Profile Carve Plugin for CamBam

[Version 1.0.1]

Purpose

This plugin is intended to provide some capabilities to create profiled surfaces suitable for CNC machining.   The finished surface can be embossed or debossed (engraved) using a set of CamBam CAD entities as primary profile definers.

The surface to be profiled is assumed to be basically flat (at Z = 0) and the profile is carved into the surface in the negative Z-direction (debossed), or the finished surface is carved above Z=0 (embossed). In this latter case, the surface model may be translated (transformed) in CamBam so that it is placed below the stock surface for machining purposes.

The profiles are created from a CamBam drawing comprised of a set of CAD elements that define a set of lines drawn on the Z=0 plane. The drawn lines define the edges of the profile shapes that are to be carved out of the surface, at varying depths/heights and slopes. The depth/height of the surface profile at any (X,Y) point depends on its distance from the nearest edge line and the preset (limiting) minimum or maximum Z-value.

The plugin may have applications in:

- Creating surface textures from free-form shapes.
- Creating 3D models built from more regular geometric shapes.
- Creating large text (embossed or debossed) if a sufficiently large Vee or Ball bit is not available.

The created surface is saved as an STL file, that is imported into CamBam as a Surface entity.

A separate document contains some examples.

Installation

The ProfileCarve.dll file must be placed inside the CamBam plugins folder, and CamBam restarted. The ProfileCarve option will then appear in the CamBam <Plugins> menu.

Operation

To use the plugin it is necessary to create and then select one or more:

- Lines
- Polylines (including PolyRectangles)
- Circles
- Arcs
- Splines
- PointList
- Text entities

The selected CAD entities must be defined on the Z=0 plane. The profile to be created is formed by creating a surface above this plane (embossing) or below (debossing) at a height or depth that depends on the distance from the nearest entity edge. The CAD entities may be closed or open, though closed entities (could be a Polyline, Circle or Spline) can have special properties.

Closed entities leave open the possibility that one entity may contain one or more other entities. For a closed entity it is possible to tag it (in the entity's Tag property field) to behave as follows:

- **Tag = "B" for Border**: will limit the generation surface to be only inside the entity (assuming that all other entities are contained within the Border). If a border entity is not specified the extents of the generated surface will correspond to the containing rectangle shape (see Note 2). There should only be one border entry selected.
- **Tag = "F" for Flat**: will prevent surface embossing/debossing inside this element, i.e. the surface remains flat at Z=0 (see Note 3).
- **Tag = "BF" for Border-Flat**: Any points that are inside the border and not inside any other shape will be finished Flat (i.e. Z=0.0). Points outside the border are also ignored (i.e. Tag = "B" is implied).

The Tag field must be set prior to launching the plugin.

Here is the plugin dialog:
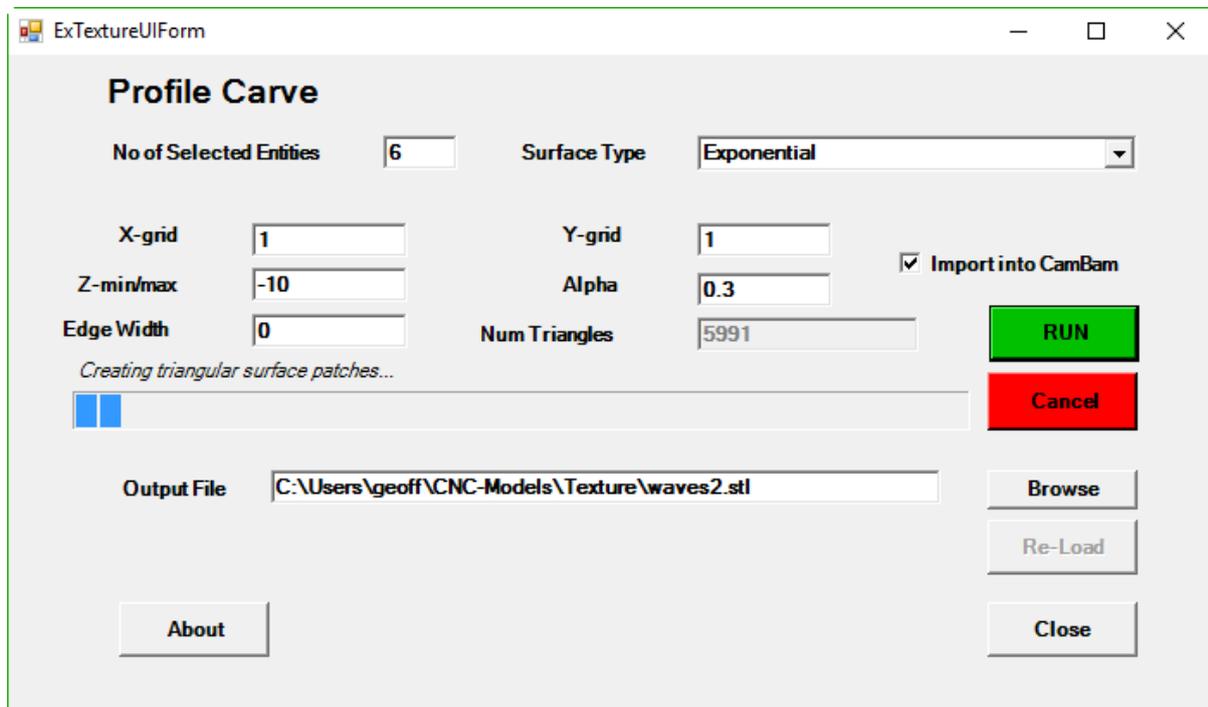
The Fields/Options are:

- **No of Selected Entities**: displays the number of entities selected when the plugin is launched. This number will include the multiple entities (Polylines) that will be generated from Text items and one for each point in a PointList (each point is treated as a pseudo-polyline).

- **Surface Type** combo: selects the required surface type, options are:

  o **Linear**: the slopes of the sides of the carving are constant (determined by Alpha values, a value of 1 means 45 deg, less than 1 means less than 45 deg) and the maximum depth/height limited to the Z-min/max value.

- o **Exponential**: the slopes of the sides of the carving are curved, following an exponential function (determined by the Z-min/max and Alpha values, Alpha is the initial slope at the edge of the profile).

- o **Circular**: the slopes of the sides of the carving follow a circular shape. The radius is defined by the Alpha value, and the Z-min/max values limit the depth/raising of the cut. The profile is tangential to the Z=0 plane.

- **X-grid** and **Y-grid**: the grid spacing (in current units) for the interpolated surface points. These values determine the accuracy of the resulting surface. Small values can increase computational times, and model sizes, significantly.

- **Z-min/max**: is the maximum Z height/depth. A negative value defines debossing (engraving), while a positive value defines embossing.

- **Alpha**: a coefficient to define the slope/shape of the edges of the profile. For linear profiles, alpha is the slope of the surface; for exponential profiles alpha is the exponential coefficient; for circular profiles alpha is the radius of curvature (in this case: alpha >= |Z-min/max|).

- **Edge Width**: is the width of the surface edges along entity lines; a zero will result in a thin sharp edge. A non-zero value is likely to effective only with entities that have edges aligned with X or Y axes or if a very high resolution grid is used.

- **Num Triangles**: shows the number of computed triangular surface patches on the surface STL model.

- **Import Into CamBam** checkbox: if checked, the STL model is automatically imported into CamBam after **RUN** is complete.

- **RUN** button: initiates the computations, the progress is displayed in the progress bar. The STL file is saved on completion. The created surface is added to the CamBam model in a new Layer named "Surface Profile", and "Surface Profile – n" for subsequent runs if this layer is not deleted.

- **Cancel** button: will terminate a long running task, and undo the most recently built surfaces.

- **Output File**: is the full path for the STL file that will be saved. By default this will be set with the same name as the current CamBam file, but with an STL extension. The **Browse** button allows this file to be re-defined. If the current CamBam file has not been saved it defaults to a file with the name "Default.stl" in the user's home directory.

- **Re-Load** button: Will reload the named STL model into CamBam. For example if removed from the **Cancel** button, or if not automatically loaded by unchecking the **Import into CamBam** checkbox.

- **Close** button: closes the dialog; the current settings are remembered for the current CamBam session.

Notes

1. There is often a need to trade-off between surface accuracy and computational times. If the solution process seems to be taking a long time (and it can do) then it may be useful to

Cancel it, and try again by setting the X and Y-grids to larger values. Having different X and Y-grid values may be useful if surfaces have curvatures primarily in one direction.

2. The plugin will normally construct a rectangular surface model corresponding to the bounding-rectangular box of the selected CAD entities. It is possible to use a closed shape as a border to limit the extent of the model. However, if this shape is not strictly convex then the resulting surface will contain some triangular patches that span the concave sections of the border shape and hence outside the border (at Z=0). The same result will occur if more than one Border type entity is defined. This may, or may not, be a concern – depending on the MOP type to be used. For example if water-line profiling is used then these surface features will probably not cause a problem.

3. Flat-topped surfaces can be defined only for closed entities. Some attempt is made to accommodate flat surfaces with holes, but holes-within-holes are not supported. In complex cases a flat surface may have to be divided into two or entities without holes to get the required surface profile.

4. Text entities are treated specially. By default all contained boundaries (i.e. the inner boundary shapes of letters like 'B' and 'O') are taken to be Flat surfaces. Hence text entities are assumed to be inside a flat border. To control more precisely how Text entities are handled they can be converted to Polylines then each entity managed as required.

5. Poorly formed Polyline entities (e.g. left over from DXF file conversions) may cause errors if selected.

6. For machining, water-line type cut profiles will often produce quite small GCode files even though the STL model is large.

ProfileCarve Plugin Versions

Version	Date	Notes
1.0.0	18/2/2017	First version for feedback and comment.
1.0.1	27/2/2017	Some suggested changes: • Some translated items removed • Undo option added • Operational logic changed for save/import operations. • UI is now modeless to provide access to main CamBam UI without closing plugin.