

TOPOSHAPER::ISO-CONTOURS

Generation of Terrain from Iso-Contours

VERSION 2.0 – 22 DEC 2014

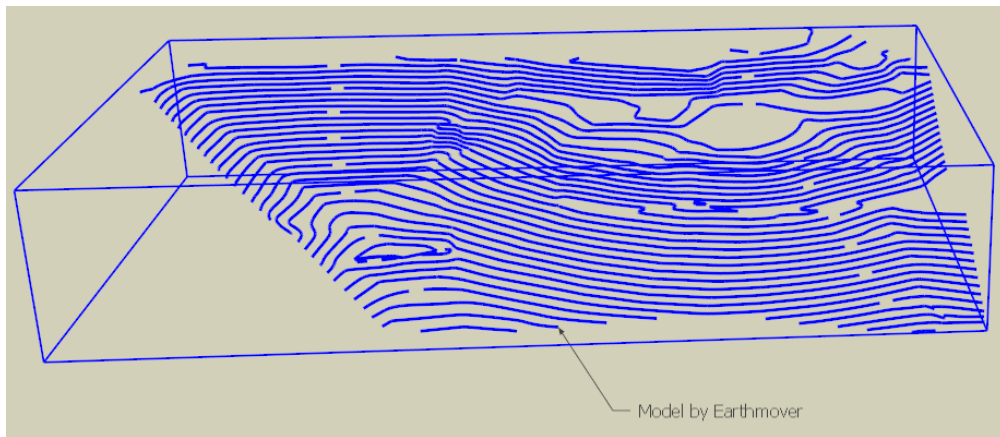
by Fredo6

1. Overview

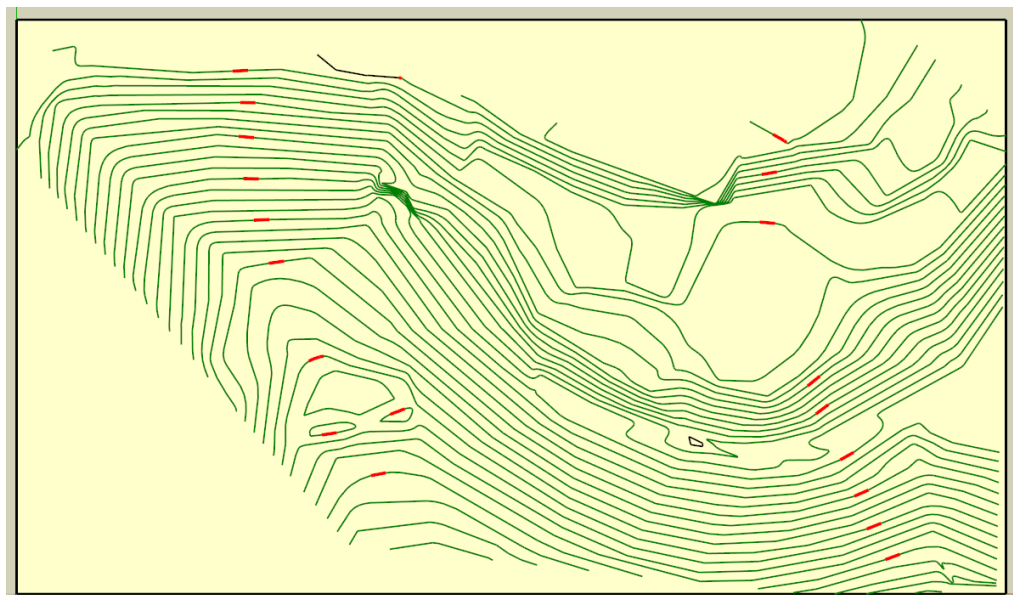
TopoShaper::Iso-Contours creates terrain from iso-contours, that is, contours which have a constant altitude. The terrain surface is generated as a **regular quad-mesh**.

TopoShaper processes the generation of terrain in **4 steps**:

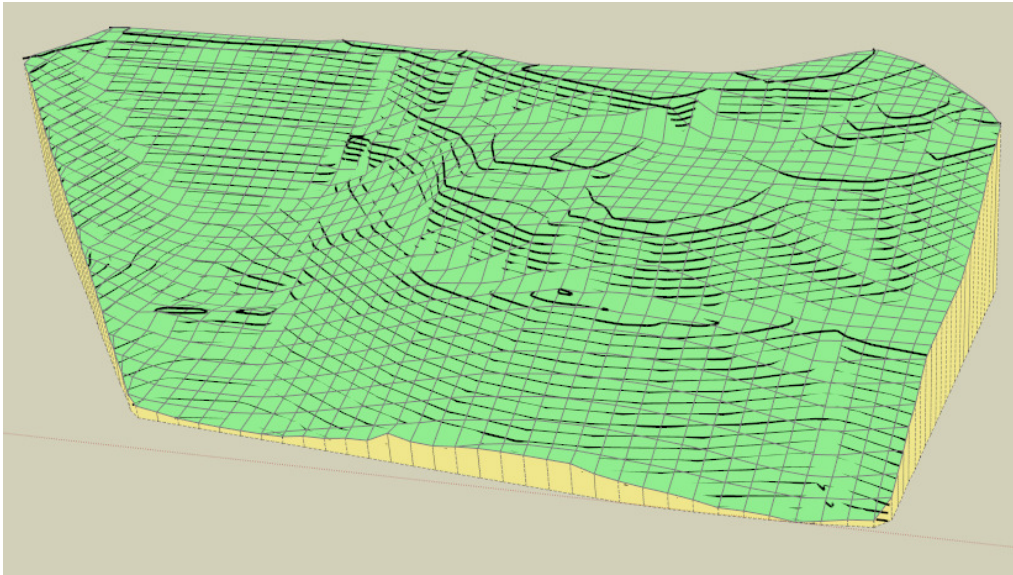
Step 1 Contour Selection: Pre-selection or interactive selection, as for Curviloft. In most cases, you contours will be enclosed in a group which you just need to preselect.



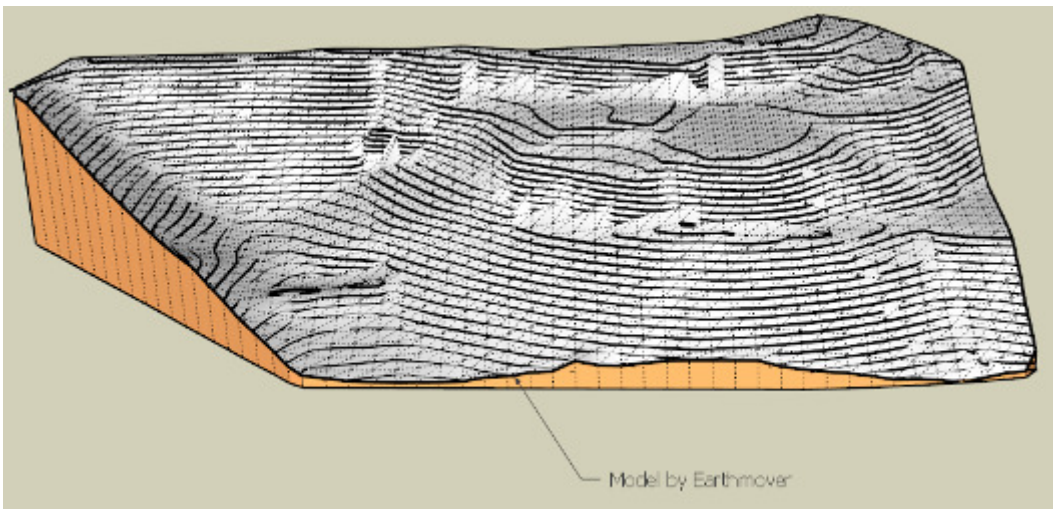
Step 2 Cleansing Contours: simplification of contours, inclusion / exclusion of contours, junction of contours and removal of small hooks. This step is based on an automatic estimation of the features to be cleansed, which you can then interactively change. You can optionally save the result of this cleansing phase.



Step 3 Calculation of Terrain and Preview: A preview of the terrain is shown in 3D and 2D. You can modify the grid dimensions and decide about the treatment of hilltops and basins (flat or rounded).



Step 4 Generation of Terrain geometry: This last step simply generates the terrain as a mesh of quads enclosed within a group. Optionally, you can include the ‘skirt’ for the terrain, as well as the contours.



Once a terrain is generated, you can further edit it, for instance to change the grid resolution or the behavior at hilltops, to add or remove the skirt, or even to go back to the cleansing step.

NOTE: *TopoShaper differs from the “From Contours” Sandbox tool by many aspects and thus in no case can be considered as a substitute for this native script. In TopoShaper,*

- *Contours must be planar or quasi-planar (i.e. iso-contour = same altitude)*
- *The terrain surface is close to the iso-contours but does not pass through the vertices of the contours*
- *The terrain surface is generated as a regular mesh made of quads, not as a TIN made of triangles of various sizes*
- *TopoShaper tries to estimate the closest concave hull to the terrain*

2. Installation






- **Sketchup Versions: 6 and above** (Free and Pro). 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**, recommended method
- **EWH** (when published)
- SU Extension Manager to install a **.rbz file**
- Unzipping into the SU Plugins directory from a .zip file (see details below)

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 |
|--|---------------------|
|  <i>SU Plugins root directory</i> | 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>).

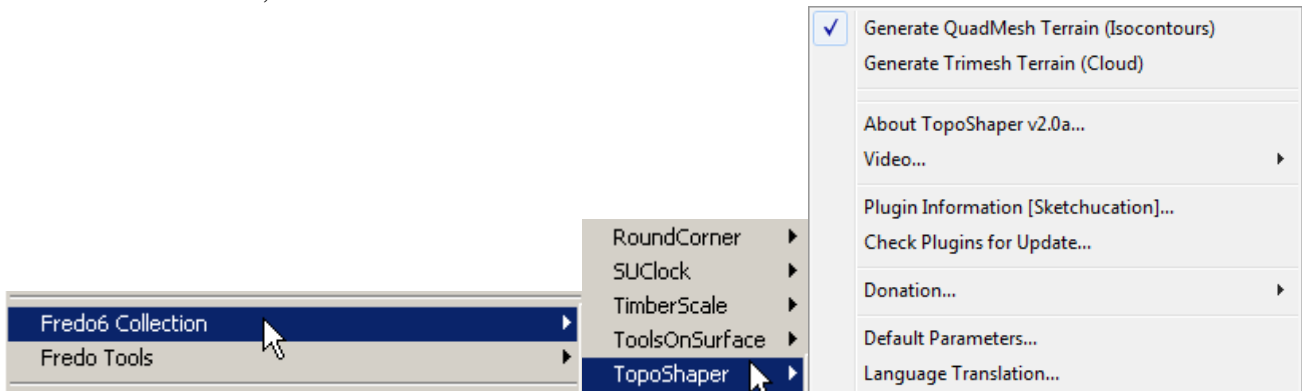
3. Menus, Toolbar and Configuration

TopoShaper 2.0 includes 2 methods for generating terrain

- As a **QuadMesh from iso-contours** (this user manual)
- As a **Triangular Mesh from a Cloud of Points** (separate 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.



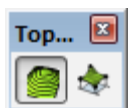
Contextual menu

When selection is a previously generated terrain group → “*TopoShaper > Edit Terrain*”

When selection contains edges → “*TopoShaper > Generate QuadMesh Terrain*”

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

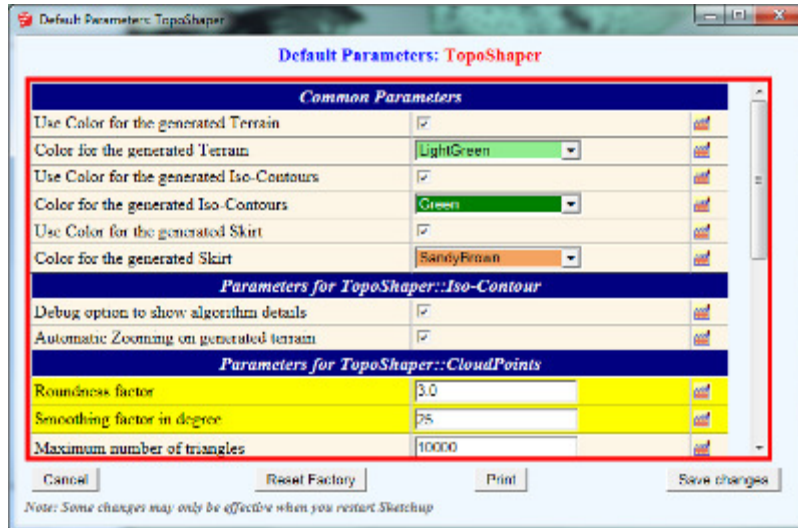
Toolbar



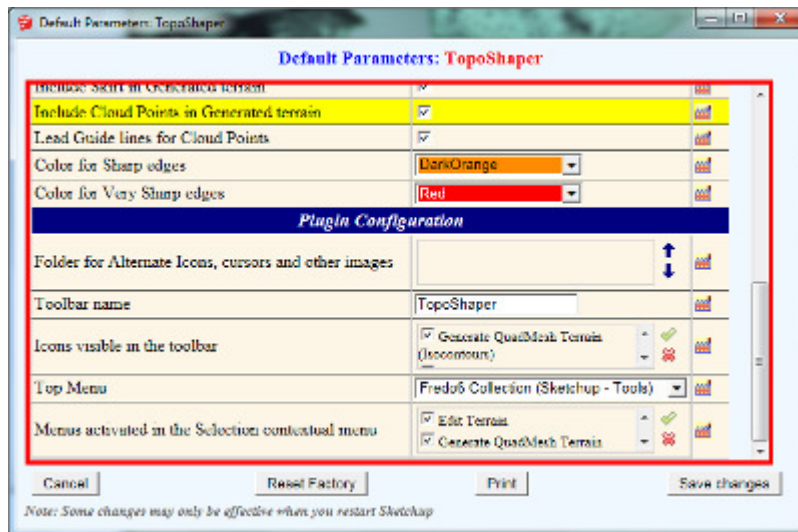
Toolbar name is *TopoShaper* by default (you can change it). In version 2.0, the icon dedicated to the generation of terrain from is-contours is the one shown below.



Default Parameters



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

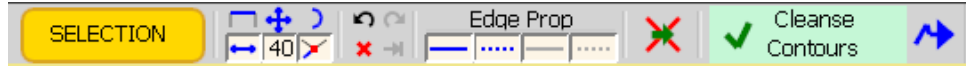


You can adjust which icon are visible in the toolbar and which commands are available in the contextual menu

Buttons Palettes

The buttons palette changes depending on the current step.

Step 1 Contour Selection: Buttons are very similar to the usual contour selection, as for Curviloft or Curvizard.



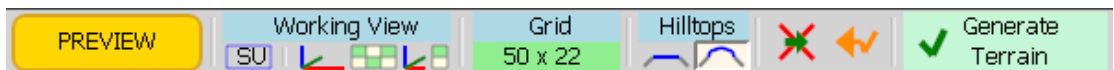
Step 2 Cleansing Contours: Automatic and manual cleansing take place in the viewport. The palette just enables to switch between working views and to save the contours once cleansed.



The status of the Cleansing process is indicated in the status zone of the palette, with current statistics (and original ones within square brackets).



Step 3 Calculation of Terrain and Preview: Options are available to change the dimension of the sampling grid and manage the shape of hilltops and basins.



Step 4 Generation of Terrain geometry: Once the terrain is generated, you can decide to include / exclude the skirt and the contours.

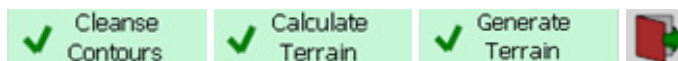


The generic buttons and actions are as follows:

- **The current step** is indicated in a yellow cartouche on the left side.



- **The next action** is indicated in a large text button in light green, with a check mark.



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

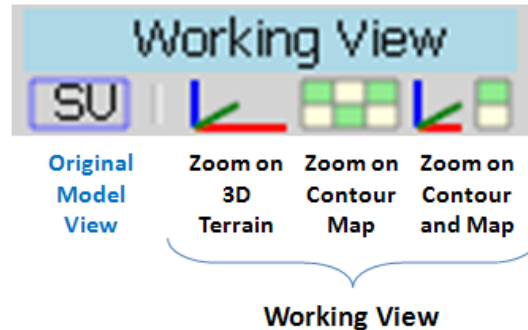


- **Abort and exiting** will exit and leave your model untouched:

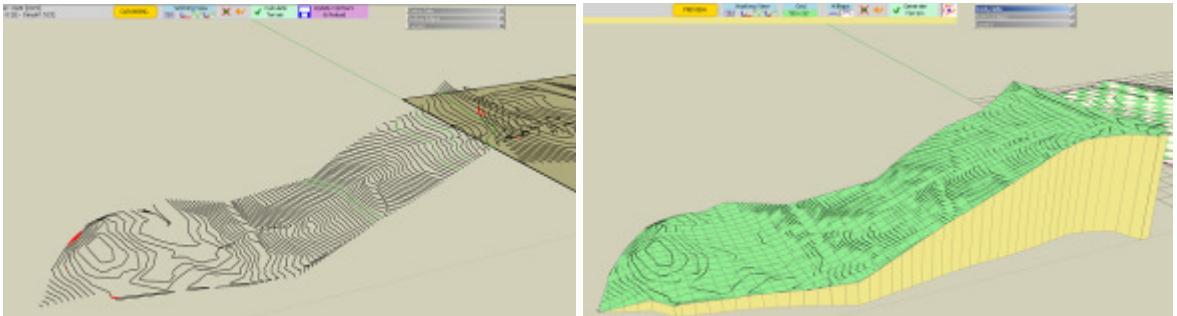


Working Views

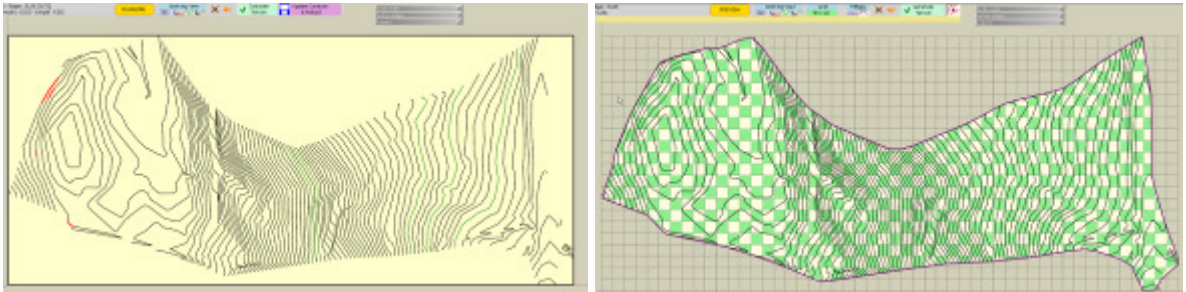
In the Cleansing and Preview steps, TopoShaper offers a **special working view mode to make the visualization and edition more comfortable**. In this working view mode, *only* the 2D map and 3D terrain are visible in the viewport. You can then navigate freely with the usual Sketchup visualization tools, Orbiting, Zooming, etc.....



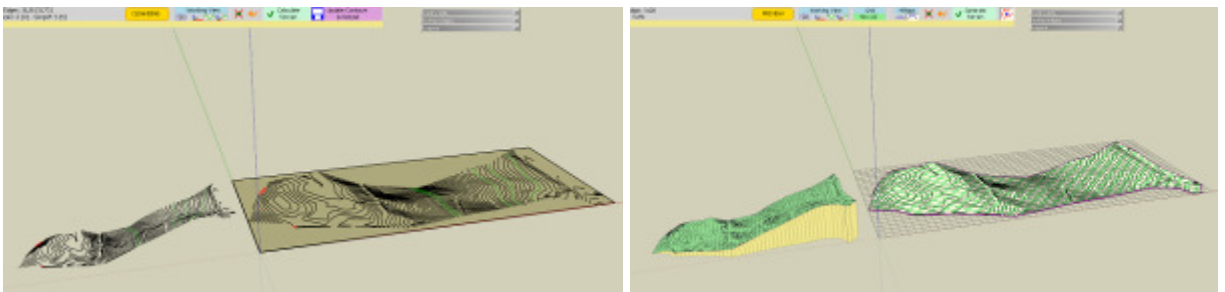
Zoom on 3D Terrain



Zoom on 2D Contour map



Zoom on both 3D terrain and 2D Contour map

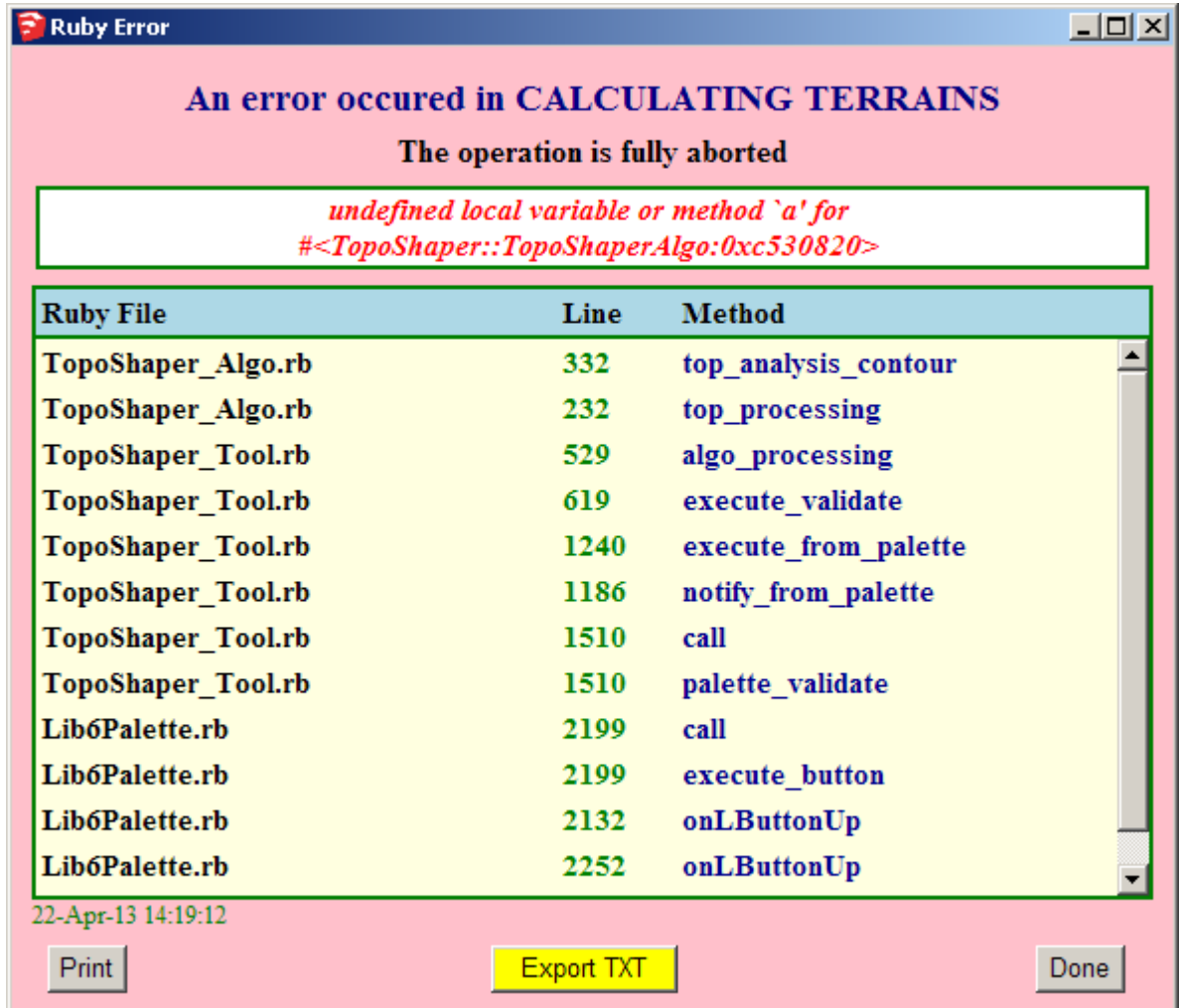


Note: Under the cover, TopoShaper creates temporarily a dedicated layer, named “LIBFREDO6_TEMP_LAYER” and only display this layer in the viewport. So, all other layers are temporarily hidden. In principle, the original view and layer visibility is restored at the end of the operations and in case of aborting by the user or by a fault in the Ruby script.

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.

Step1 – Contour Selection

TopoShaper allows selecting contours in two modes:

- 1) Pre-selection of Edges, Groups and Components
- 2) Interactive Selection of edges

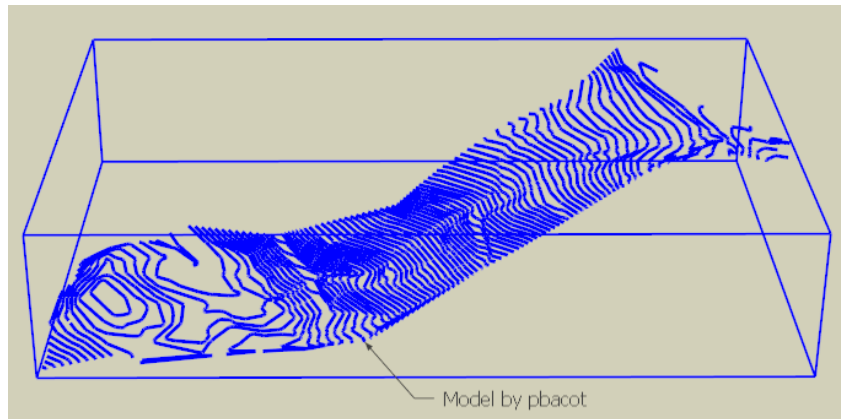
In practice, contours used to generate a terrain will be enclosed in a Group or a Component and preselected before launching TopoShaper. This is the fastest and most efficient way. So, we document here only the pre-selection method. Interactive edge selection is described in Appendix.

IMPORTANT: in TopoShaper 1.0, contours must be in the HORIZONTAL plane.

There are two cases for Pre-selection (also available in the Selection contextual menu):

- 1) **New Terrain:** Just select the group or component containing the contours and launch TopoShaper. Contours are taken as all edges at first level of the group / component. Faces and other elements, as well as subgroups are simply ignored.

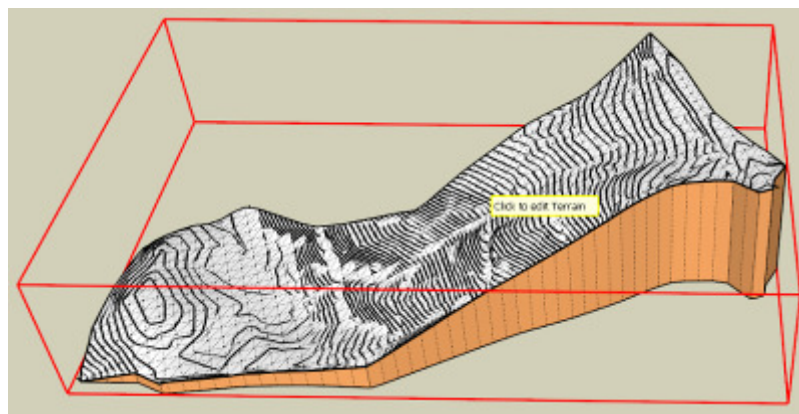
The next step is **Cleansing Contours**



- 2) **Editing a Terrain previously generated:** Select the terrain group and launch TopoShaper.

The next step is **Calculating Contours and Preview**

Alternatively, you can start TopoShaper without a selection and hover on existing terrain groups which will be highlighted in **Red**. Clicking on the terrain group will recalculate the terrain and directly go to the Preview mode.



Step 2 – Cleansing Contours

In many cases, the iso-contours have been created in another application and then imported into Sketchup, often as a DWG file. If so, the contours may not be ready for a straight calculation of terrain and need some cleansing.

TopoShaper Cleanser currently provides support for the following cleansing features.

- 1) Exclusion of designated contours
- 2) Contour simplification
- 3) Small hooks at extremity of contours
- 4) Contour junctions (automatic and manual)

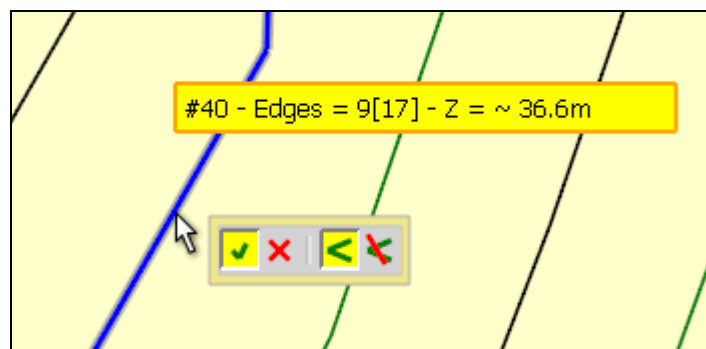
The impact of all corrections made (automatic and manual) is summarized in the message area of the button palette, with the convention “*Current figures [original figures]*” for each category of information.

```
Contours: 293 [303] - Edges: 5044 [43163]
Junctions: 182 [190] - Hooks: 11 [11] - Simplif: 281 [293]
```

In the above example, 293 contours were kept, out of 303, and 281 contours were finally simplified out of the proposed 293 (so simplification was refused for 12 contours). This reduces the number of edges from 43,163 down to 5,166. 190 junctions were detected but only 182 were kept by the user. 11 small hooks were detected, all accepted.

The default working environment for the Cleanser is the **Contour 2D-map**, where you can visualize the proposed corrections and possibly alter them or complement them interactively.


Contours can be selected and deselected, by clicking on them. A small button palette will then appear close to the cursor:



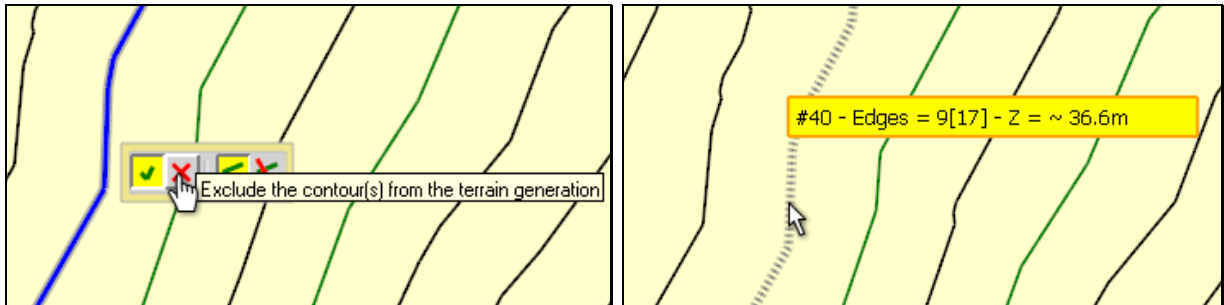
Contours can all be deselected by clicking anywhere, except on a contour.

Note that the options for cleansing are also available from the contextual menu, including when a contour is just highlighted as you hover on it.

1) Contour Exclusion

Once you have selected contours, just click on the **red cross**  to exclude the contours. By clicking on the green check mark, you will include them again in the contour set.

Excluded contours are shown with a **dashed line**.



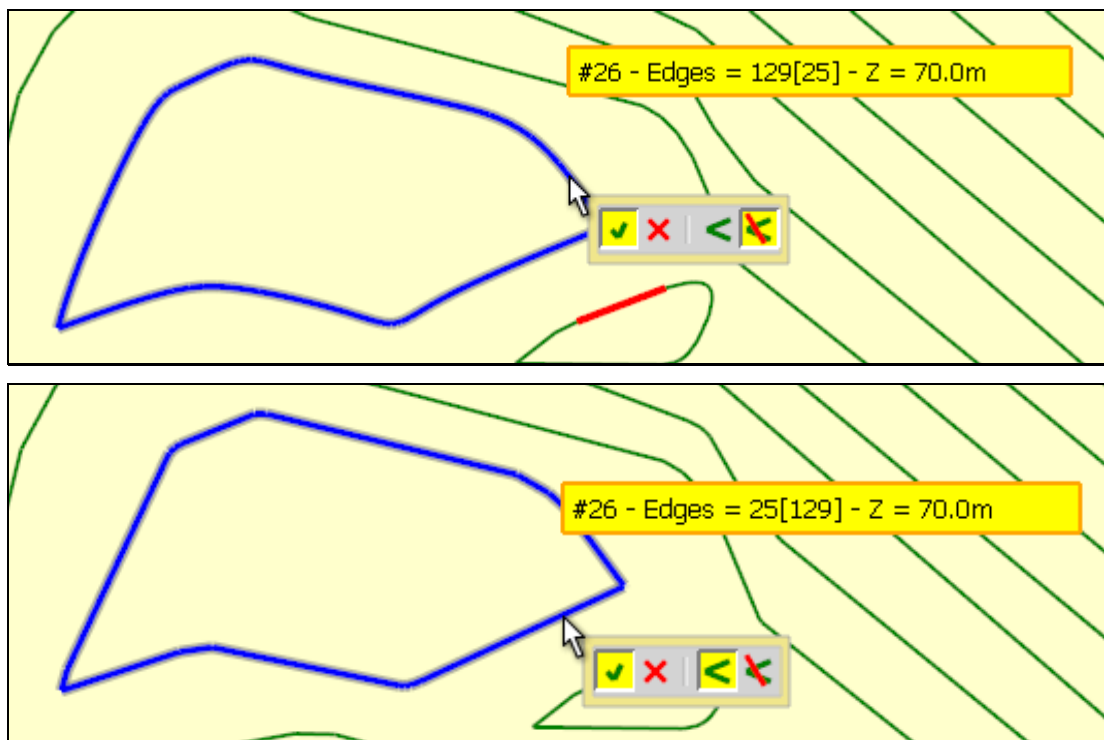
2) Contour Simplification


TopoShaper makes the terrain calculation based on a rectangular grid. Therefore, the precision of contours is of secondary importance (it actually rather slows down the calculation).

TopoShaper provides automatic simplification of contours. The Angle used, 8 degrees, is small enough that you may not visually notice the difference in shape, but this will drastically reduce the number of edges and speed up the terrain generation.

Simplified contours are shown in green.

The new number of edges after simplification and the original number of edges are shown in the tooltip of the contours. Hereunder, a contour of 129 edges originally that can be simplified into a contour with 25 edges only, without any impact on the terrain generated.



You can decide to ignore the simplification for selected contours. If so, select the contour(s) and click on the 'Do not simplify' button 

Note that Simplification is really welcome as it can reduce considerably the number of edges taken into account, with almost the same results as with the original contours. Typically, you can reduce the edge footprint of an original DWG file from 40,000 edges to 2,000 or 3,000 without any impact on the quality of the terrain generated by TopoShaper.

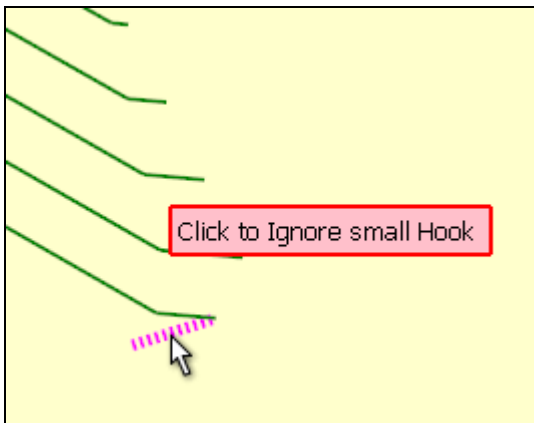
As a rule of thumb, a contour set corresponding to **less than 5,000 edges** gives acceptable performance for terrain generation.

3) Small Hooks

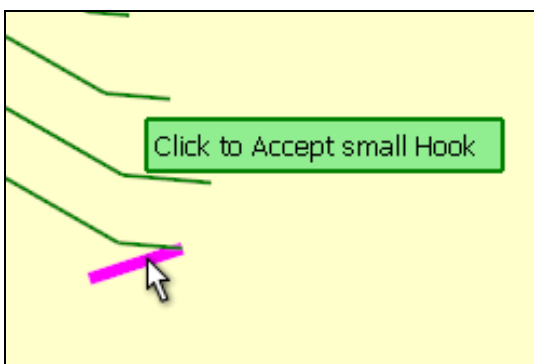
With DWG imported contours, it is frequent to observe very small hooks at the extremity of some contours. These hooks do not bring added value to the terrain generation, as they are much smaller than the grid resolution used for calculation. Instead they create problems to compute the concave hull of the set of contours.

TopoShaper detects some of these small hooks and proposes to eliminate them. This work as a toggle: just click on a small hook to enable / disable them.

Small hooks are shown in purple (but quite often difficult to see in the viewport, as they are precisely 'small').



By default, Small Hooks detected are shown in dashed line since the small segment(s) will be eliminated.

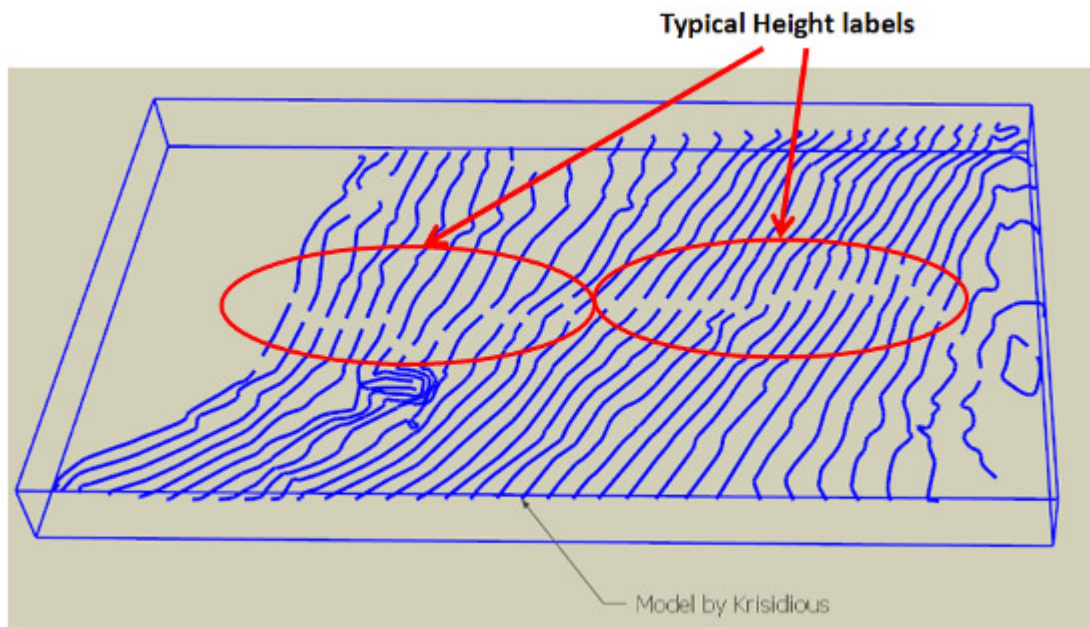


If you disagree with the proposal, you can force TopoShaper to ignore the small hook and include the small segment(s) into the contour.

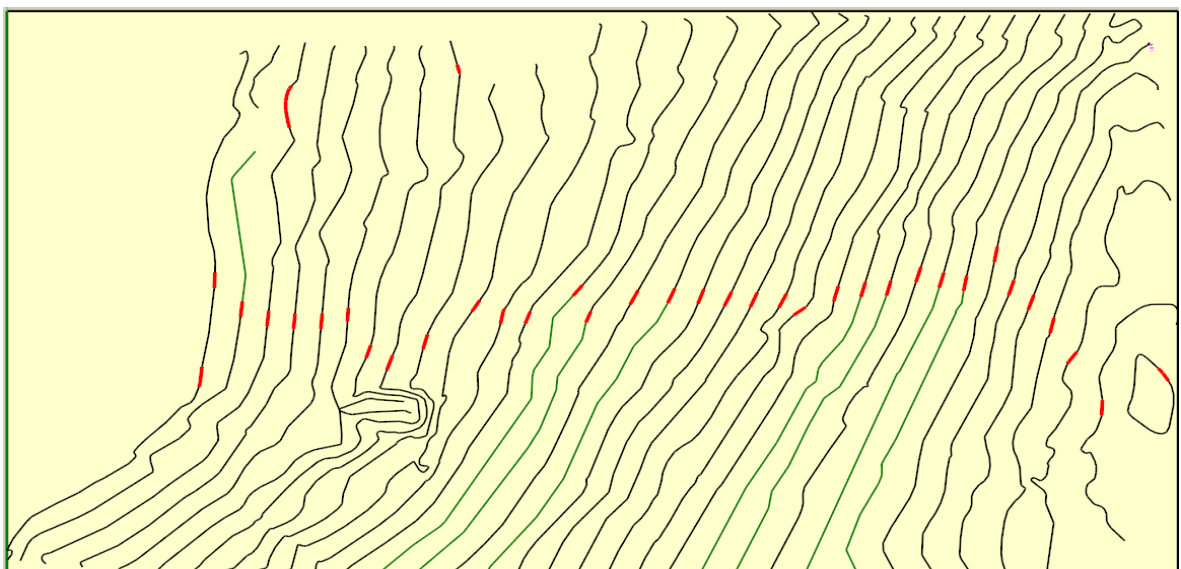
4) Contour junctions

Contours with the same altitude may not be junctive whereas they should actually formed one unique contour.

A very common case is due to the DWG importing when the **height labels** overlaying contours are simply hiding the underlying edges and prevent their importing into Sketchup. As a result this creates small gaps in the original contours.



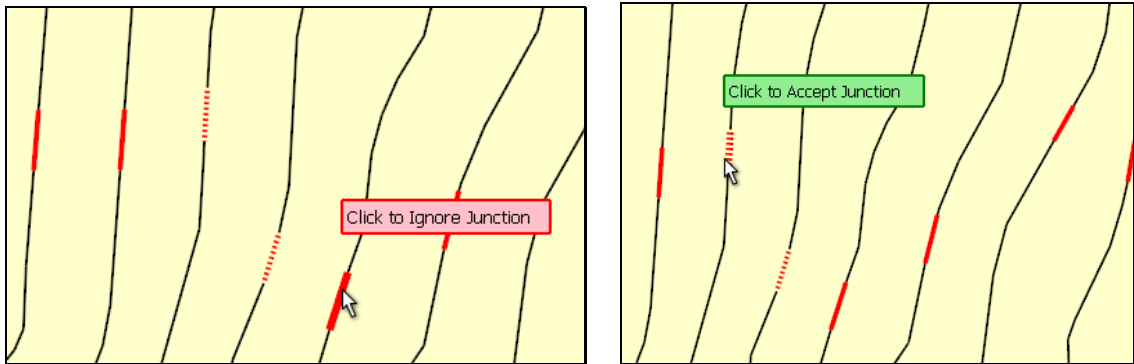
When possible, TopoShaper detects these gaps and proposes to join the contours, here highlighted in **red**.



Note: Junctions are calculated as **splines** rather than as straight segments. This means that a junction may be composed of more than one segment.

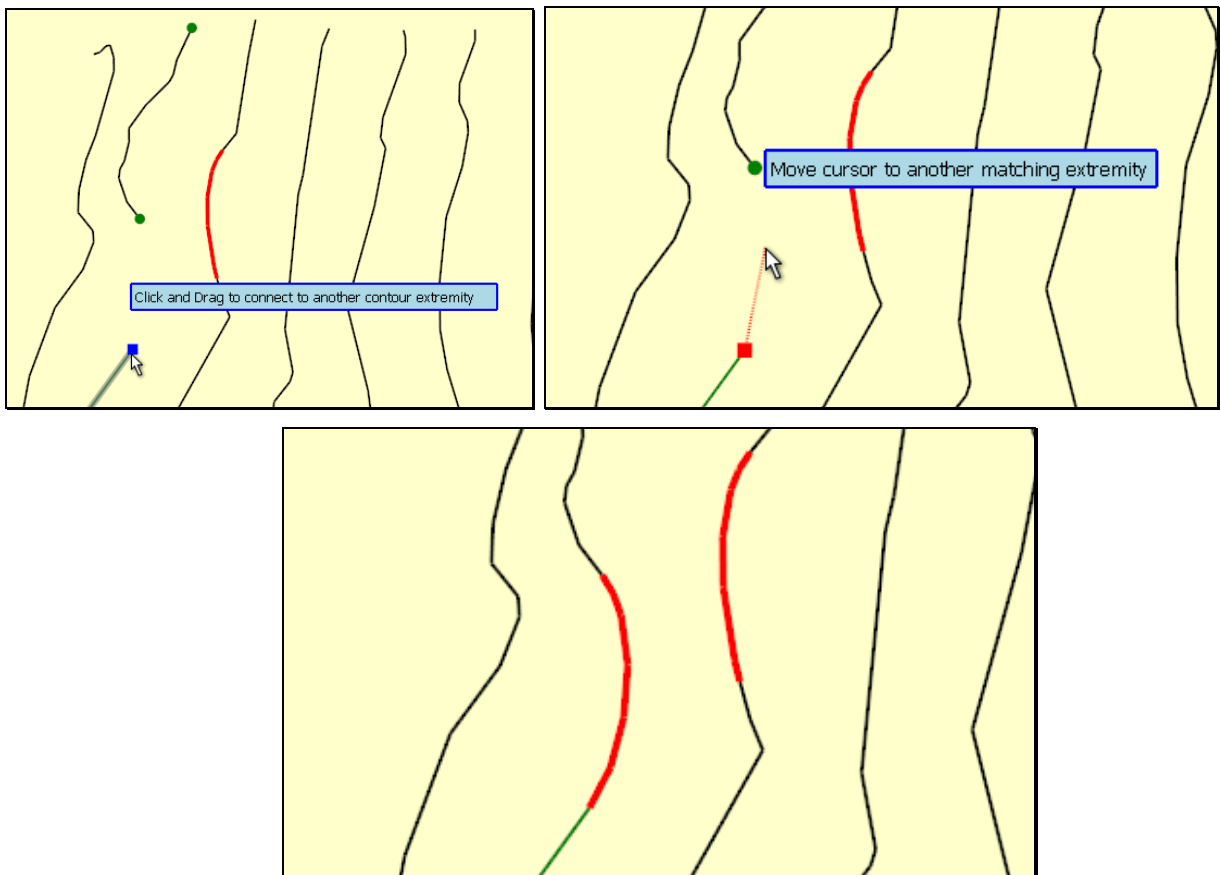
This automatic detection can however be incomplete or wrongly done, especially when the contours are arranged in quite complex configuration with various lengths. In such case you can interactively handle the junctions:

- a) **To ignore an automatic junction:** just click on a junction and it will be ignored (ignored junctions are shown with a dashed line). This ‘accept / ignore’ feature works as a toggle: if you click on an ignored junction, this will re-enable it.

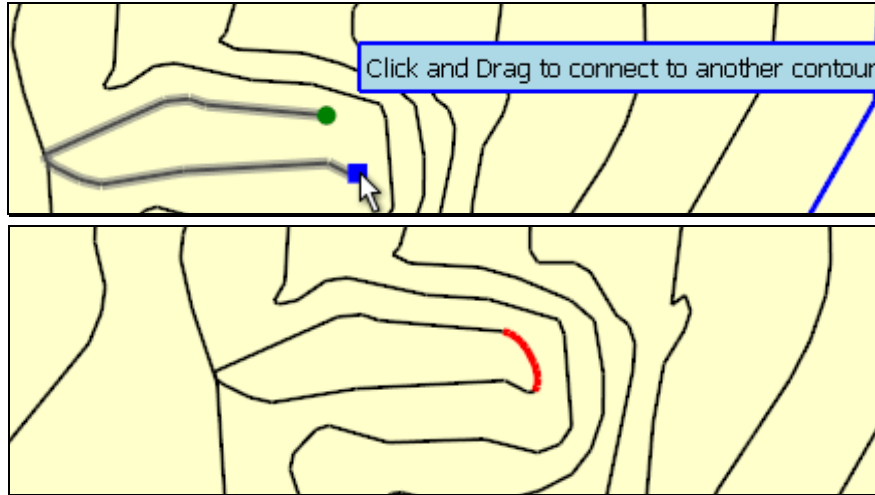


- b) **To create a manual junction:**

- hover the mouse on the extremity of the first contour, until you see a **blue square**.
- Other extremities of contours with the same altitude are shown with a **green dot**.
- click and drag to the extremity of the other contour (you see a **red square**). Alternatively, you can click / release and then drag.



This also works on the same contour when you want to close it as a loop.



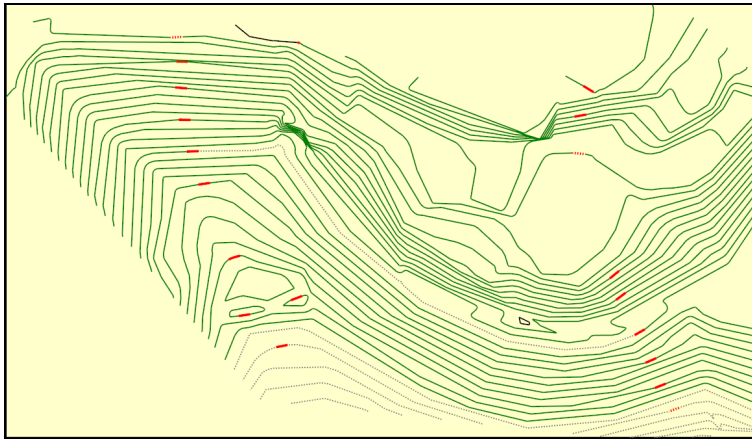
5) Updating Contours and Reload

At any point during the cleansing process, you have the possibility to save your modifications and update the original model.

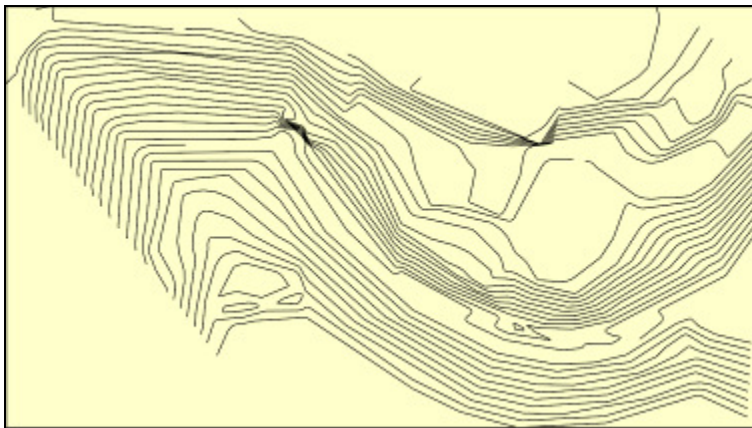


Since this is an update of the original contours, make sure you have a copy of the original ones if you need to.

The new contour set is then reloaded into the Cleanser, but this time, there is no automatic detection performed. You can then possibly exit TopoShaper.



Before Save



After Save and Reload

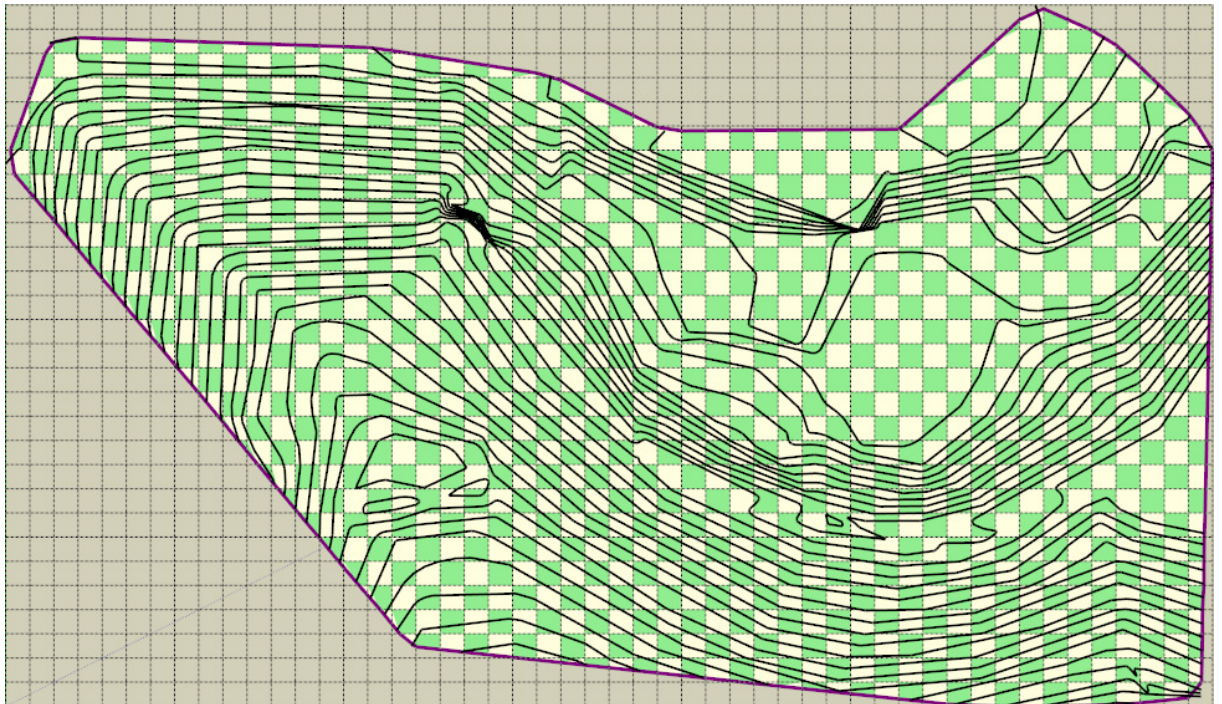
Step 3 – Calculating Contours and Preview

Once you have cleansed the contours, you can launch the Terrain Calculation process.

1) *About the Terrain algorithm*

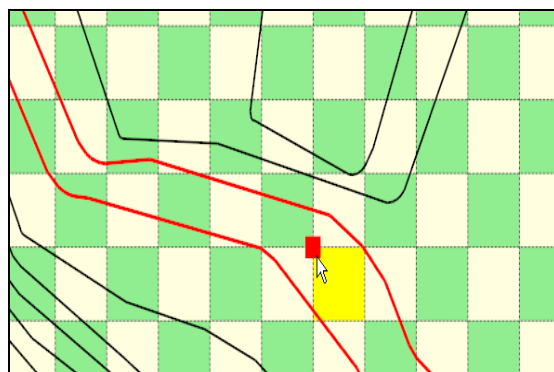
In TopoShaper v1.0, the calculation is performed on a rectangular grid. You can of course change the cell dimension in X and Y within certain limits.

The Hull of contours is calculated, except if there is a particular contour enclosing all others. This hull is often irregular and concave and implies to rely on some heuristics. This gives the projected footprint of the terrain.

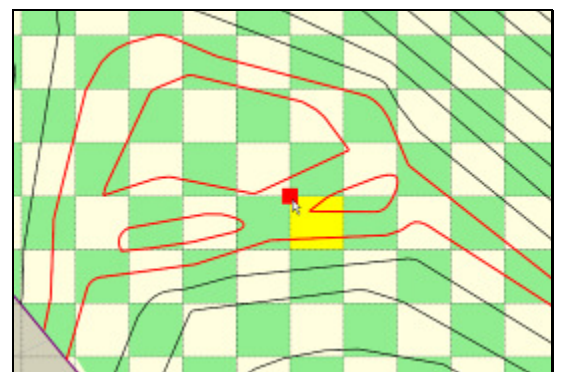


The altitude at each node of the grid is calculated in 2 configurations:

- 1) **Interpolation**: the node is located between 2 or more contours. TopoShaper determines which contours are influencing the node:

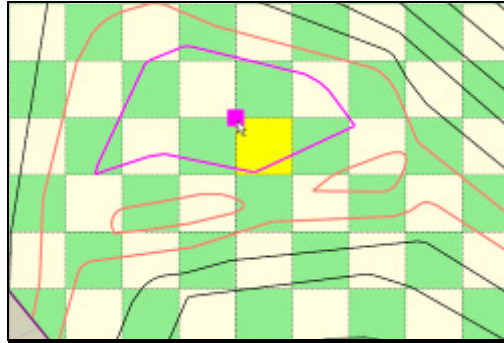


Node influenced by 2 contours

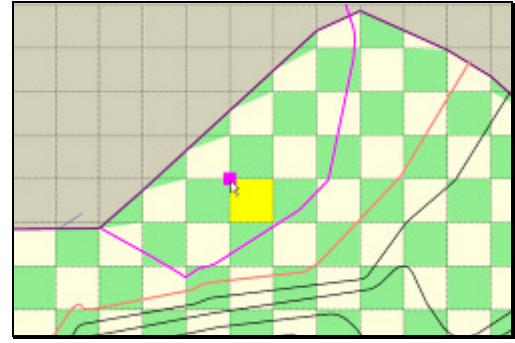


Node influenced by more than 2 contours

- 2) **Extrapolation**: the node is determined by a single contour, either because it is a loop, or when this contour is the last one before the border. Extrapolation is performed based on the altitude of this single contour (*in purple*) and the altitude of the immediate neighbors of this contour (*in pink*).



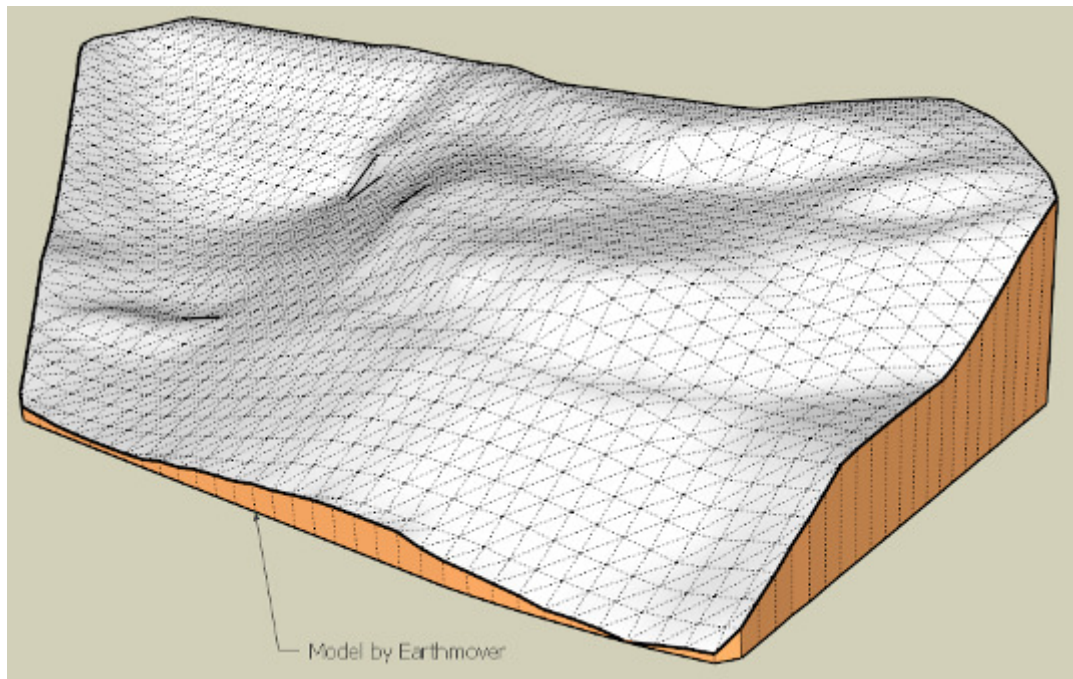
Node enclosed in a single contour



Node between a single contour and the hull border

Extrapolation is however just a heuristics whereby the shape of a hilltop (or a basin) ‘usually’ follows the surrounding slopes in a ‘smooth’ fashion. In some cases, you may want to impose a flat shape to these hilltops and basins (see later about the hilltop option).

Note: The algorithm has nothing to do with draping, shape smoothing or surface splines. A contour really acts as a barrier for influencing the local shape of the terrain as in natural landscapes. This means that the terrain can display some sharp changes of slopes and may not be smooth globally.



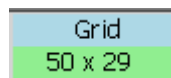
2) Setting the dimension of the Grid

For the first calculation, TopoShaper uses a grid based on quasi-square cells of **dimension 50 in the longest side**. This provides a quick preview of the terrain in order to decide on further parameter changes.

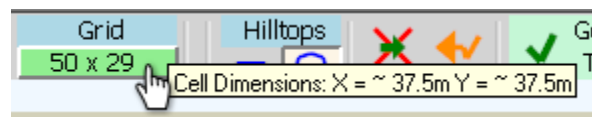
You can however change the grid resolution, either the number of cells in X, in Y or in both X and Y. When you give the resolution in one dimension only, TopoShaper calculates the resolution in the other dimension in order to keep grid cells roughly square.

TopoShaper maintains minimum and maximum values for the grid resolution, currently between 20 and 200 cells for the longest dimension. Verification is performed whenever you enter a value via the VCB or the dialog box.

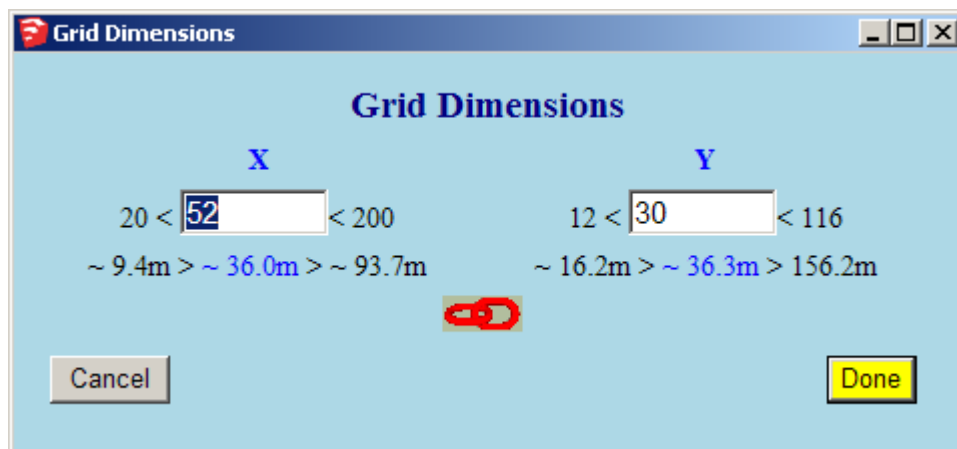
The current grid resolution is indicated in the dedicated button in the palette.



The tooltip gives the corresponding cell dimensions in current model unit.




To change the resolution, just click on the button. This will invoke the following dialog box:



In each field, you can type (formulas accepted):

- Either a resolution (number of cells)
- Or the dimension of the cell (float for current unit, or float + unit, including architectural units): example: “36.0”, “45m”, “100’4””, “4400cm”

The **red chain link** indicates that resolutions or dimensions in X and Y are linked together. When you enter one, the other is computed to keep the cells roughly square. The red chain link button works as a toggle. If you click on it, it becomes **green**,  meaning that you can now specify each dimension independently.

Alternatively, you can specify the grid resolution via the **VCB** (formulas accepted):

- Typing the resolution (number of cells) as integer
 - Just one integer indicates resolution in X. Ex: “60”
 - Two integers *separated by a space* specifies resolution in X and Y. Ex: “60 40”
 - 0 followed by an integer specifies just the resolution in Y. Ex: “0 50”. The resolution in X is then calculated.
- Typing the resolution (length of cells) as SU length, either a float for current unit or a float and the unit abbreviation. The same rules for specifying X, X and Y or just Y apply.
 - Example: “36.0”, “45m”, “100’4””, “36m 4400cm”, “0 30.5m”
 - The grid resolution will indeed be rounded up based on the dimensions

Once you have changed the grid resolutions, TopoShaper recalculates the terrain and display it in the current working view.

3) Hilltops and Basins

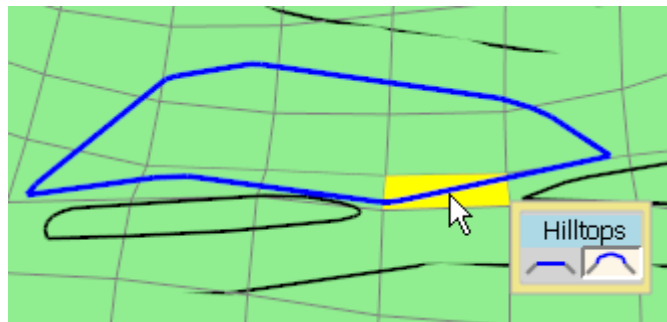
Extrapolation at hilltops and basins can be parameterized, either globally or for selected contours. There are two options:

- **Rounded**, with an extrapolation based on surrounding contours
- **Flat**

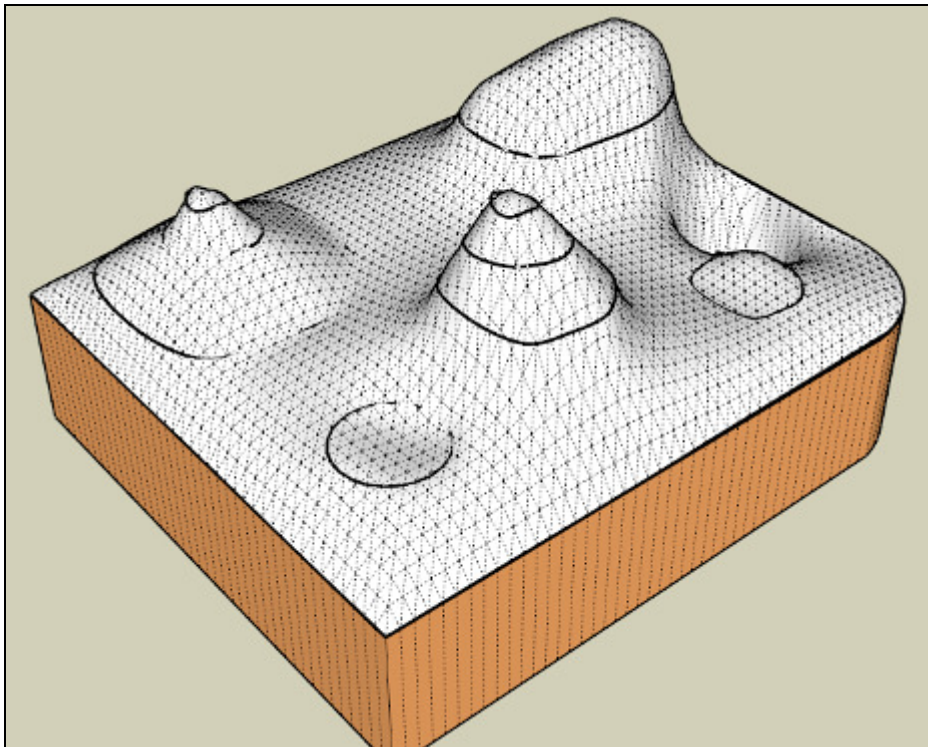
The option applicable to ALL contours is available in the main palette:



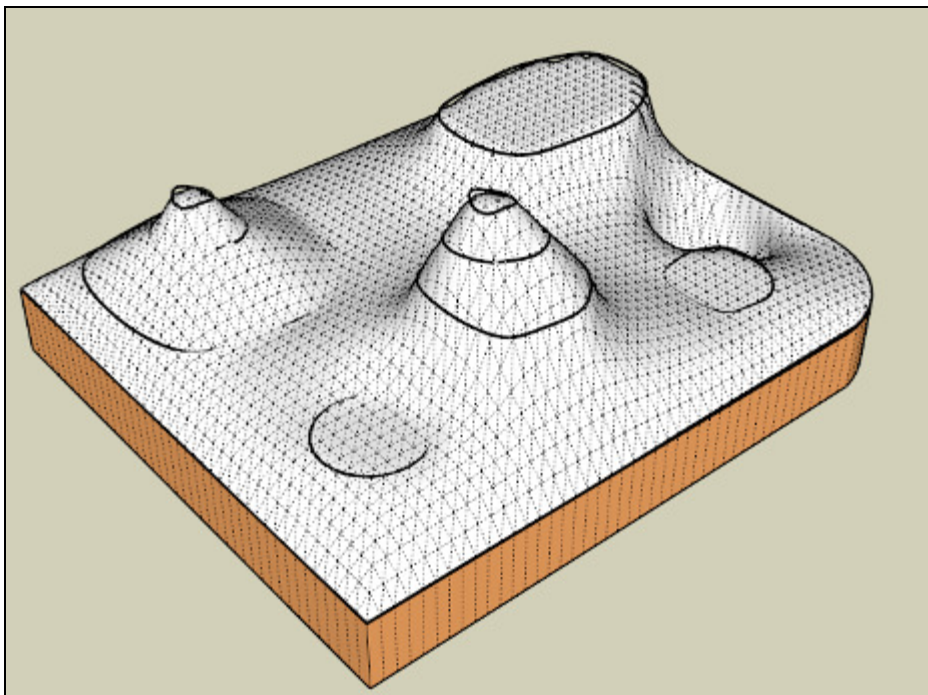
If you wish to change the option for ONE or SELECTED contours, then click on the relevant contours (this works only on contours that enclose a hilltop or basin). A small button palette will appear close to the cursor displaying the options.



Here is a typical case showing the effect of the two options



*All
Rounded*

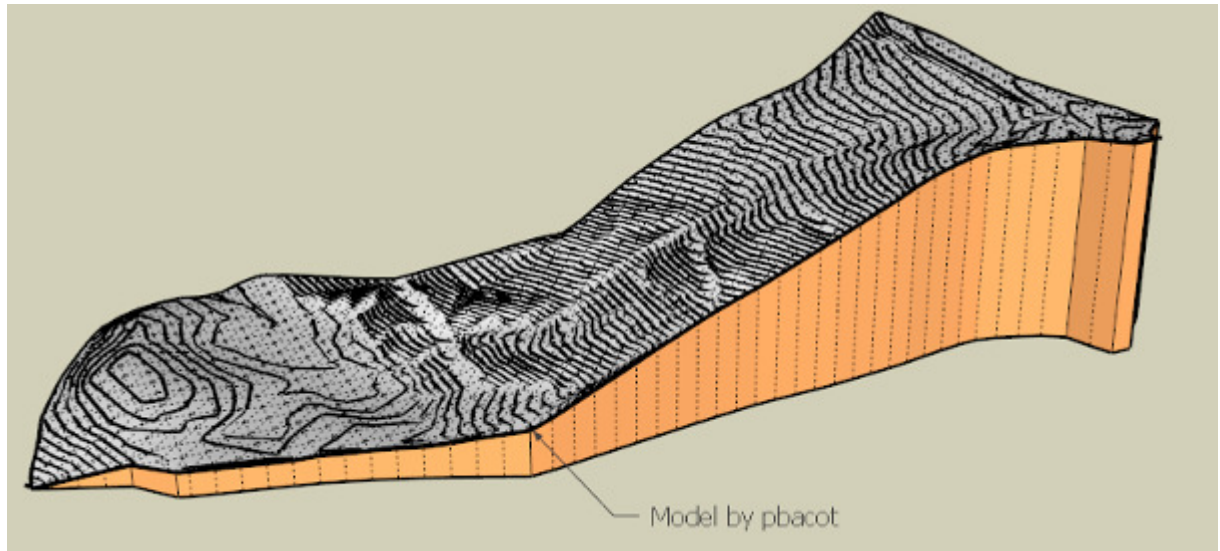


All Flat

Step 4 – Generating the Terrain Geometry

This last step performs the generation of the terrain as a Sketchup surface made of quads. These quads are made of 2 triangles. The diagonal respects the convention introduced by **thomthom** to identify quad meshes (i.e. diagonals have 'cast shadows' property off).

The current view is switched back to the main model view, with a zoom on the surface.

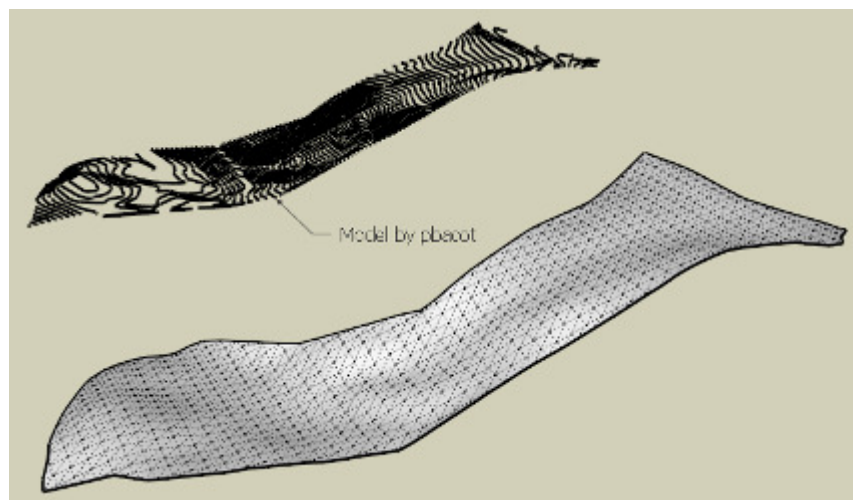


You can optionally include 3 elements, via the buttons in the palette

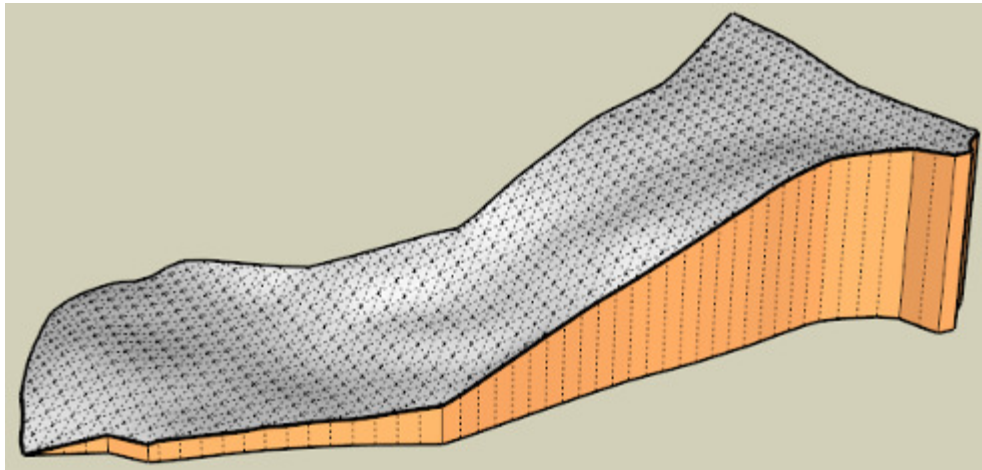


- 1) **The skirt**, which is adjusted between the level of lowest and highest altitudes. This option is enabled by default.
- 2) **The contours**. This option is disabled by default
- 3) **The contour 2D map**. This option is disabled by default

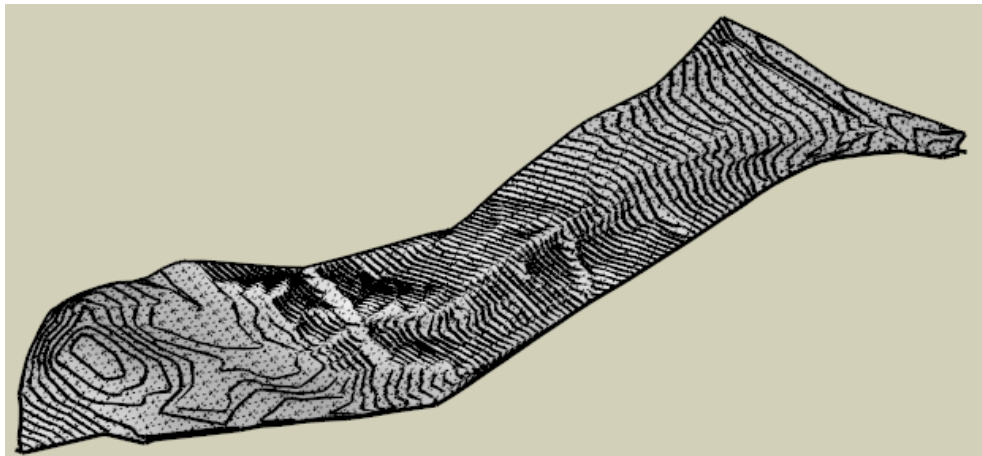
The terrain is generated as a main group containing the terrain surface.



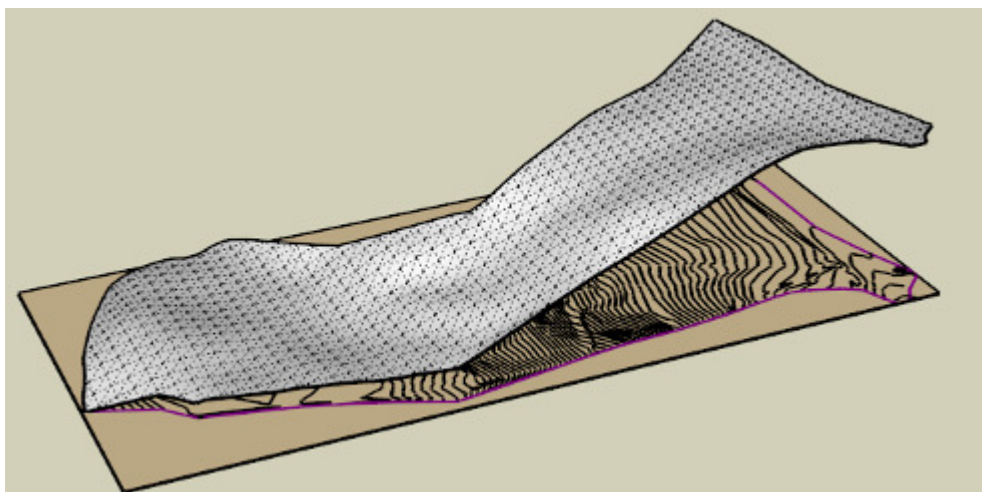
The skirt, the contours are included as subgroups of this main group. So you can easily remove them later on.



Terrain with Skirt



Terrain with Contours



Terrain with 2D contour map

APPENDIX

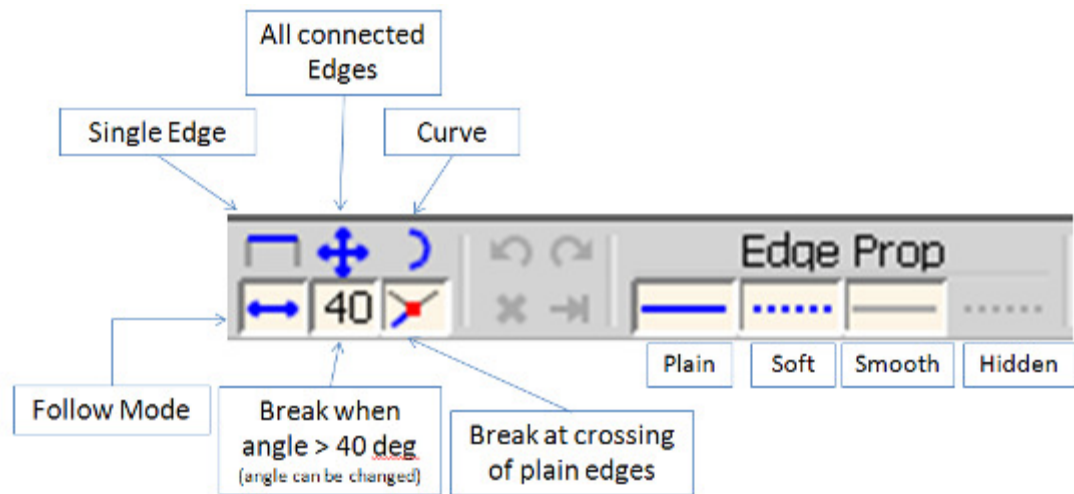
Interactive Selection of Contours

The interactive selection of contours in TopoShaper is the same as for Curviloft and Curvizard.

1) Interactive Edge Selection

TopoShaper allows selecting edges by:

- **Clicking on an edge:** one or several edges in sequences will be selected depending on the active *Extension mode* and *Edge Property filter*:



- **Clicking on a face:** This selects the edges bordering the face (but not the holes)
- **Clicking on a vertex:** this selects the edges connected to the vertex
- **Double-clicking on an edge or a face** will select all connected edges
- **Click and drag will enter the Rectangle selection mode:**
 - Dragging *left to right* only selects edges fully with the rectangle.
 - Dragging *right to left* selects edges which cross the rectangle

The edge property buttons allows filtering the edges to be selected.

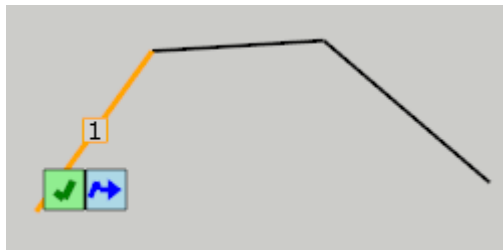
To unselect edges, the same rules apply, that is:

- Clicking on a selected edge will deselect the edge and neighbors according to the active Extension mode.
- Clicking on a face will deselect its bordering edges
- Double Clicking will deselect all selected edges which are connected.

2) Defining Sequences of edges (Contours)

TopoShaper automatically groups connected edges which are in sequence. This allows defining Contours on which to perform the requested operation. Contours are visually shown with a small number. Different Contours are displayed with different colors.

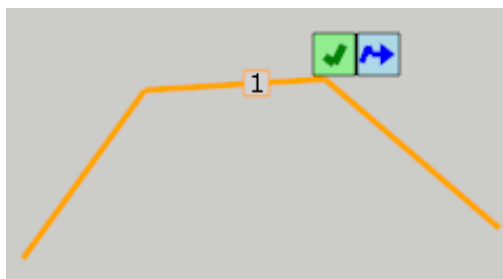
When 2 edges or sequences of edges are not connected, you have 2 Contours. They will merge into one single Contour if you click on an edge that connects them.



Clicking on the leftmost edge create Contour #1

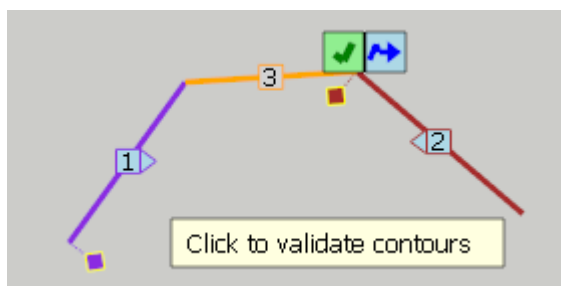
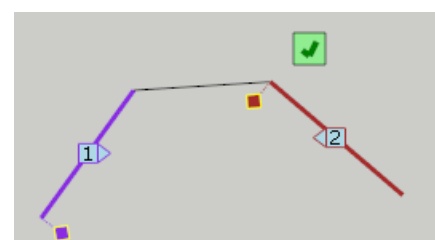
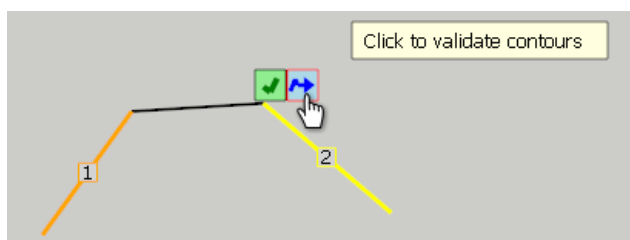


Clicking on the rightmost edge create a second Contour #2



Clicking on the middle edge will merge Contours #1 and #2 into a single Contour

However, you may want to define two or more Contours from a single sequence of connected edges. **To freeze Contours** with the current edge selection, click on the Blue arrow (or press Enter). Frozen Contours are show with a small diamond label.



The middle edge will now be part of a 3rd Contour, leaving Contours #1 and #2 frozen.

There are several ways to Freeze Contours

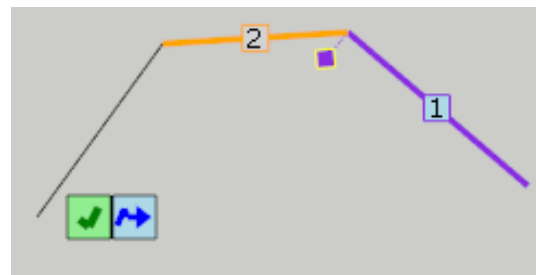
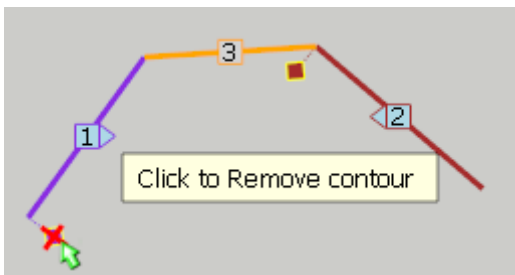


- Click on the small blue arrow near the cursor
- Click on the same blue arrow in the main palette
- Click anywhere in the empty space
- Press Enter
- Via the contextual menu

Note: If you start TopoShaper with a pre-selection, Contours will be defined based on the edges connected in the pre-selection.

3) Unselecting Contours

Just mouse over the diamond label of a Contour. A small cross appears. If you click, the Contours will be deselected.

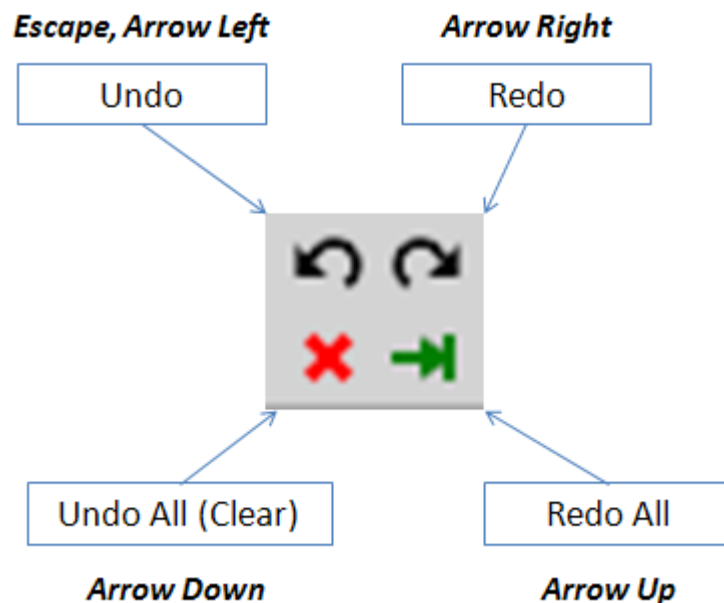


4) Undo and History navigation

All steps of the selection are recorded.

You can **Undo in sequence** by pressing Escape or Ctrl-Z¹.

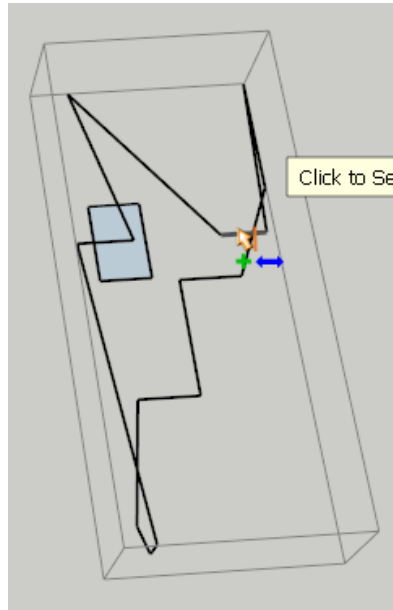
You can also use the History navigation buttons in the main palette. For convenience, the history navigation commands are mapped on Arrow keys:



¹ In Edge selection mode, the Sketchup Undo is disabled

5) **Selecting Edges within Components and Groups**

There is no difference, except that when you mouse over edges which are located within a component or a group (at any level), **its bounding box is shown in pale gray**.



Note: edges which are located in different groups or components cannot be put in sequence and therefore always belong to different Contours

6) **Validating Contours**

When you are done with the Contour selection, **you can go to the next step, which is either Preview mode or Execution mode.**

You can validate by one of the following ways:



- a) Click on the small green check mark near the cursor
- b) Click on the same green checkmark in the main palette
- c) Click anywhere in the empty space
- d) Press Enter
- e) Entry in the contextual menu