

# Knurl Maker

USER GUIDE  
MARCIN SZYDŁOWSKI

# Table of Contents

DISCLAIMER.....	2
<b>1. Description .....</b>	<b>3</b>
Application .....	3
Parameters.....	4
UI parameters.....	4
Real-time calculated parameters .....	4
<b>2. Installation and uninstallation .....</b>	<b>6</b>
Windows .....	6
Mac OS.....	7
Problems .....	7
<b>3. Running and managing the plugin.....</b>	<b>8</b>
<b>4. User interface .....</b>	<b>10</b>
First run.....	10
Tooltips .....	11
Common elements.....	12
Tabs and specific functions .....	18
Main parameters.....	19
Option’s tab.....	22
Information tab.....	24
<b>5. Additional information.....</b>	<b>25</b>
Sensitive data.....	25
Runtime directory.....	25
Errors.....	25
Invoices .....	26
Discounts.....	26
Known problems.....	26
Support and contact.....	28
<b>6. Table of figures .....</b>	<b>29</b>
<b>7. Table of tables .....</b>	<b>29</b>

## DISCLAIMER

Presented program should be used only for educational purposes or for creating 3D models for hobby additive printing or other proof of concepts. Models prepared by this program are very accurate and they are created due to mathematical formulas but the program itself does not perform any analysis such as checking strength, durability, or interferences.

Please make sure that the necessary validation and post-actions are done before releasing this onto production, especially when you want to make such elements by expensive CNC machines. Author of this plugin is not responsible for any damage to machines and injuries sustained due to improper use of models created by this program or due to independent modifications of the program.

Description of settings provided by the program are described later. Samples on how to perform interference, sections, and motion study is shown on the *YouTube* channel. There are also many other videos about basic operations like combining, cutting bodies, or modifying and post-processing them. If you have a specific case which needs further analysis, you can ask about it by the email in the *Support and contact* section at the end of this document.

# 1. Description

## Application

The plugin creates knurl patterns on various types of surfaces<sup>1</sup> of existing bodies. Program lets to choose the type of pattern, knurl angle, helix angle, hand of knurling and few other parameters. Document contains instruction how to install the plugin, full description of an interface, how to work with it and how to change settings.

---

<sup>1</sup> They are described in the *Common elements* section

## Parameters

Section describes parameters used in the program.

### UI parameters

Table contains ranges of options accessed by the user interface.

Table 1. Ranges of options.

Name	Symbol	Range		
		(mm or in)	(°)	-
Pattern				straight, crossed <sup>(1)</sup> , diagonal, diamond male, diamond female
Start offset	$o_s$	$\geq 0^{(2)}$		
End offset	$o_e$			
TPI	$t_{pi}$			8, 10, 12, 14, 16, 20, 25, 30, 35, 40, 50, 80 <sup>(3)</sup>
Knurl angle	$\gamma$		70, 80, 90	
Grooves numer	$n_g$	$> 0^{(4)}$		
Helix angle	$\beta$		10 ... 60 <sup>(5)</sup>	
Hand	$hnd$			RH, LH <sup>(6)</sup>
Tip flattening factor	$f_{tf}$			0 ... 1
Fillet factor	$f_f$			0 ... 0.2 <sup>(7)</sup>
angle format				decimal, HMS

(1) available for cylindrical surfaces,

(2) available when *Full length?* option is checked and depends on length of face and second offset,

(3) for very small diameters the smallest TPI may starts from larger number than 8,

(4) available for crossed pattern,

(5) available for diagonal and diamond patterns,

(6) available for diagonal pattern,

(7) available for straight and diagonal patterns.

### Real-time calculated parameters

When settings are changed or surface is selected, it automatically triggers calculation of parameters which cannot be changed manually and have only informative purpose. Table below describes meaning of these parameters.

Table 2. Real-time calculated parameters.

Name	Symbol	Meaning
Working blank diameter	$d_{wb}$	Displays diameter in millimeters and inches of selected surface. When surface has no constant diameter (conical, toroidal, or created by NURBS profile), it shows diameter of selected start which can be modified by <i>Swap start?</i> checkbox.
Teeth number	$z$	Displays number of teeth (or grooves) calculated for working blank diameter for given TPI and/or helix angle at start side.

## 2. Installation and uninstallation

Before you download the installer, please switch to the proper OS which you use. Buttons shown below should be visible on the product's website under the title of the plugin:

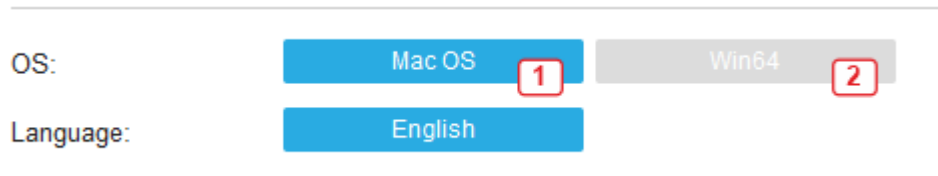


Figure 1. Active OS for downloading installer - Mac OS in this case.

Chosen system is marked by the blue color so in this case a Mac OS **(1)** is active. For choosing Windows you need to click the gray button **(2)**.

Mac OS installer should have \*.pkg format whereas Windows installer \*.msi.

### Windows

#### Installation

Installer should run automatically when you downloaded it from Autodesk® App Store. If not, you need to run it by double-click or selecting it and pressing *Enter*.

Installer is not digitally signed so file, especially when there is a new version of the plugin, can trigger Antiviruses or UAC. When such information about non-trusted file is displayed, try to proceed the operation by clicking *More options* button or make the security rule for the program.

#### Uninstallation

Exit the Fusion 360™ if you are currently running it and:

- rerun the plugin's installer and select the *Uninstall* button.

or

- go to the *Control Panel\Programs\Programs and Features*, find the plugin, select it, and click the *Uninstall* button.

## Mac OS

### Installation

Installer should run automatically when you downloaded it from Autodesk® App Store. If not, you need to run it by double-click or selecting it and pressing *Enter*.

### Uninstallation

Exit the Fusion 360™ if you are currently running it, go to the `./ApplicationsPlugins` folder and select the app bundle of the plugin, then:

- then drag the bundle to the *Trash* or right-click and select *Move to Trash*

or

- select the app bundle and then hit *Command+Delete* to move the app to *Trash*.

## Problems

- You have Windows but accidentally downloaded installer for Mac OS
  1. Unpack the *Content* folder from the `*.pkg` file – it can be done, for example, by [Zip](#) package manager;
  2. Change the name of the *Content* folder to *Pluginname*;
  3. Move this folder to the  
`C:\Users\[YOUR USER NAME]\AppData\Roaming\Autodesk\ApplicationPlugins`
  4. Run the plugin<sup>2</sup> or restart Fusion 360™.

Note: this cannot be done in Mac OS.

- You have Mac OS but plugin is not visible after installation
  1. Unpack the *Content* folder from the `*.pkg` file – it can be done, for example, by [Suspicious](#) package manager;
  2. Change the name of the *Content* folder to *Pluginname*;
  3. Copy it to the  
`~/Library/Application Support/Autodesk/Autodesk Fusion 360/API/AddIns`
  4. Run the plugin or restart Fusion 360™.

---

<sup>2</sup> Next section explains how to do this.



### 3. Running and managing the plugin

Plugin is designed to work with the newest version of Fusion 360™ and works only with tabbed UI. When installation went properly, plugin should be shown in the *OTHERS* (1) panel of *SHWIVEL* (2) tab of *DESIGN* (3) workspace:

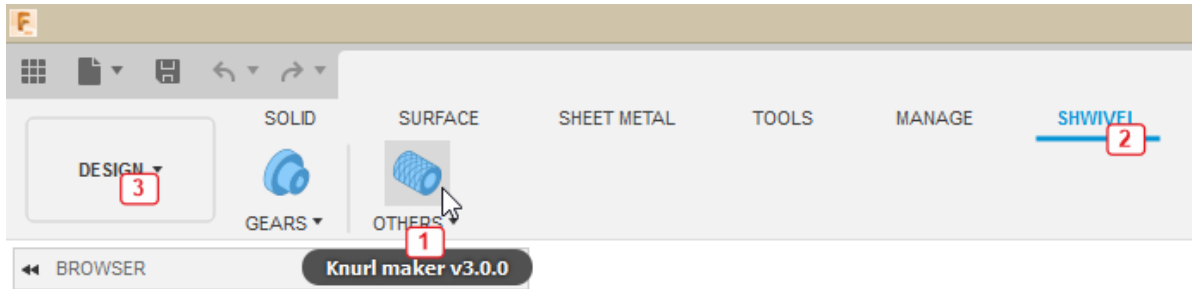


Figure 1. Where to find the plugin.

Then, plugin is ready to work and for run it, you need to click the icon or position in the *OTHERS* panel.

If the plugin is not visible but you know the installation went without errors, first check if the plugin is visible by the Fusion 360™ and try to start it manually. For managing plugins, you need to run the *ADD-INS* (1) window of the *TOOLS* (2) tab as shown in the next image. By clicking the name of the plugin in *Add-Ins* (3) tab you can stop it (5), run it (6) or turn off (4) if you don't want to start it automatically with the Fusion 360™. You can get the location of the main script (8) by expanding the *Details* (7) button. This location can also be opened by pressing the *Plugin folder* (33) button which is described later.

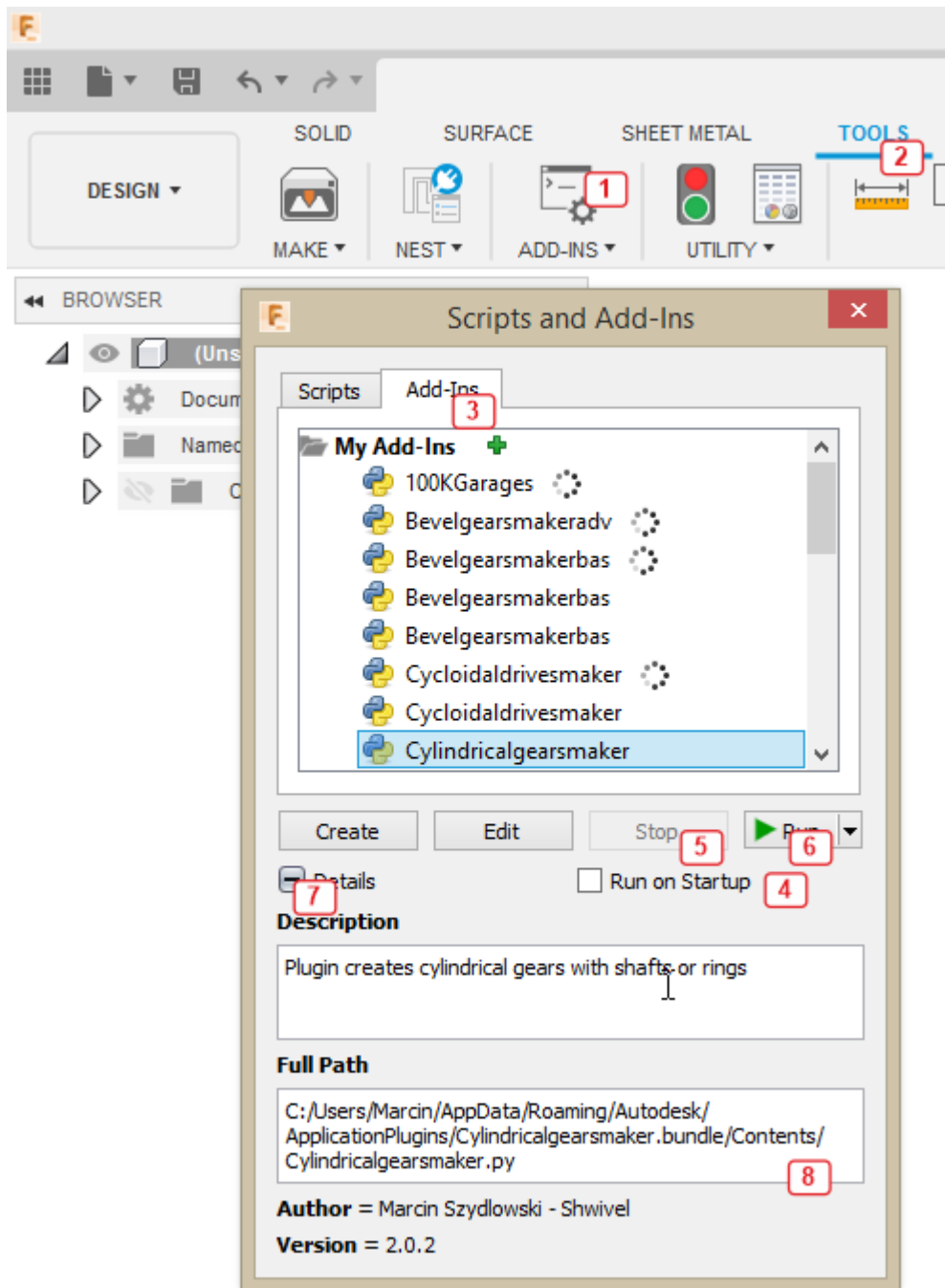


Figure 2. Managing the plugin. Add-in should be visible in the My Add-Ins tree.

## 4. User interface

This section describes functions available on user interface (UI) and how to work with the plugin.

### First run

When you run the program for the first time, window should look similar to this:

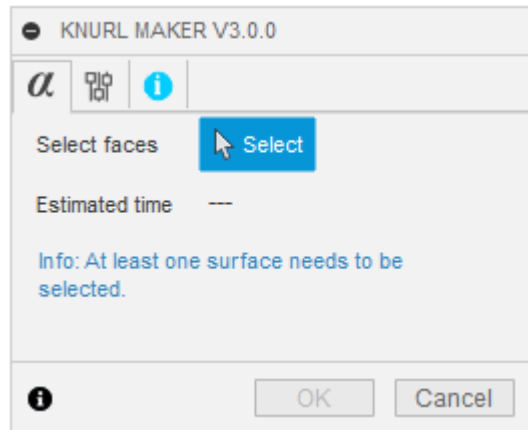


Figure 3. Plugin's window at first run.

At the default, size of the window is the same as other plugins or tools available in Fusion so it may be very narrow and cause difficult access to settings. To change this, window can be resized by dragging the lower-right corner as shown in the next image.

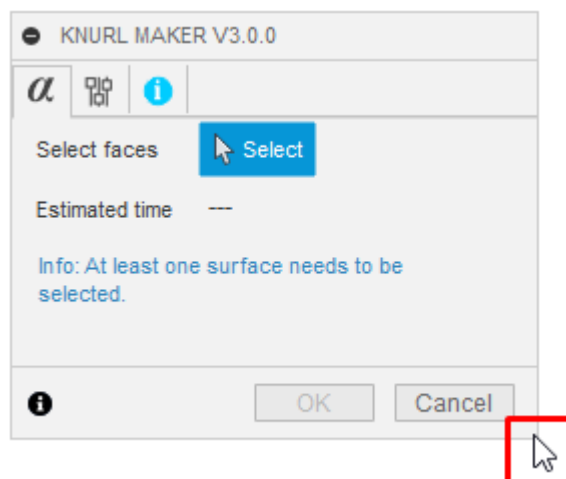


Figure 4. Resizing window.

## Tooltips

Most of the inputs contains tooltips and images for displaying quick help-balloons explaining the meaning of parameter or setting. For showing it, mouse cursor must be hovered for a second over the input. Image shows an example of this feature for selector of surfaces:

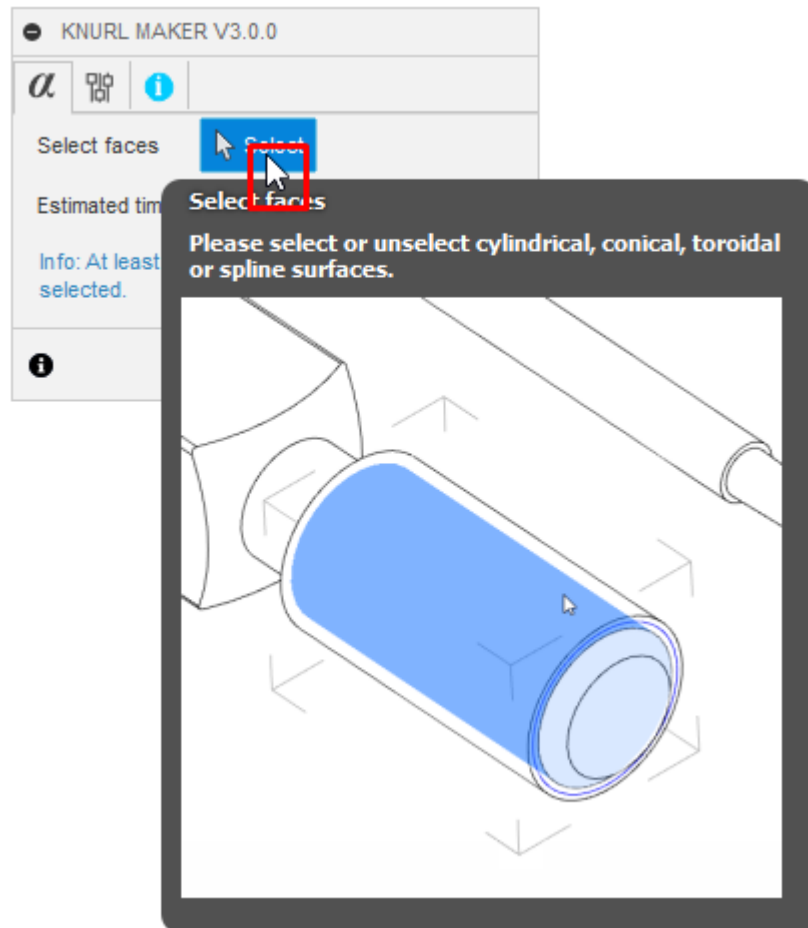


Figure 5. Tooltips.

## Common elements

Common elements of UI are always visible<sup>3</sup> and accessed on every tab.

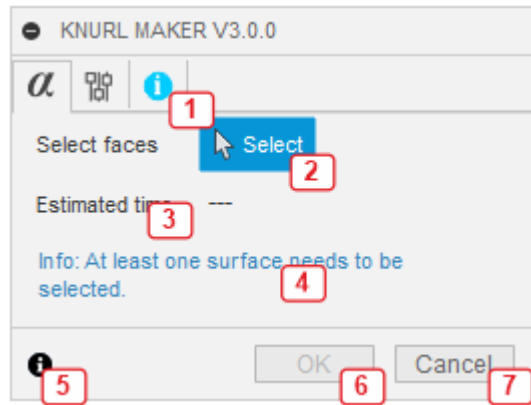


Figure 6. Common elements.

*tabs strip* (1) – used for splitting settings and organize them as groups.

*Select faces* (2) – selector for choosing surfaces. There are 5 types of surfaces which can be selected:

cylindrical:

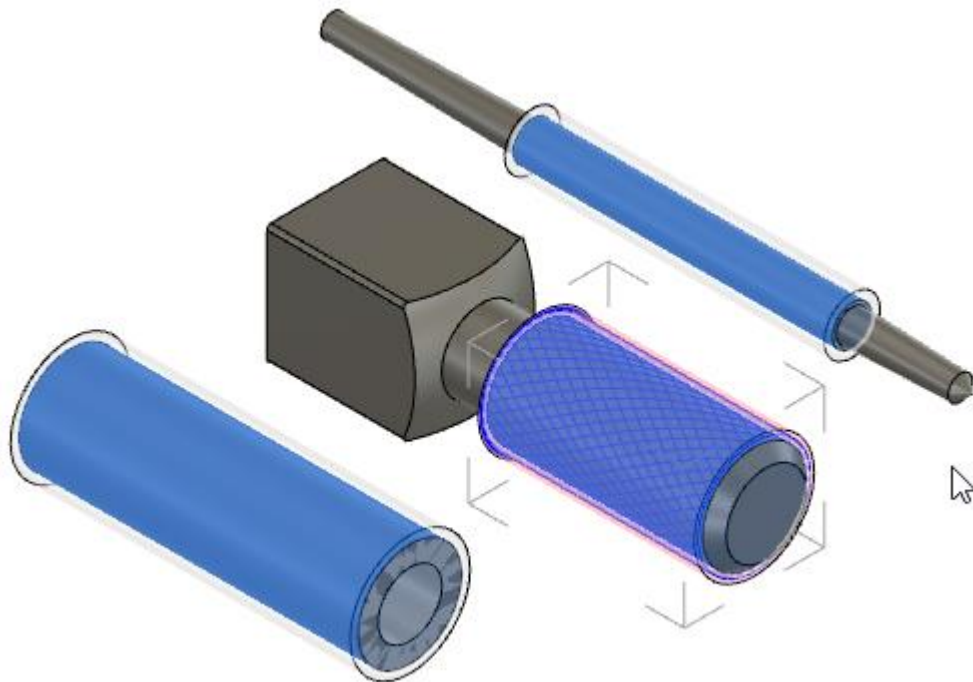


Figure 7. Selected cylindrical surfaces.

<sup>3</sup> Messages (11) are usually hidden. It is described later.

conical:

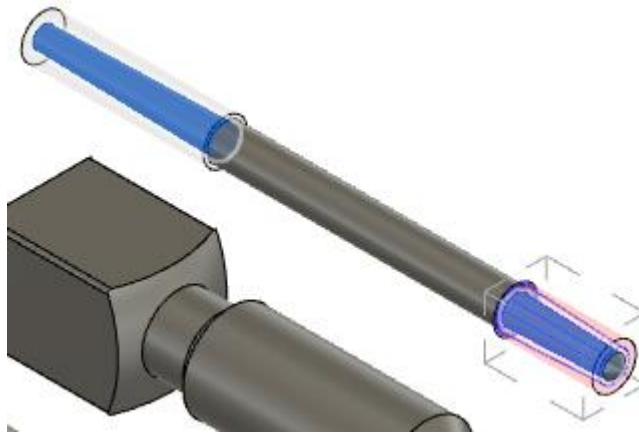


Figure 8. Selected conical surfaces.

toroidal (convex):

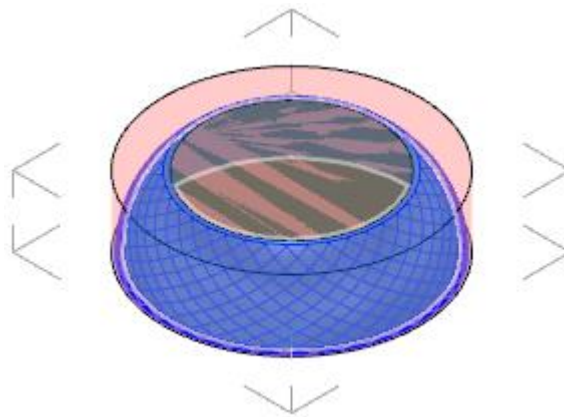


Figure 9. Selected toroidal (convex) surface.

toroidal (concave):

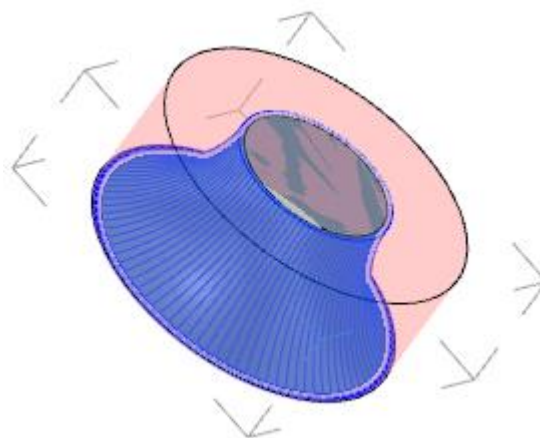


Figure 10. Selected toroidal (concave) surface.

NURBS<sup>4</sup>:

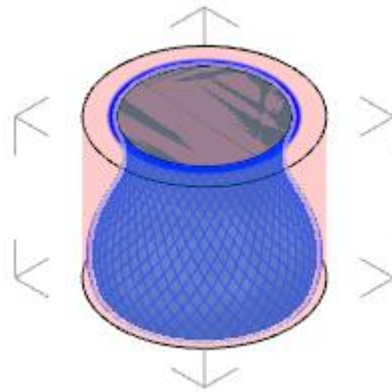


Figure 11. Selected NURBS surface.

Surface can be selected when:

- it was made by revolving around some axis:
  - line (cylinder, cone),
  - arc (ball or torus - convex or concave),
  - NURBS curve,
- it has only circular or arc edges located on its ends,

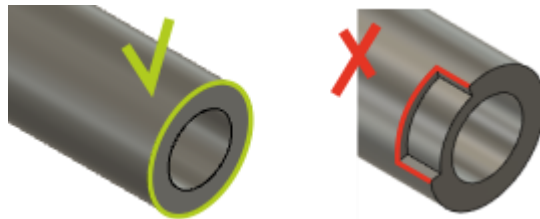


Figure 12. Valid surface (left), invalid one (right).

- has no edges between ends (holes, spigots),

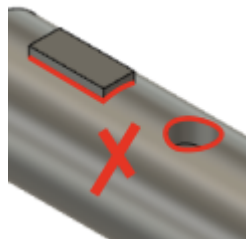


Figure 13. Invalid surface (spigots or holes).

---

<sup>4</sup> Non-Uniform Rational B-Spline

- is not an internal surface (for example, part of hole),

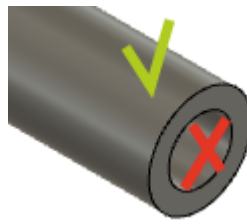


Figure 14. External surface and internal surface.

- intersection of surface has no local extrema through the axis of the surface (cases for arcs and NURBS curves).

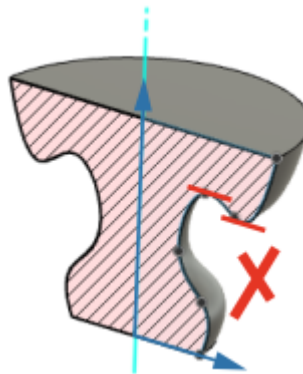


Figure 15. Local extrema of the surface's intersection.

When at least one surface is selected, a table of surfaces is presented and accessible on all tabs. Specific surface can be removed from the table by selecting it again:

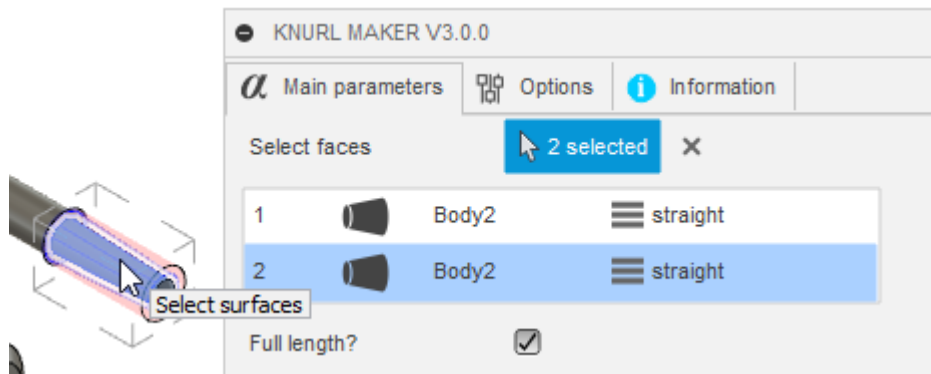


Figure 16. Unselecting surface by clicking it again.

All surfaces can be removed by pressing the “x” button near the selector’s button:



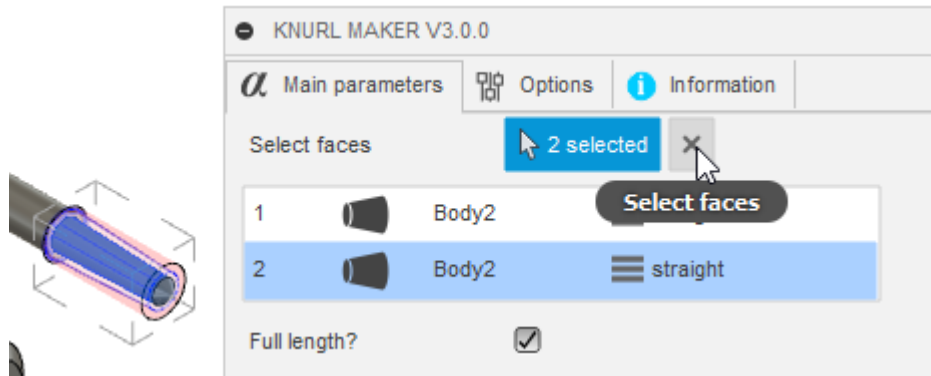


Figure 17. Removing all surfaces.

**Estimated time (3)** – shows estimated time needed for processing surfaces; the more runs, the better estimates; when program cannot find similar settings, no estimation is displayed. For small value of TPI and short surfaces, process lasts no more than few seconds. In case of non-cylindrical surfaces, larger values of TPI and diamond patterns, processing of a single surface may take a few minutes.

**Messages (4)** – shows information why something is happening or cannot be done; messages that relate to surfaces are visible only when the item related with the surface is selected; there are two types of messages:

information (**blue color**) – only one information in this plugin that the list of surfaces is empty; it prevents the process from start,

Info: At least one surface needs to be selected.

Figure 18. Information.

error (**red**) – describes the error caused by the wrong configuration of settings or range of parameter; if the error is related with the range of parameter, the wrong value of parameter will be erased when other item is selected; item error prevents further actions till error will be fixed, even when the invalid item is not selected; invalid items are marked by an exclamation mark.

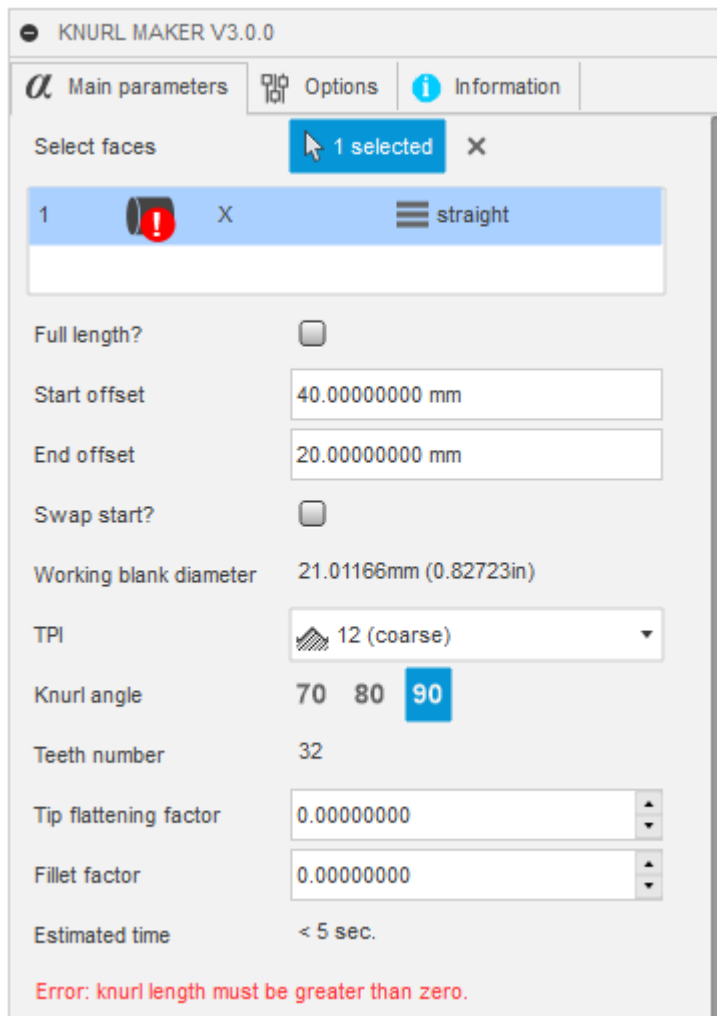


Figure 19. Error – invalid item prevents start of the process.

*Information (5)* – opens basic documentation in the default web browser.

*OK (6)* – starts processing surfaces; it is active when list is not empty, and all items are valid.

*Cancel (7)* – cancels changing settings and temporary hides the plugin's window.

## Tabs and specific functions

Interface is divided into three tabs.

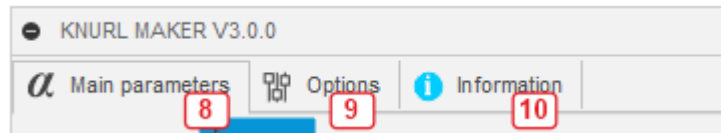


Figure 20. Tabs.

*Main parameters (8)* – settings of parameters of modified surfaces.

*Options (9)* – settings of formatting angles and displaying preview.

*Information (10)* – documentation, links, checking updates.

## Main parameters

Parameters are automatically displayed when an item is selected.

*Table of selected surfaces (11)* – shows selected surfaces; it is visible on every tab.

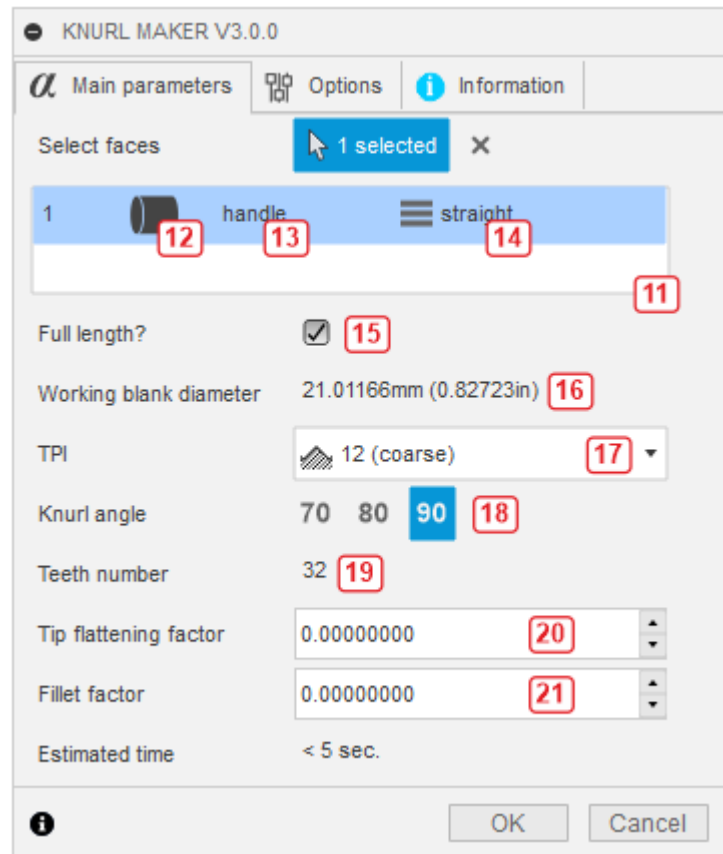


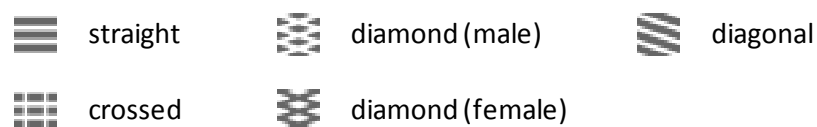
Figure 21. Main parameters.

*Type of surface (12)* – icon which represents type of the selected surface:



*Name of body (13)* – name of the parent body of the surface.

*Type of pattern (14)* – type of pattern for selected surface:



*Full length?* **(15)** – if this option is checked, knurling will be performed through the whole surface. Otherwise, there are possible to change both start and end offset of knurling range:

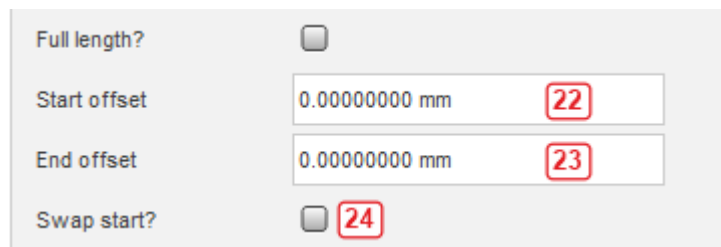


Figure 22. Changing range of knurling.

*Start offset* **(22)** – distance between the beginning of surface and the knurled area.

*End offset* **(23)** – distance between the ending of surface and the knurled area.

*Swap start?* **(24)** – checking this option swaps start with end of knurled area; it also changing the number of teeth for non-cylindrical surfaces.

*Working blank diameter* **(16)** – diameter of surface on the start side; for cylindrical surfaces it is constant, for other types it may be changed by using the *Swap start?* checkbox. It always indicate start or end diameter of the surface.

*TPI* **(17)** – teeth per inch, denotes number of teeth per one inch of circumference for working blank diameter; when working blank diameter does not give an integer number of teeth, theirs number will be rounded.

*Knurl angle* **(18)** – angle between flanks of teeth.

*Teeth number* **(19)** – number of teeth based on TPI, working blank diameter and (in case of diagonal and diamond patterns) helix angle.

*Tip flattening factor* **(20)** – factor used for mimics the amount of material squeezed during the process; when it's value equals 0, teeth are sharp, whereas 1 means that teeth are no higher than the working blank diameter.

*Fillet factor* **(21)** – factor used for adding fillet on the root and top of teeth; this setting is unavailable for diamond patterns; radius of fillet relates to the tooth's height.

### Option for crossed pattern

Crossed pattern is available only for cylindrical surfaces. It gives possibility for setting number of horizontal grooves:




Figure 23. Additional option for crossed pattern.

*Grooves number* **(25)** – number of horizontal grooves for crossed pattern.

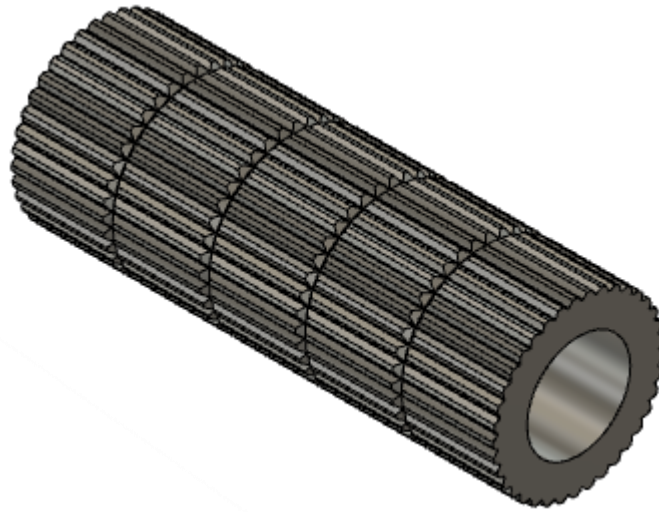


Figure 24. An example of knurl with four horizontal grooves applied to cylindrical surface.

#### Option for diagonal and diamond patterns

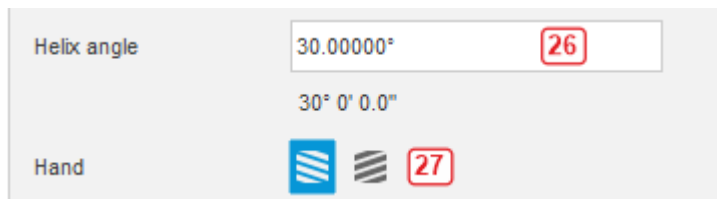


Figure 25. Additional options for diagonal and diamond patterns.

**Knurl angle (26)** – helix angle of teeth; it can be entered as decimal or HMS format<sup>5</sup>; corresponding HMS or decimal value is displayed.

**Hand (27)** – direction of teeth (right - RH or left - LH); this setting is available only for diagonal pattern.

<sup>5</sup> Angles can be switched between decimal or HMS format.

## Option's tab

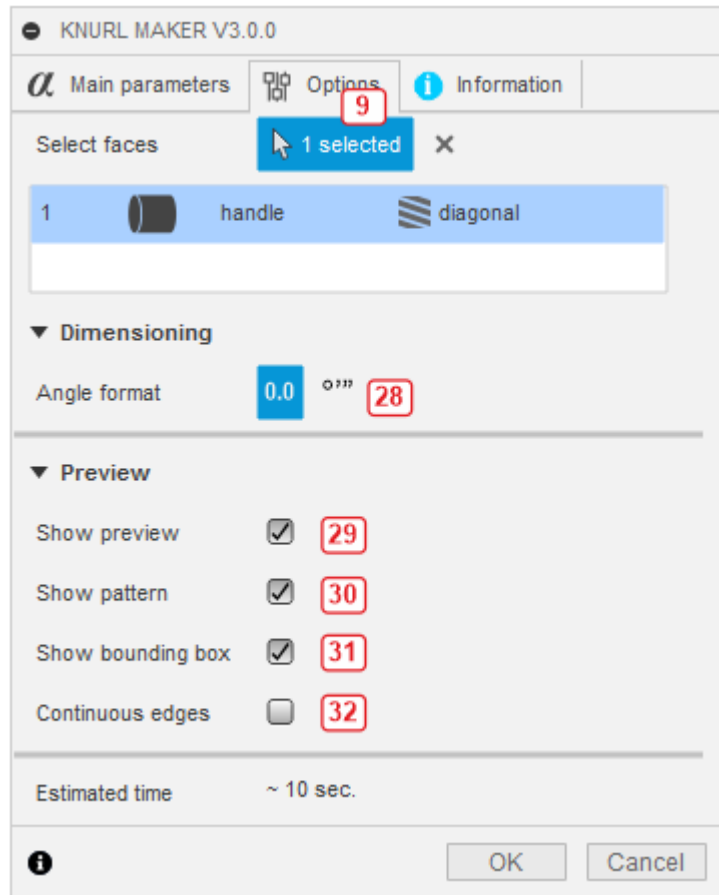


Figure 26. Option's tab.

**Angle format (28)** – options for changing way how angular values are set: as decimal (default) or HMS.

**Show preview (29)** – if this option is checked, preview of items is shown.

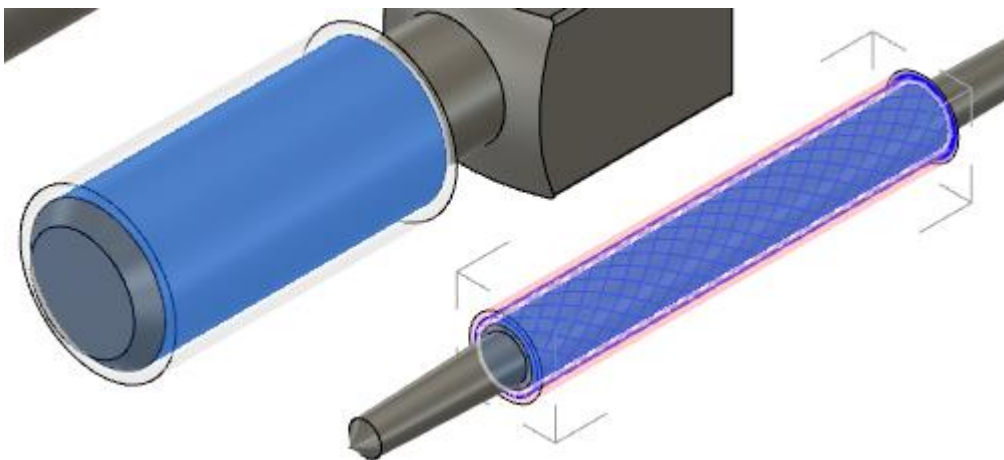


Figure 27. Preview of two surfaces: in this case, selected one is indicated by bounding box and lines of pattern.

*Show pattern (30)* – if this option is checked, lines of pattern are shown in knurling area.

*Show bounding box (31)* – if this option is checked, a bounding box is drawn around the selected item.

*Continuous edges (32)* – if this option is checked, edges of bounding box are drawn as lines, otherwise only corners are marked.



## Information tab

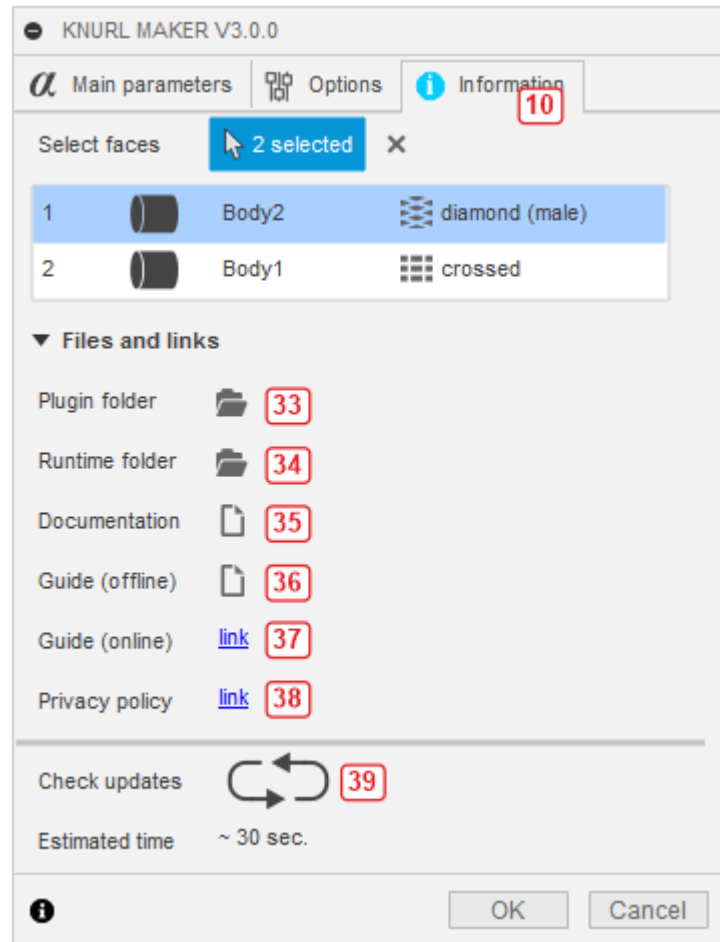


Figure 28. Information tab.

*Plugin folder* **(33)** – opens root directory of the plugin.

*Runtime folder* **(34)** – opens runtime directory of the plugin.

*Documentation* **(35)** – opens basic documentation, the same as on the website but available offline.

*Guide (offline)* **(36)** – opens this guide offline by the default PDF reader.

*Guide (online)* **(37)** – redirects to this guide by default web browser.

*Privacy policy* **(38)** – privacy policy (only online).

*Check updates* **(39)** – button for checking updates.

## 5. Additional information

### Sensitive data

Apart from version checking, no other Internet communication is done by the plugin. User data which are stored (only in case of errors) are paths of directories. This is a natural consequence of how the logging stores stack trace of errors. It is a normal and common behavior in all programming languages and technologies, and it helps to search the cause of error in files and to find solutions.

### Runtime directory

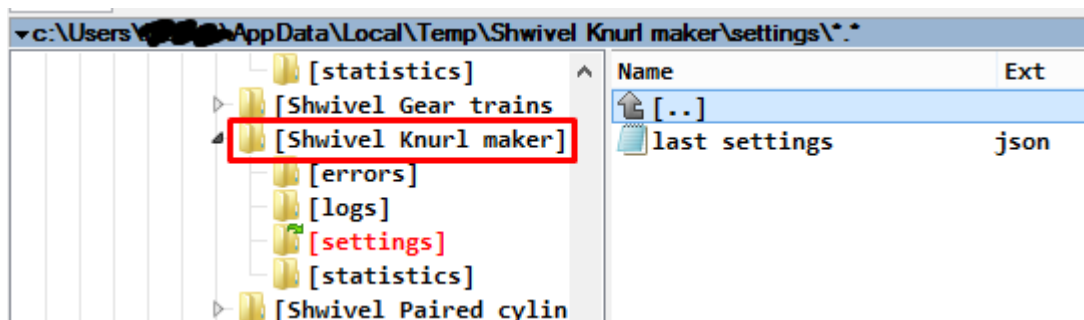


Figure 29. Runtime directory – example on Win machine.

Plugin uses a runtime directory located in the temporary folder of your system's directory. If your user does not have read/write permissions to this directory, files will not be created but you will be informed (on the *Information* tab) what you should do. Files created and used by the plugin are:

*last settings.json* - contains settings of last used parameters; it is useful when you want to repeat operation for the same values without setting all the fields once again,

*stats.json* - contains times of executions used for estimating time,

*Error\_YYMMDD\_HHmms.json*, *Stacktrace\_YYMMDD\_HHmms.txt* - contains information about errors and it is used for fixing them.

### Errors

In case of errors, information about them is saved in the *Errors* folder of the plugin. You can easily check the content of the files using the simplest text editors. These files may be very useful for fixing errors and they need to be attached to the mail to the support.

## Invoices

If you purchased the program as an entrepreneur, please send the following data to get an invoice maximum to the 15th day of the next month after the month of the purchase:

- Name of product,
- Date of purchase,
- Name of company/institution/buyer,
- Address,
- Your VAT number (in case of the company).

As a private individual you can request for an invoice 3 months after the month of purchase. Mail is in the *Support and contact* section.

## Discounts

Discount is available in case of buying a necessary number of licenses but first, they need to be bought. After that, you need to send an email which provide the name of application you bought and the number of licenses. Discount will be returned to the same PayPal account which was used for buying the plugins.

Table 3. Discount.

Number of licenses	Discount
1-3	0%
4-10	10%
10-20	25%
>50	50%

## Known problems

For some configuration of settings and specific surfaces there may occur very thin vertical surfaces after knurling:

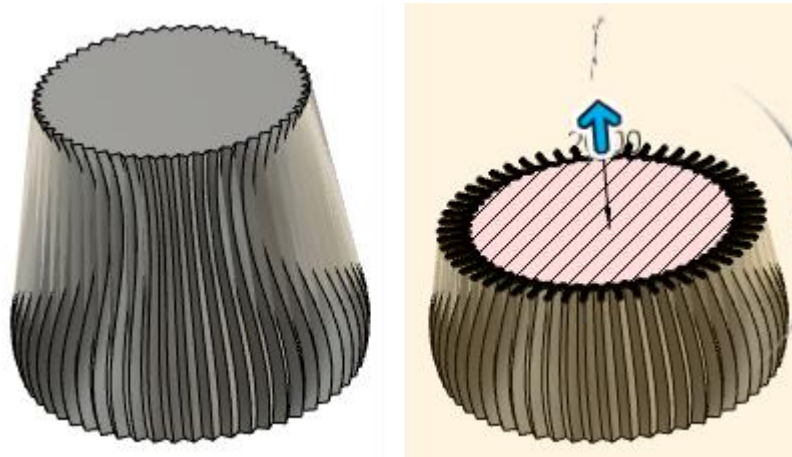


Figure 30. Very thin additional surfaces (vertical on the left) and section of the body showing them.

For avoiding it, try to change the flattening factor (**20**) for 0.05 or 0.1 (also larger values if it doesn't help). However, for printing purposes, models exported as STL are sliced without these geometries, so perimeters are valid:

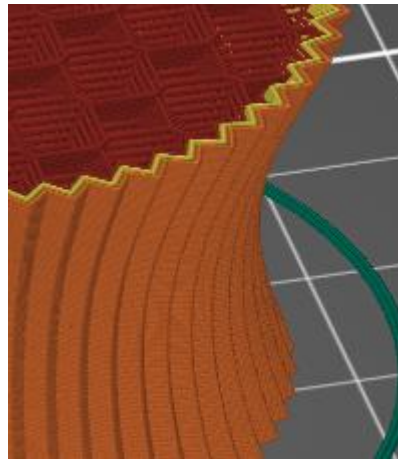


Figure 31. Sliced STL model with proper perimeters.

If you need the model for CNC graving, perform the simulation first to see if these surfaces do not prevent the tool from cutting or do not affect the path of machining.

Other problems are described in the *Problems* subsection of

*Installation and uninstallation* section. If you encounter an error linked with specific set of parameters, please use the mail from the *Support and contact* section to explain and describe your problem.

## Support and contact

Mail: [shwivel360@gmail.com](mailto:shwivel360@gmail.com)

Response would take few hours in a workday or one to two days during weekend.

## 6. Table of figures

Figure 1. Where to find the plugin.....	8
Figure 2. Managing the plugin. Add-in should be visible in the My Add-Ins tree.....	9
Figure 3. Plugin's window at first run.....	10
Figure 4. Resizing window.....	10
Figure 5. Toolclips.....	11
Figure 6. Common elements.....	12
Figure 7. Selected cylindrical surfaces.....	12
Figure 8. Selected conical surfaces.....	13
Figure 9. Selected toroidal (convex) surface.....	13
Figure 10. Selected toroidal (concave) surface.....	13
Figure 11. Selected NURBS surface.....	14
Figure 12. Valid surface (left), invalid one (right).....	14
Figure 13. Invalid surface (spigots or holes).....	14
Figure 14. External surface and internal surface.....	15
Figure 15. Local minima of the surface's intersection.....	15
Figure 16. Unselecting surface by clicking it again.....	15
Figure 17. Removing all surfaces.....	16
Figure 18. Information.....	16
Figure 19. Error – invalid item prevents start of the process.....	17
Figure 20. Tabs.....	18
Figure 21. Main parameters.....	19
Figure 22. Changing range of knurling.....	20
Figure 23. Additional option for crossed pattern.....	20
Figure 24. An example of knurl with four horizontal grooves applied to cylindrical surface.....	21
Figure 25. Additional options for diagonal and diamond patterns.....	21
Figure 26. Option's tab.....	22
Figure 27. Preview of two surfaces: in this case, selected one is indicated by bounding box and lines of pattern.....	22
Figure 28. Information tab.....	24
Figure 29. Runtime directory – example on Win machine.....	25
Figure 30. Very thin additional surfaces (vertical on the left) and section of the body showing them.....	27
Figure 31. Sliced STL model with proper perimeters.....	27

## 7. Table of tables

Table 1. Ranges of options.....	4
Table 2. Real-time calculated parameters.....	5
Table 3. Discount.....	26