Contours can be specified by a **set of faces** enclosed within the group of Cloud Points. These faces may include holes or even form holes altogether.
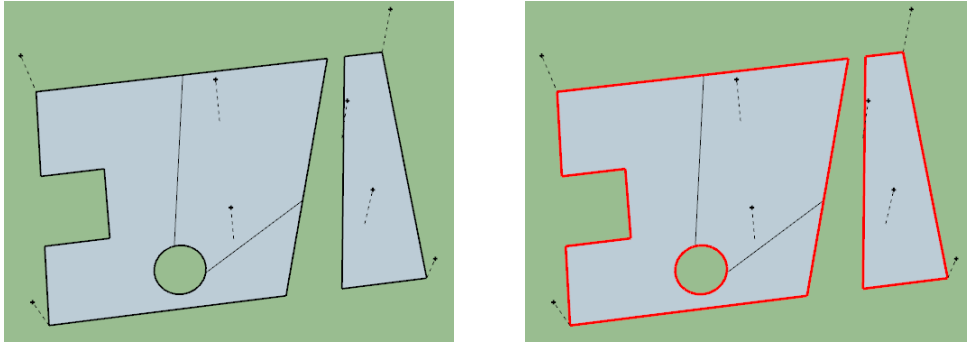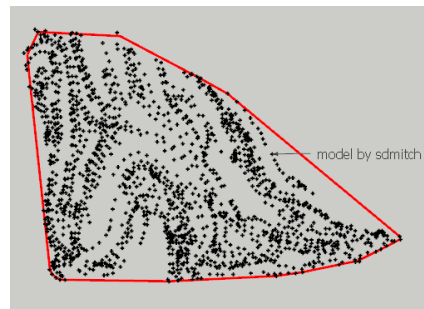

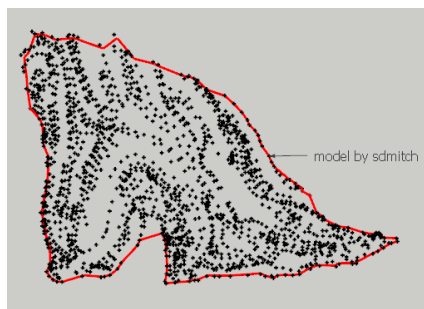Alternatively, or in case you don't have faces for contours specifications, you have the choice of usual contours:

– **Convex Hull** (default when no faces are specified)
– **Concave Hull**, which is never unique, so may work for you or not
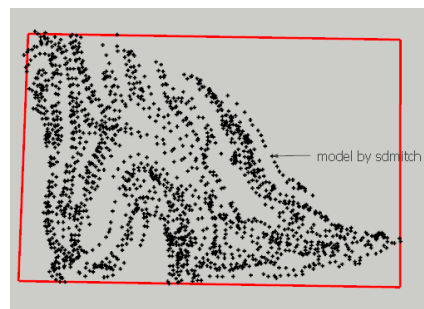– **Best Fitting Rectangle**
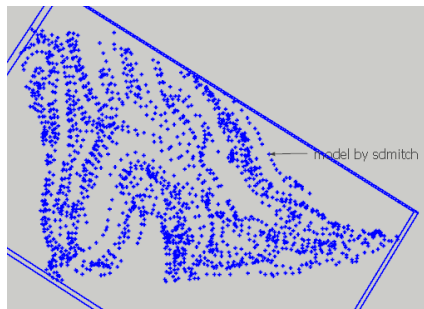
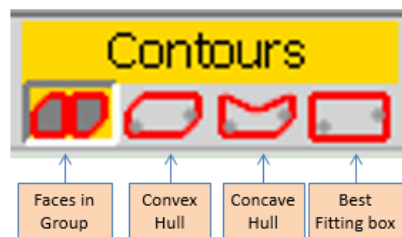*Original Cloud of Points*   *Convex Hull*

Concave Hull   *Best Fitting Rectangle*

You can modify the options for specifying the contours via the button palette, but you must do it **before** calculation.

3 – Triangulation Parameters

The triangulation is controlled by 3 parameters. You can type their value in the VCB[1].

Roundness	Smoothing	Max. Tri
◄ 3.0 ►	◄ 20° ►	◄ 10000 ►

1) Roundness

The interpolation uses a **power factor** which gives some roundness to the terrain. In TopoShaper the range varies from 1.0 (linear interpolation) to 4.0. The role of this factor is to **control the influence of neighbor points at a given location**. This is important because a too low value may accentuate hills and basins, whereas a too high value may artificially over-emphasize reliefs.


Roundness = 1.0   *Roundness = 2.0*

Roundness = 3.0   *Roundness = 4.0*
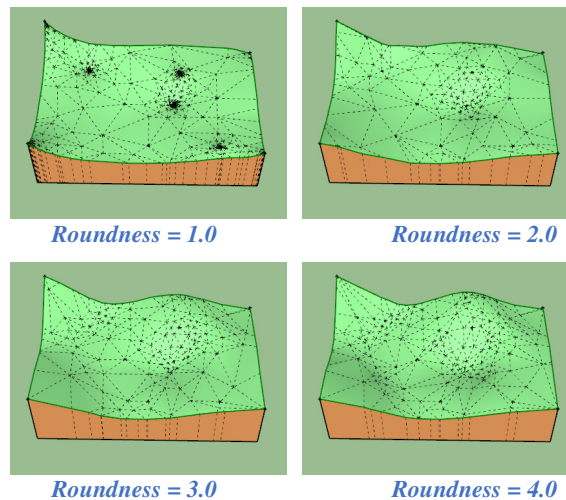
The values advised for the Roundness factor are comprised between 2.0 and 3.5.

2) Smoothing

The Smoothing factor, given **as an angle in degree**, specifies the acceptable sharpness of edges, that is, the angle between the normal of the two faces bordering each edge.

This influences the number of triangles in the terrain. So it is advised to beware of very low values. TopoShaper always highlights:

– **the Sharp edges**, whose roof angle is > angle and < angle * 125%
– **the Very Sharp edges**, whose roof angle is > angle * 125%
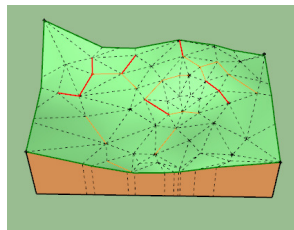
**In most case a value of 20-25 degrees would give a visually smooth terrain.**

3) Maximum number of Triangles

This value, comprised between 100 and 100,000 just stop the generation when the number of triangles gets close to the maximum specified.

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[1]   There is no ambiguity since their range do not overlap.

4 – Navigation in Triangulation

The navigation palette allows to proceed with a generation step-by-step or in auto-mode. TopoShaper keeps the image of each step in history so that it can be recalled without calculation.
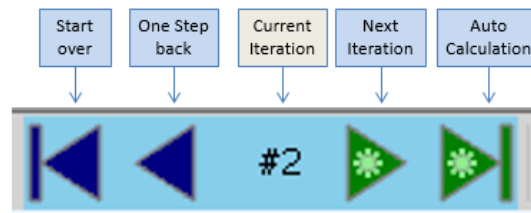
The palette includes 4 buttons (also mapped on Arrow keys):

- **Next Step** and **Auto-Generation** have different states depending on:
  - **Calculation** required → **Green**
  - Calculation will **starts from the beginning** → **Red**
  - Step is retrieved from **History** → **Blue**
- **Start-Over** and **Previous Step** buttons are always **Blue** (or disabled) as they do not imply calculations. Previous Step is always taken from History.

The rules are:

- Any change to the Roundness will provoke a start-over calculation:
- Changes to Smoothness and to Triangles Max will for a calculation for the next steps. You can for instance make a step-by-step calculation with a smoothing factor of 20° and then change it to 25° for the subsequent steps:

TopoShaper displays information about the current iteration:
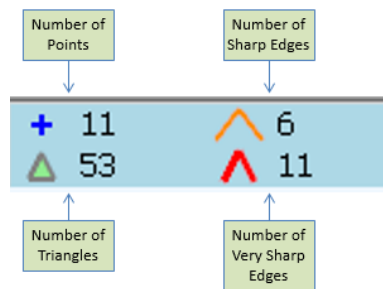
Note: a dedicated button in the palette (or **Toggle Shift**) allows to toggle the display of triangles (i.e. show/hide hidden geometry) and sharp edges. You can also temporarily hide the sharp edges by maintaining down the **Ctrl key**.

You can also inspect the generated terrain. Moving the mouse over a sharp edge will display its roof angle.
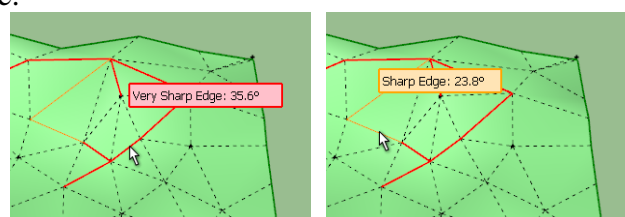
5 – Generation of Terrain

The Terrain is generated at each step or at the end of the auto-processing.

The Terrain surface is created **as a Group at top-level of the model**.

At any time you can indicate which complementary elements you want to include in the terrain **as sub-groups of the main group**. Whenever you enable or disable these elements, this is reflected immediately in the model.
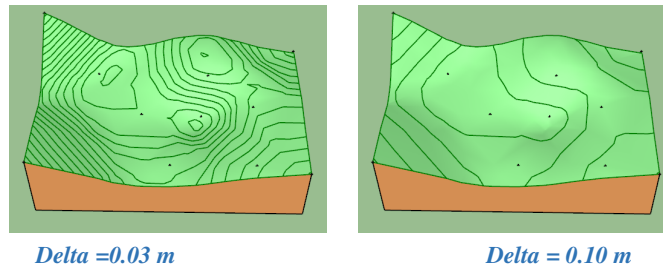

Note: the default color for the Terrain is available in the *Default Parameters* of TopoShaper:
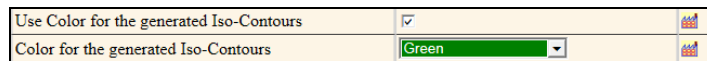

1) Iso-Contours

You can enable or disable iso-contours by clicking on the top button.

The altitude delta between iso-contours can also be specified by clicking on the lower button. A default value is computed based on the initial points and units.
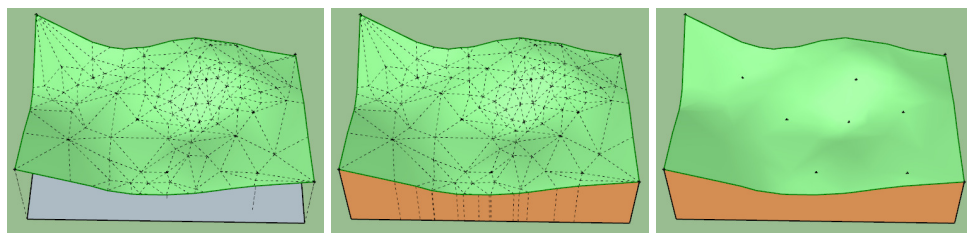

Delta =0.03 m   *Delta = 0.10 m*

Note: the default color for Iso-Contours is available in the *Default Parameters* dialog box:
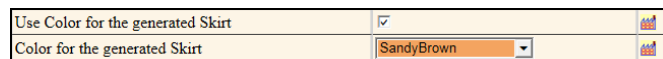

2) Skirt

You can show / hide the Skirt.

Note: the default color for the Skirt is available in the *Default Parameters* dialog box:

3) Original Points

You can include the original Points as a subgroup of the generated terrain.

If so, you have two modes:
1) Just the points as a Guide Point
2) or as a Guide Point and a portion of Guide Line

6 – Final Remarks

1) Default Parameters

All parameters are set at their default values when you start TopoShaper.

However, when you change the parameters, they are attached to the original Group during the Sketchup session so that you can preserve them if you are doing trial and errors.

2) Performance

The algorithm is not very fast (it is fully in Ruby). It is mainly impacted by:

- **The number of points in the cloud**, which is the main slow-down factor

- **The shape of the terrain**, in particular if there are sharp changes of altitudes in small local areas

- **The specified smoothing factor**. If too low (say 5° to 15°), the terrain will require many triangles and takes long to calculate.

There are a few heuristics to speed up the calculation. They may generate some artefacts. A slight change of one parameter may circumvent the problem.

3) Future Work

Some features may be included in future versions:

- **Point Editor and Cleanser**, as it is not very straightforward to move points in X, Y plane and in altitude in Sketchup, or to add points. This would come with a Working View concept, analog to what exists in TopoShaper::IsoContours.

- **Mesh simplification**: in the current version, the triangular mesh can be a little bit oversized.