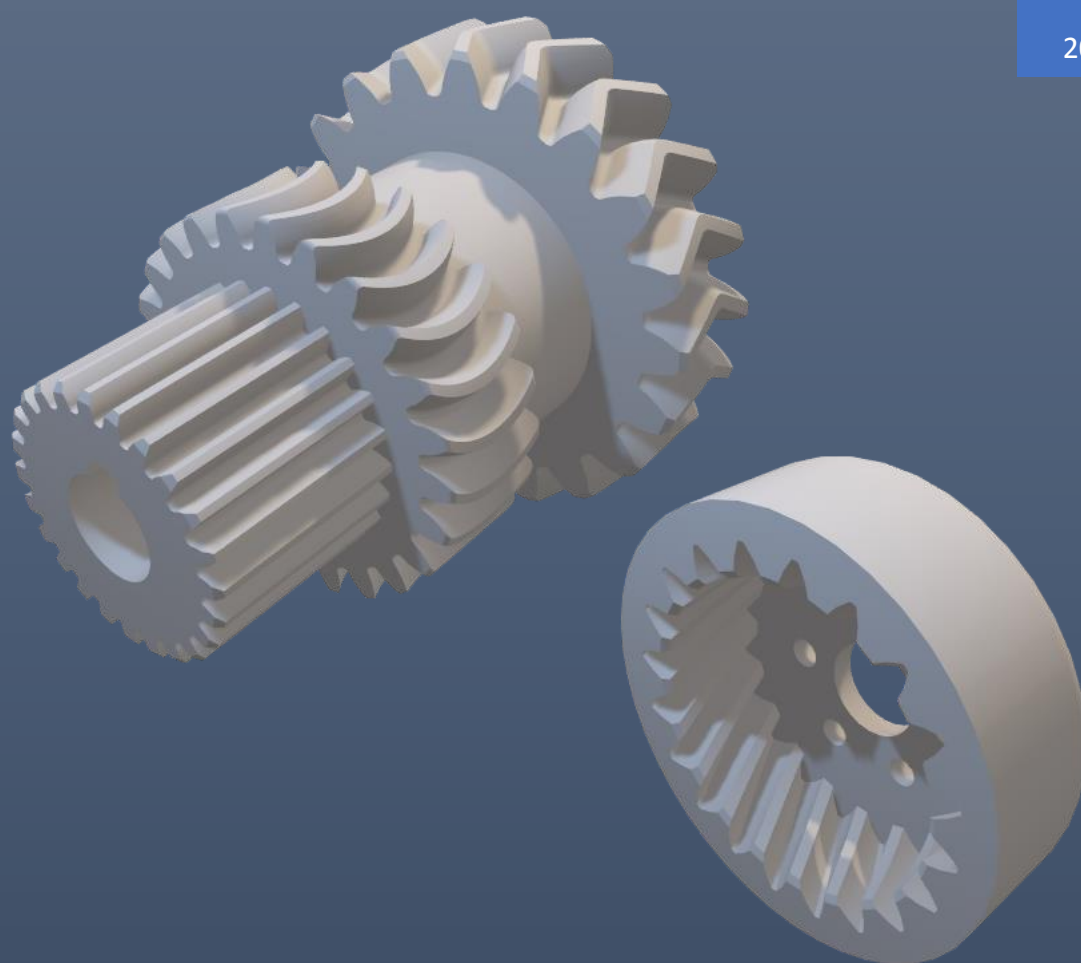


2021



# Cylindrical Gears Maker

USER GUIDE  
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SHWIVEL | <https://www.shwivel.com>

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## DISCLAIMER

The program should be used only for educational purposes or for creating 3D models for hobby additive printing. 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. The author 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 advanced settings like profile-shifting (addendum modification), backlash, tapering is 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 cylindrical gears for various set of parameters. Program lets to choose shape of teeth, system of module, dimensioning of module, units and much more. It is also possible to create simple shafts and rings if necessary. Document contains instruction how to install the plugin, full description of an interface, how to work with it and how to manage settings.

# Parameters

Section describes parameters used in the program.

## UI parameters

Table contains ranges of parameters accessed by the user interface.

Table 1. Ranges of parameters.

Name	Symbol	Range			
		(mm)	(in)	(°)	-
module	$m$	0.25 ... 50	1/128 ... 2		
diametral pitch	$DP$				0.25 ... 160 <sup>(1)</sup>
circular pitch	$CP$		0.1 ... 20		
pressure angle	$\alpha$			14.5 ... 25	
gear side					external, internal
teeth shape					straight, helical, double helical, herringbone, arc
module system					axial (A), normal (N)
Gear hand					RH, LH
helix angle	$\beta$			10 ... 45	
groove width	$w_{gr}$	0 ... $t^{(2)}$			
groove depth	$d_{gr}$				
fillet radius	$r_{ft}$	0 ... $m^{(3)}$			
cutter radius	$r_c$	0.75 $t$ ... 10000 <sup>(4)</sup>	0.75 $t$ ... 400 <sup>(4)</sup>		
teeth number	$z$				6 ... 400
clearance factor	$f_c$				0.1 ... 0.25 <sup>(6)</sup>
great diameter	$d_g$	0 ... 10000 <sup>(5)</sup>	0 ... 400 <sup>(5)</sup>		
thickness	$t$	0.5 ... 2000	1/64 ... 80		
profile shift factor	$x$				-1 ... 1
normal backlash	$j$	-0.2 ... 0.2	-1/32 ... 1/32		
taper factor	$f_t$				0 ... 0.5 <sup>(7)</sup>

relief type					tangent arc, line
relief width	$w_r$	0 ... 0.45 $s_a^{(8)}$			
relief height	$h_r$	0 ... < 0.5 $m^{(8)}$			
edge finishing type					height-width, height-angle, equal size, radius
edge finishing height	$h_{ef}$	0 ... $m^{(9)}$			
edge finishing width	$w_{ef}$	0 ... min{0.5 $w$ , $m\}^{(9)}$			
edge finishing angle	$\gamma_{ef}$			5 ... 40	
edge finishing radius	$r_{ef}$	0 ... min{0.5 $w$ , $m\}^{(9)}$			
edge finishing sides					right, left, both
hole diameter	$d_h$	0 ... 1000 <sup>(5)</sup>	0 ... 40 <sup>(5)</sup>		
custom pin diameter	$d_{cp}$	0.9 $d_{ip}$ ... 1.5 $d_{ip}$			
outer diameter	$D$	0.5 ... 2000 <sup>(10)</sup>	1/64 ... 80 <sup>(10)</sup>		
inner diameter	$d$	0.25 ... $D$	1/128 ... $D$		
length	$L$	1 ... 10000 <sup>(10)</sup>	1/32 ... 400 <sup>(10)</sup>		
displayed units					mm, in
module dimensioning					m, DP, CP
angle format					decimal, HMS
numbers precision	$pr.$				0 ... 6

- (1) all values within the range are possible,
- (2) available for double-helical gears; depends on thickness of gear, type (external/internal) and hole diameter if applied,
- (3) available for herringbone gears,
- (4) available for arc gears,
- (5) available for internal gears; limited by root diameter and depth of groove if gear is double-helical,
- (6) for internal gears or gears with very small or even non existing root area clearance can be smaller because of fillet,
- (7) available for external gears,
- (8) available for external gears and when there are no other modifications ( $x = j = f_{\bar{r}} = 0$ ),
- (9) values can be greater but then teeth have no head surfaces,
- (10) available for shaft and ring.

## Real-time calculated parameters

When settings are changed, they automatically trigger calculation of radial and measurement parameters of gears. These parameters are displayed in the *Dimensions* group which is described in the *Main parameters – gear* subsection. Table below describes meaning of these parameters.

Table 2. Real-time calculated parameters.

Group	Symbol	Meaning
Diameters	$d$	pitch diameter
	$d_b$	base diameter
	$d_a$	outside diameter
	$d_f$	root diameter
Top land parameters	$\alpha_a$	outside pressure angle; for internal gears there is $f$ denotion of root area)
	$\theta_a$	half of top land angle
	$s_a$	top land thickness
Chordal measurement	$s$	circular tooth thickness, $s_n$ – normal circular tooth thickness for helical gears
	$z_v$	equivalent spur teeth number (only for helical gears)
	$\theta$	half pitch angle, $\theta_v$ – for helical gears
	$s_j$	chordal thickness
	$h_j$	addendum
Span measurement	$z_{mth}$	edge teeth number
	$z_m$	teeth number
	$s_m$	span measurement
Over/between ball/pin measurement	$\psi/2$	half base space angle, $\psi_v/2$ – for helical gears
	$\alpha_p$	pin point pressure angle, $\alpha_v$ – for helical gears
	$\varphi$	pin center pressure angle
	$d_{ip}$	ideal pin diameter
	$d_p$	pin diameter
	$d_m$	balls/pins measurement

### Parameters saved in components

Parameters are also saved in created components. They are written in the *Description* field of *Properties* window of the component, so it is possible to copy them from it and paste to the text editor:

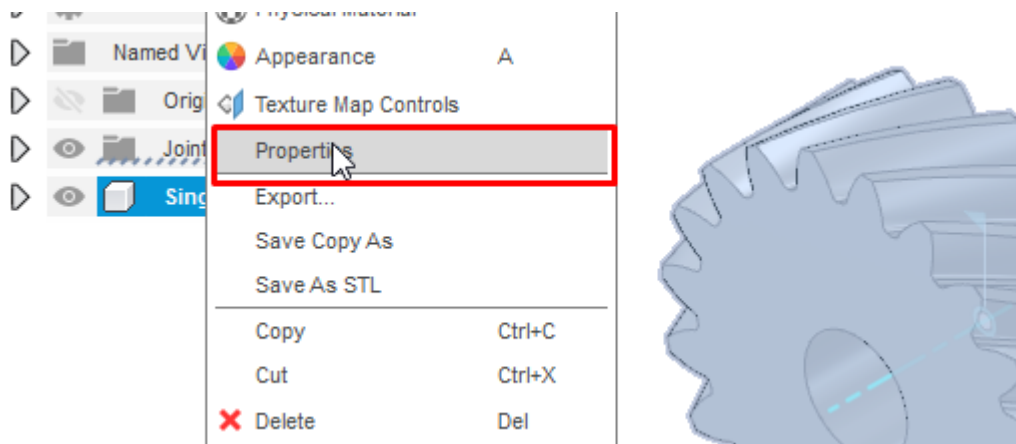


Figure 1. Properties of the component.

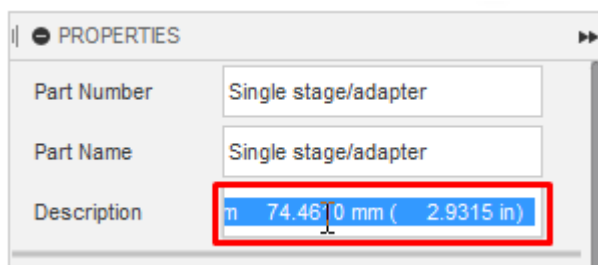


Figure 2. Selecting and copying description.

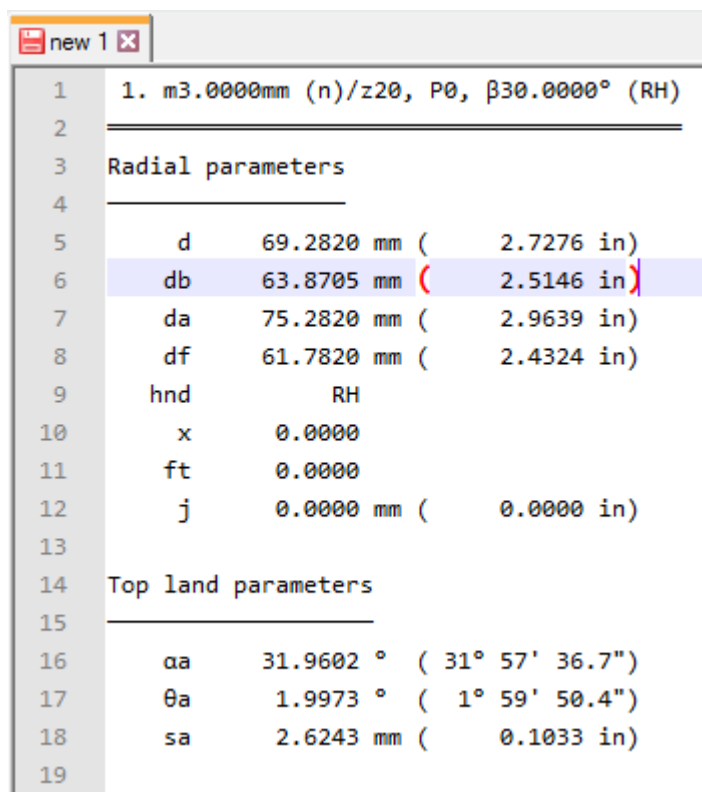


Figure 3. Pasted parameters.



## 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:

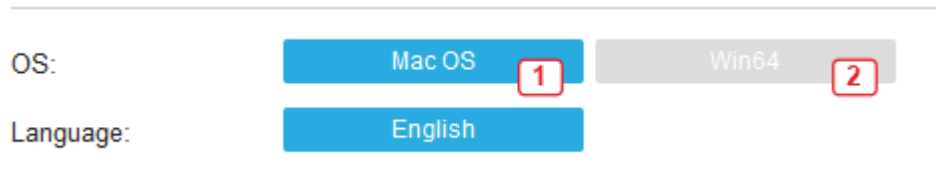


Figure 4. Active OS for downloading installer - Mac OS in this case.

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>1</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>1</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 **GEARS (1)** panel of **SHWIVEL (2)** tab of **DESIGN (3)** workspace:



Figure 5. 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 **GEARS** 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 (91)** button which is described later.

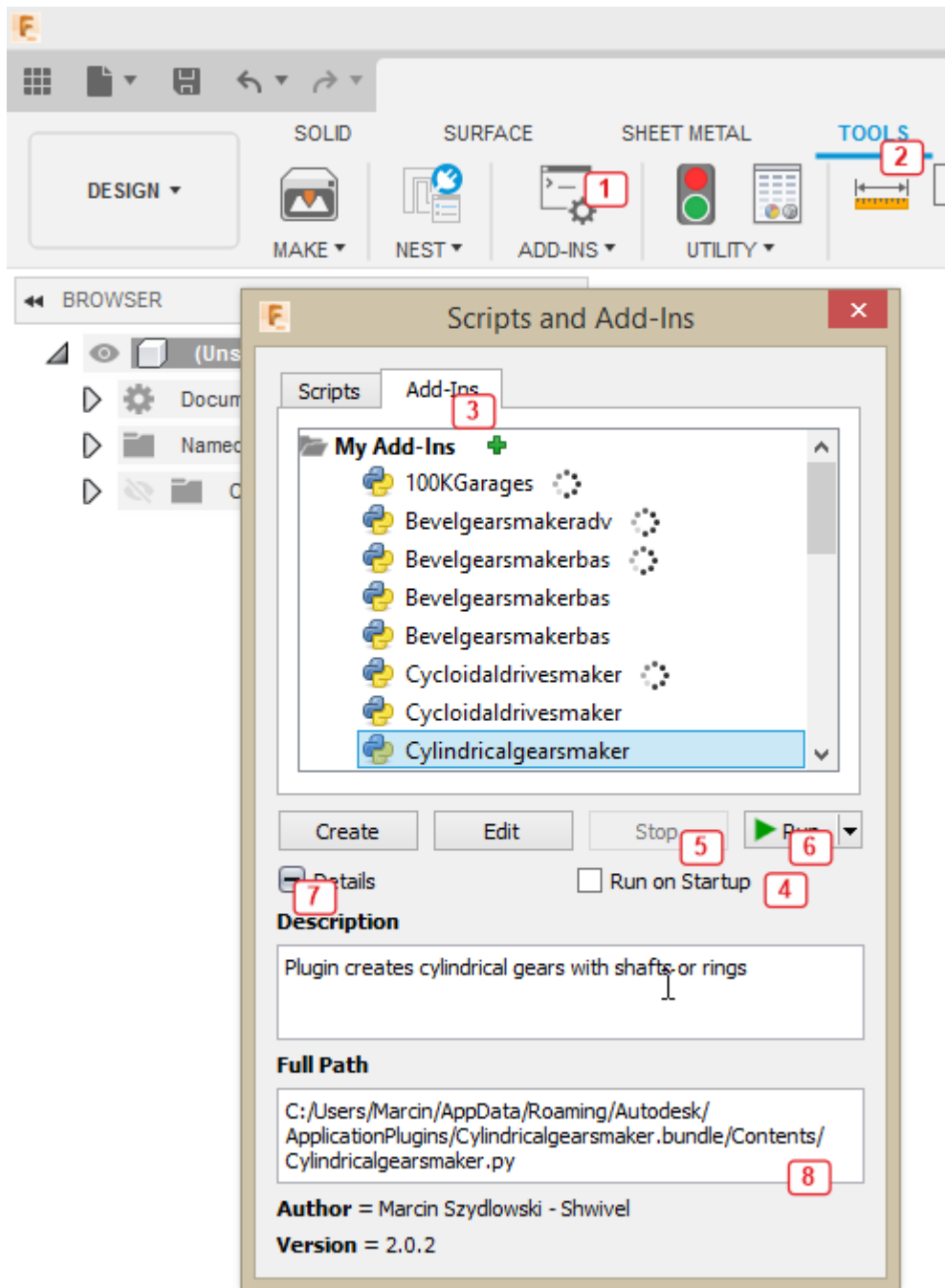


Figure 6. Managing the plugin.

## 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:

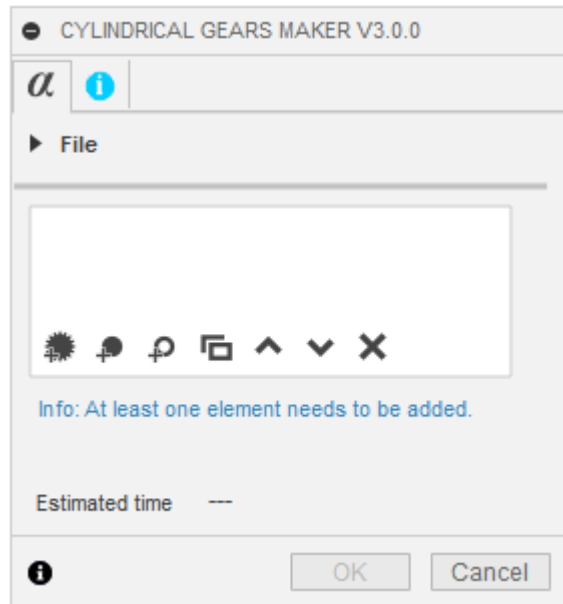


Figure 7. Plugin's window at first run.

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.

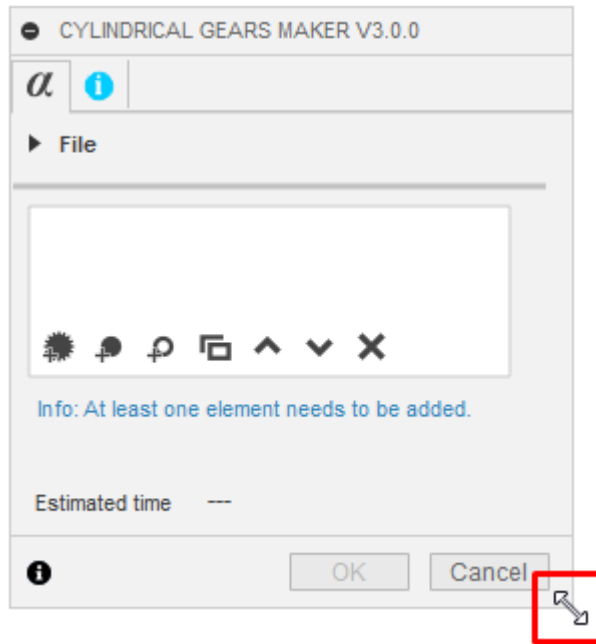


Figure 8. Resizing window.

## 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 shape of teeth:

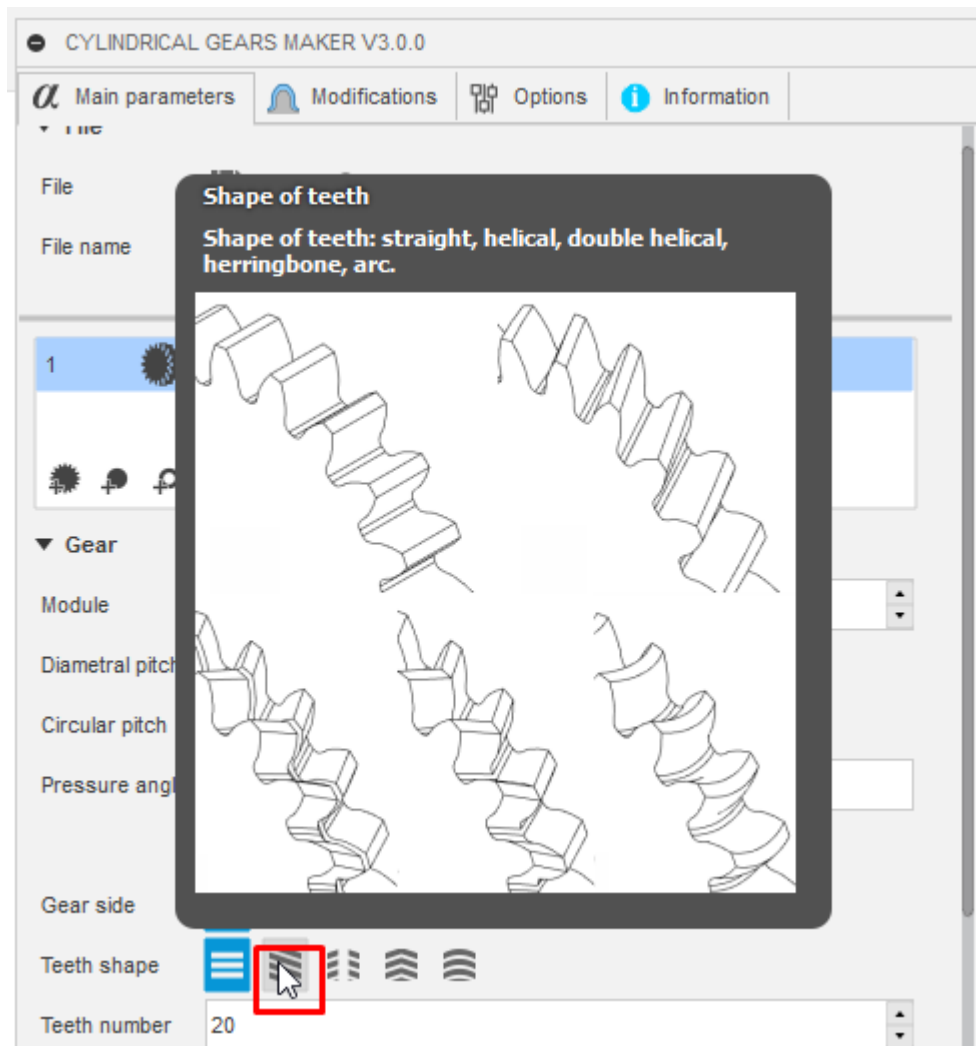


Figure 9. Tooltips.

## Common elements

Common elements of UI are always visible<sup>2</sup> and accessed on every tab.



Figure 10. Common elements.

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

*File (2)* – menu which provides saving, loading and reset setting which means fast delete (clear) all created items.



Figure 11. File group.

*Save (16)* – saves settings as JSON file to the chosen location.

*Load (17)* – loads settings.

*Reset (18)* – deletes all items.

*File name (19)* – path to the file which was loaded<sup>3</sup>.

<sup>2</sup> Messages (11) are usually hidden. It is described later.

<sup>3</sup> When there are unsaved changes, this text is marked by (\*)



*table of items (3)* – list of all items.

*Add gear (4)* – clicking this button creates a new gear<sup>4</sup>.

*Add shaft (5)* – creates a new shaft.

*Add ring (6)* – creates a new ring (shaft with a hole).

*Copy item (7)* – copies selected item and add it at the end of list.

*Move up (8)* – moves selected item one position up.

*Move down (9)* – moves selected item one position down.

*Delete item (10)* – deletes selected item.

*Messages (11)* – shows information why something is happening or cannot be done; messages that relate to items are visible only when that item is selected; there are three types of messages:

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

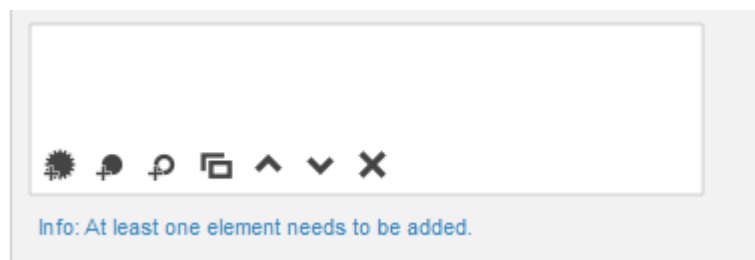


Figure 12. Information.

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<sup>4</sup> Newly created item has always default values and is placed at the bottom of the list.

warning (**gold**) – describes that the parameters may disqualify items to use, ex. because of edges finished too much, but still possible to manufacture,

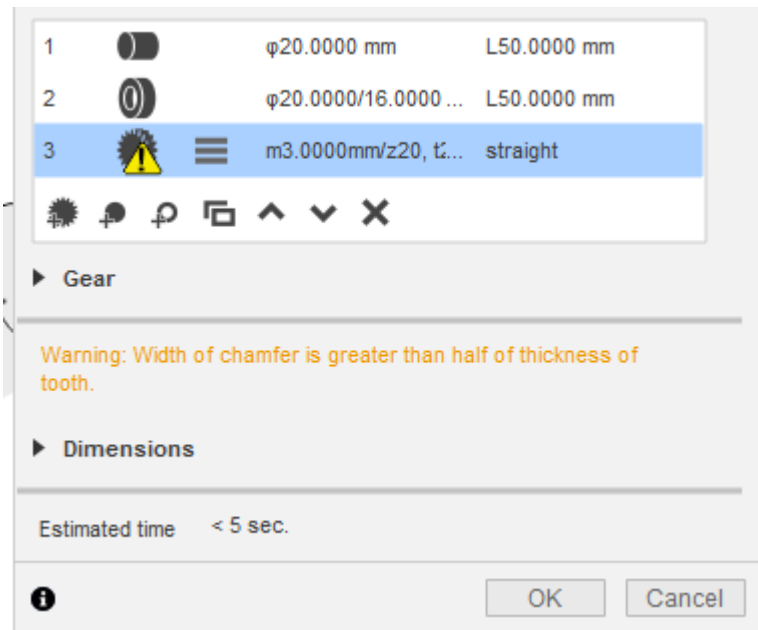


Figure 13. Warning – teeth of gear will have unusual shape, but process can be started.

error (**red**) – describes the error which can be related with the specific item (wrong configuration of settings – marked by the exclamation mark) 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:

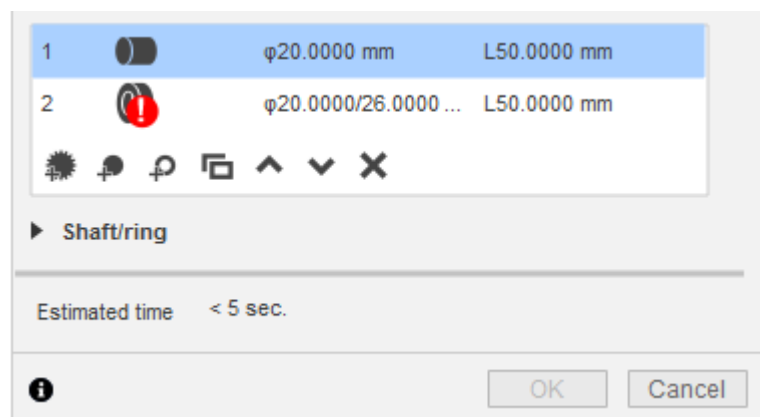


Figure 14. Error – invalid item prevents start of the process.

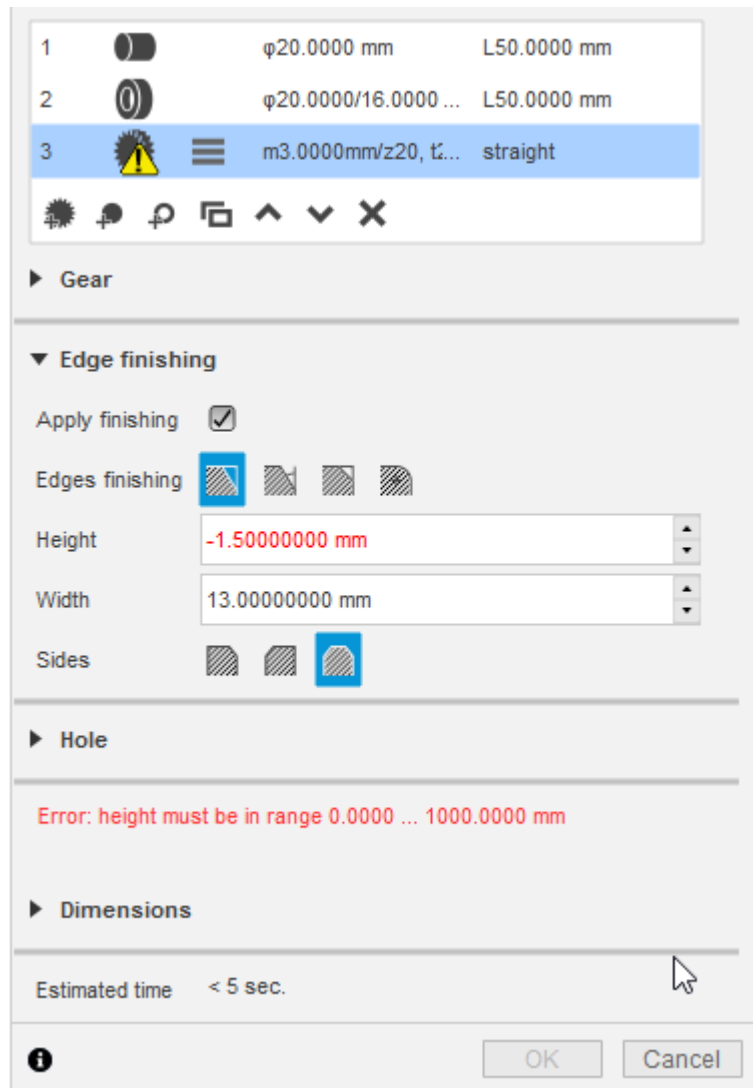


Figure 15. Error – invalid value prevents start of the process.

**Estimated time (12)** – shows estimated time needed for creating items; the more runs, the better estimates; when program cannot find similar settings, no estimation is displayed.

**Information (13)** – opens basic documentation in the default web browser.

**OK (14)** – starts creating items; it is active when list is not empty and all items are valid; when there is at least one invalid element; invalid items are marked by an exclamation mark.

**Cancel (15)** – cancels changing settings and temporary hides the plugin's window.

## Tabs and specific functions

Generally, interface is divided into four tabs but some of them may be invisible depending on the type of selected item or specific configuration of settings.

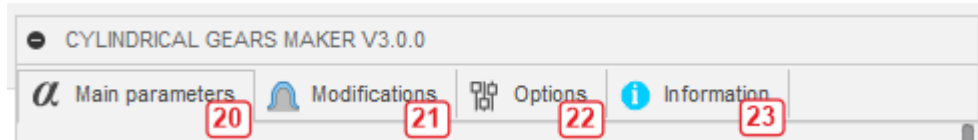


Figure 16. Tabs.

*Main parameters (20)* – settings of most important parameters of gears and shafts/rings.

*Modifications (21)* – additional settings like profile shifting, tapering, backlash, etc.; it is visible only for gears.

*Options (22)* – units, decimal places, module dimensioning, design, joints, axis, preview; it is visible when item is selected.

*Information (23)* – documentation, links, checking updates.

## Main parameters - gear

This group is visible when gear is selected on the list (24):

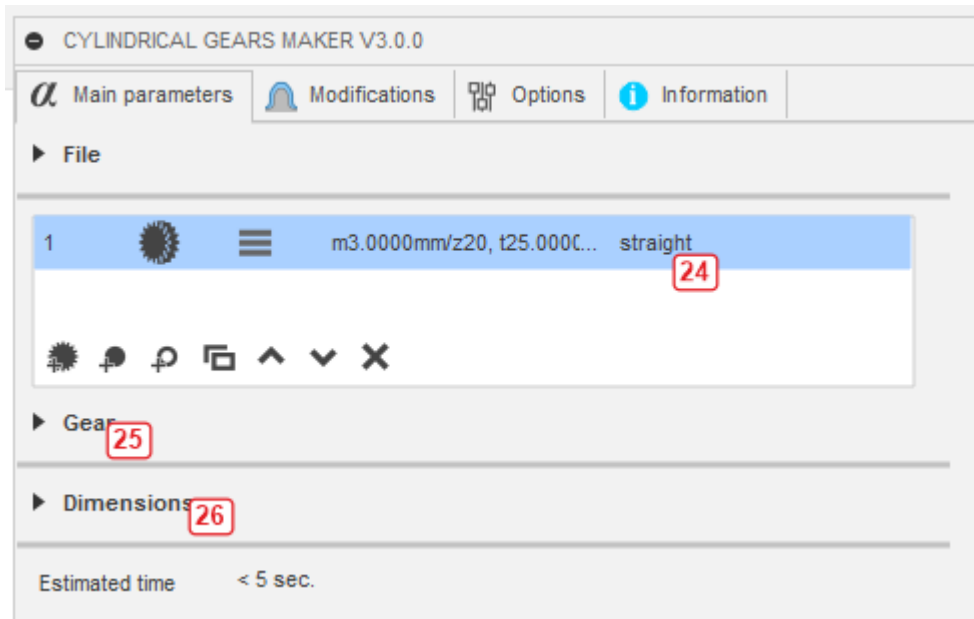


Figure 17. Main parameters - gear.

**Gear (25)** – main parameters of gear.

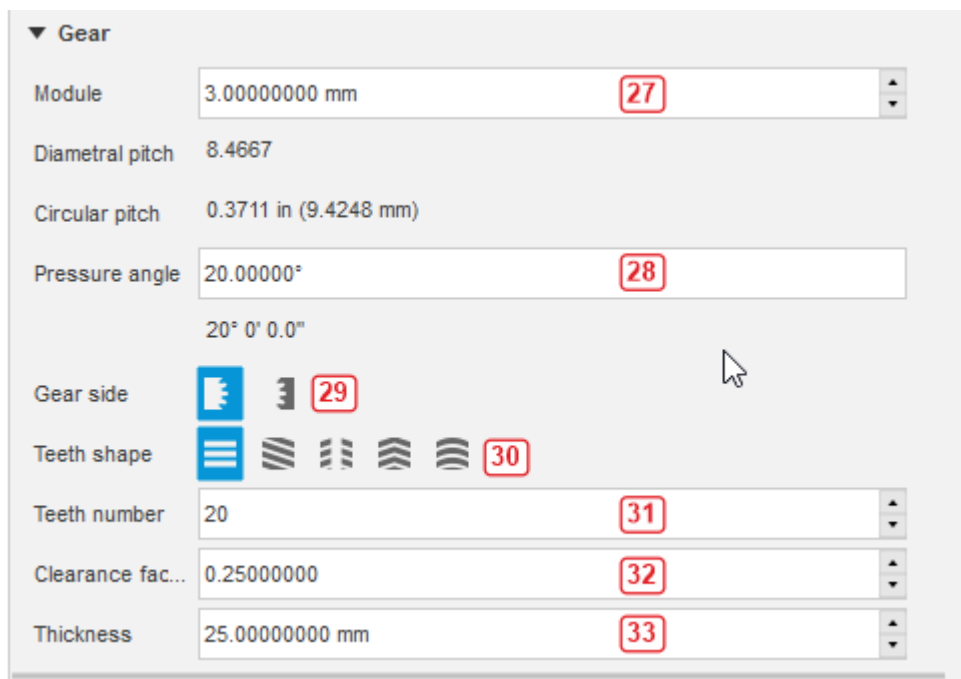


Figure 18. Gear group.

**Module (27)** – module ( $m$ ), in millimeters or inches<sup>5</sup>; corresponding diametral pitch (DP) and circular pitch (CP) are displayed below this input; there is also possible to switch dimensioning between module, DP, CP<sup>6</sup>.

**Pressure angle (28)** – pressure angle ( $\alpha$ ); it can be entered as decimal or HMS format<sup>7</sup>; corresponding HMS or decimal value is displayed below the input.

**Gear side (29)** – side of gear: external (default) or internal.

**Teeth shape (30)** – shape of teeth: straight (default), helical, double helical, herringbone, arc.

**Teeth number (31)** – number of teeth ( $z$ ).

**Clearance factor (32)** – factor ( $f_c$ ) which denotes amount of space between root and head of teeth of matched gears; clearance ( $c$ ) equals  $f_c m$ .

**Thickness (33)** – thickness ( $t$ ) of gear.

#### Option for internal gears

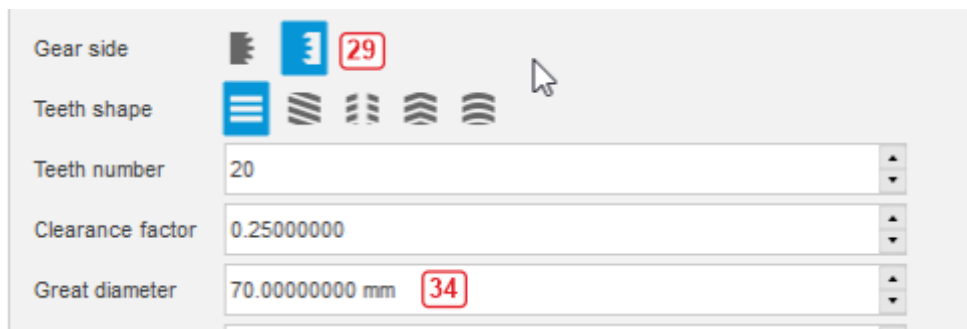


Figure 19. Additional option for internal gears.

**Great diameter (34)** – outermost diameter ( $d_g$ ) of an internal gear.

<sup>5</sup> All scalar inputs with defined units can be switched between millimeters and inches.

<sup>6</sup> Both switching between units and dimensioning is described later.

<sup>7</sup> All angular inputs can be switched between decimal or HMS format.

### Options for helical gears

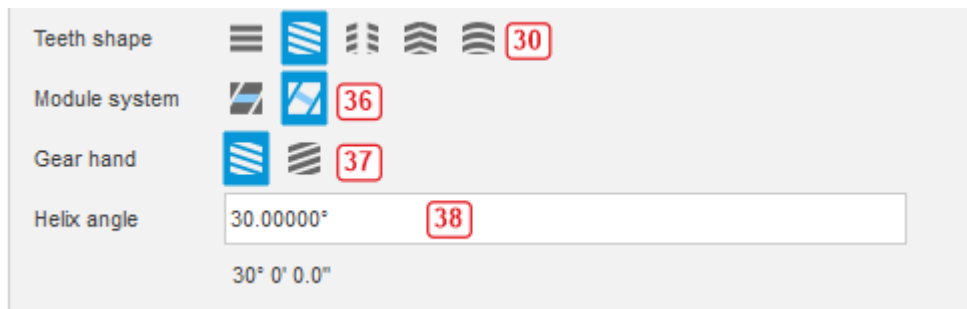


Figure 20. Options for helical gears.

**Module system (36)** – module system of gear: axial (A), normal (N - default).

**Gear hand (37)** – direction of teeth: right (RH - default), left (LH).

**Helix angle (38)** – helix angle of teeth.

### Options for double-helical gears



Figure 21. Options for double-helical gears.

**Shift opposite teeth (39)** – when this option is checked, teeth on opposite sides are placed alternately.

**Groove width (40)** – width of groove ( $w_g$ ).

**Groove depth (41)** – depth of groove ( $d_{gr}$ ).

### Options for herringbone gears

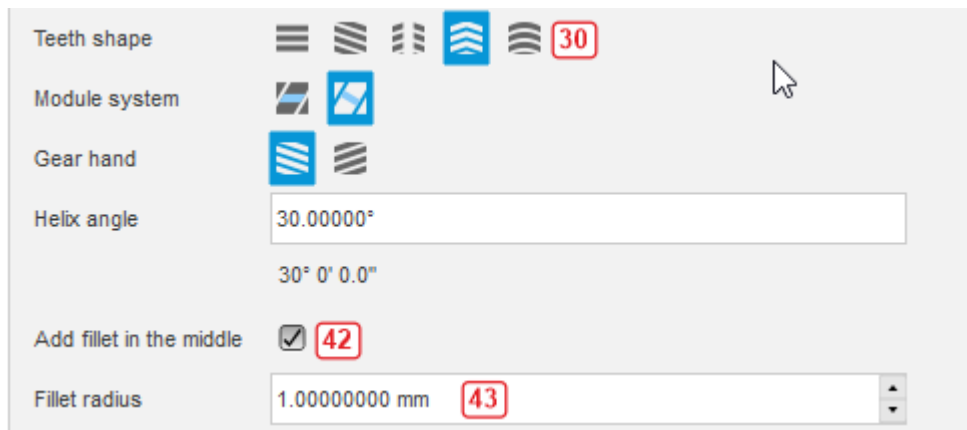


Figure 22. Options for herringbone gears.

**Add fillet in the middle (42)** – when this option is checked, transition in the middle part of tooth is smooth.

**Fillet radius (43)** – radius of fillet ( $r_{hf}$ ).

### Options for arc gears

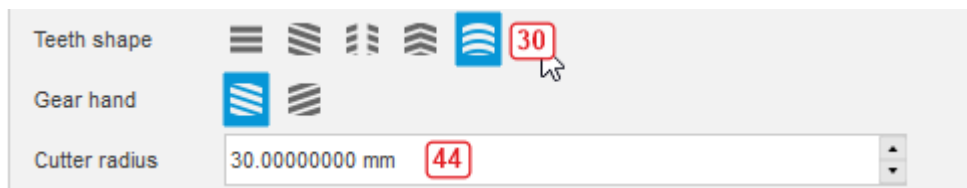


Figure 23. Options for arc gears.

**Cutter radius (44)** – radius of cutter ( $r_c$ ).



**Dimensions (26)** – dimensions of gear; there are radial and measurement dimensions<sup>8</sup>; it is also visible on other tabs; meaning of symbols is described in the *Real-time calculated parameters*.

▼ Dimensions		
<u>Gear</u>		
d	69.2820	mm
db	63.8705	mm
da	75.2820	mm
df	61.7820	mm
<u>Top land parameters</u>		
$\alpha_a$	31.9602	° ( 31° 57' 36.7" )
$\theta_a$	1.9973	° ( 1° 59' 50.4" )
sa	2.6243	mm
<u>Chordal measurement</u>		
sn	4.7124	mm
zv	30.7920	
$\theta_v$	2.9228	° ( 2° 55' 22.2" )
sj	4.7103	mm
h <sub>a</sub>	2.0501	mm

Figure 24. Real-time calculated parameters.

<sup>8</sup> Backlash and taper factor are not included for measurement parameters like chordal thickness, span measurement and over pin/ball measurement. When parameters cannot be calculated they are not displayed.

## Main parameters – shaft

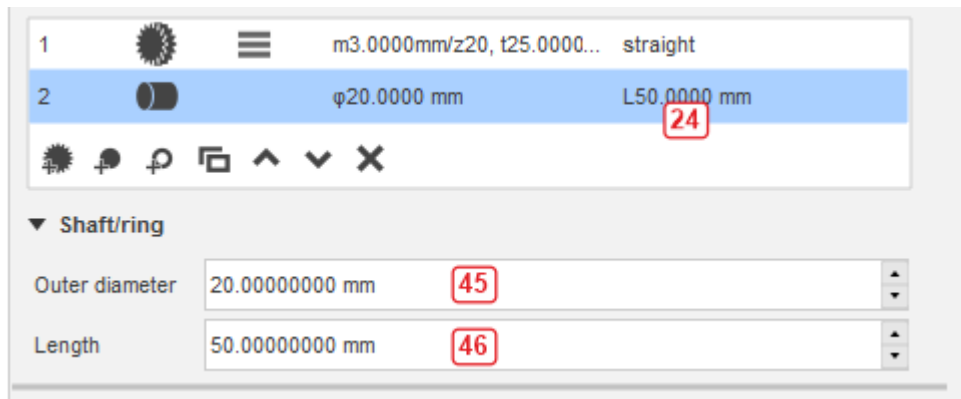


Figure 25. Main parameters – shaft.

*Outer diameter (45)* – diameter (D) of shaft.

*Length (46)* – length (L) of shaft.

## Main parameters – ring

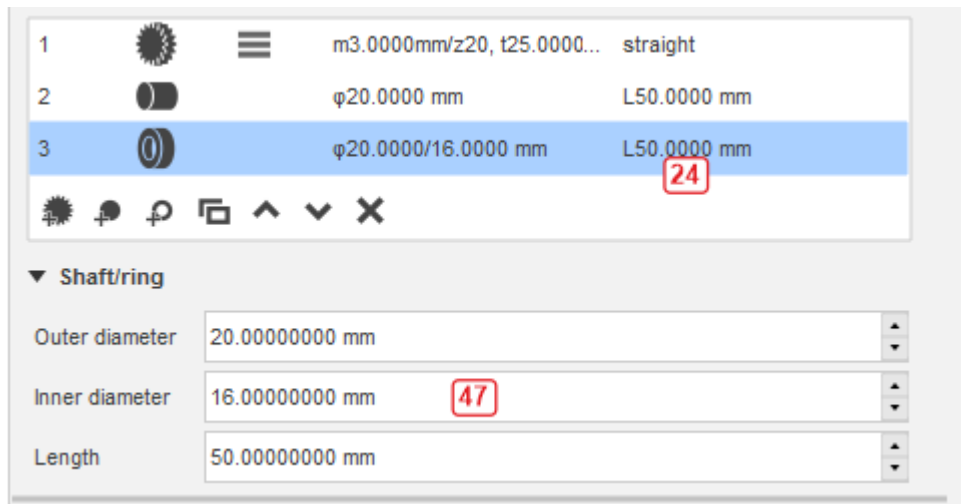


Figure 26. Main parameters - ring.

*Inner diameter (47)* – hole diameter (d) of ring.

## Modification's tab

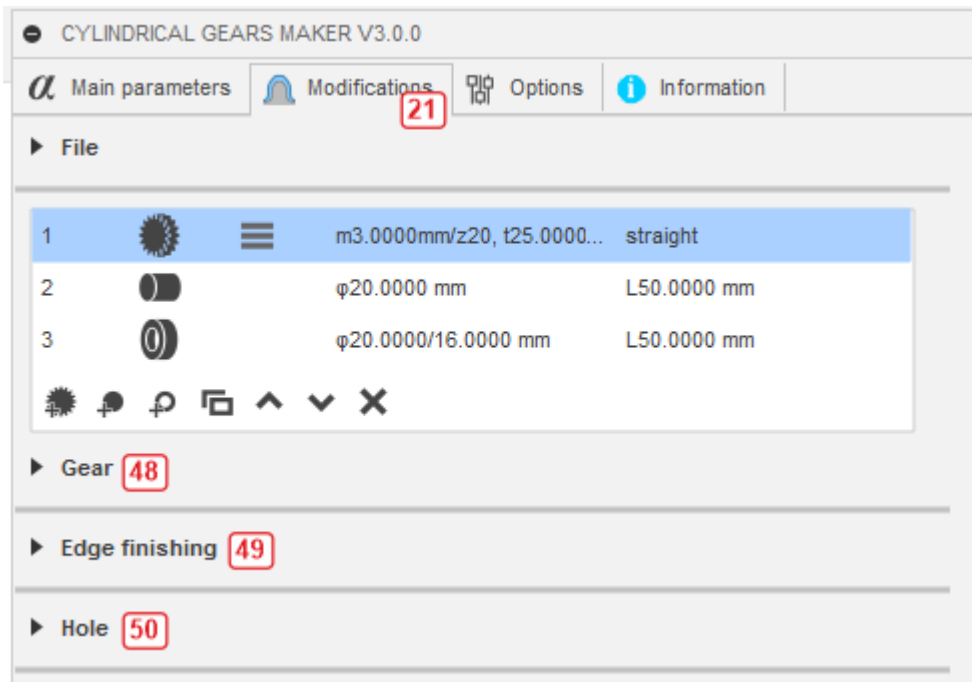


Figure 27. Modification's tab.

**Gear (48)** – modifications of tooth's profile.

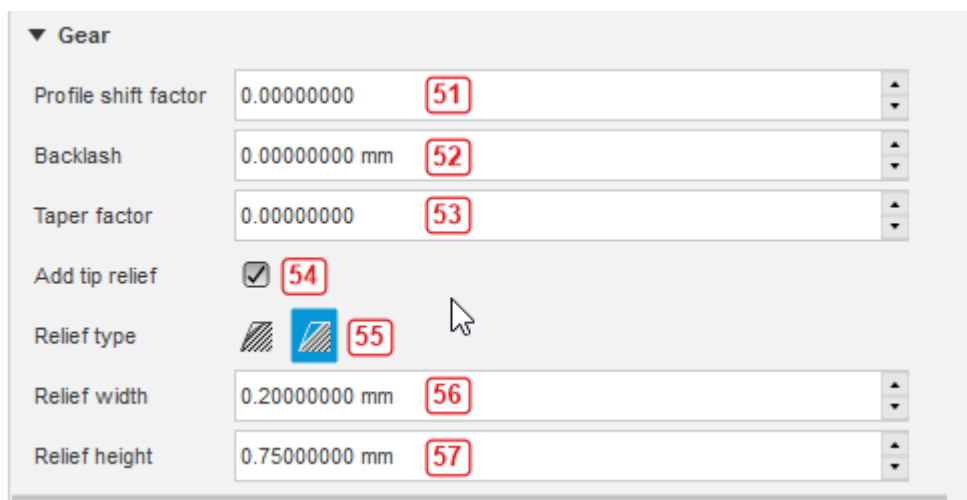


Figure 28. Modifications - gear.

**Profile shift factor (51)** – profile shift factor (addendum modification) (x).

**Backlash (52)** – normal backlash (j).

**Taper factor (53)** – taper factor ( $f_t$ ); available only for external gears.

**Add tip relief (54)** – if this option is checked, tip relief is applied; available only for external gears and when profile shift factor, backlash and taper factor are 0.

**Relief type (55)** – type of relief: smooth (arc tangent to the flank) or line (default).

**Relief width (56)** – width of relief ( $w_{tr}$ ).

**Relief height (57)** – height of relief ( $h_{tr}$ ).



Figure 29. Outside fillets.

**Outside fillets (58)** – applies fillets to internal teeth at outside diameter; available only for internal gears.

**Edge finishing (49)** – modifications of side edges of teeth.

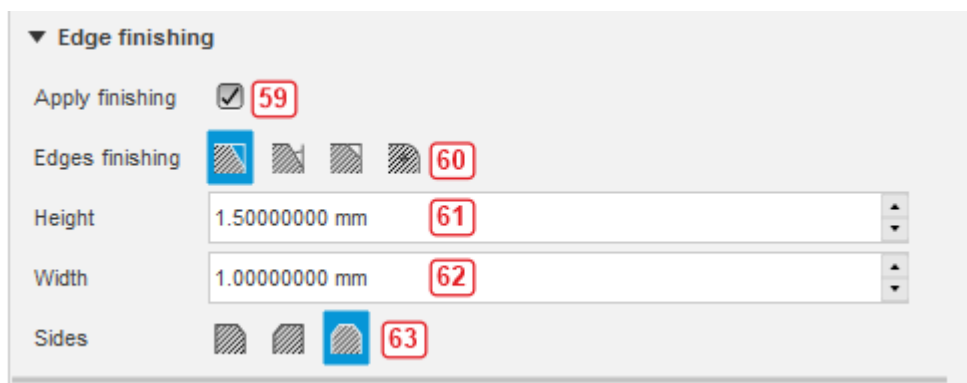


Figure 30. Edge finishing: height-width.

**Apply finishing (59)** – if this option is checked, side edges of gear are finished.

**Edges finishing (60)** – type of finishing: height-width (default), height-angle, equal-size, radius.

**Height (61)** – height of finishing ( $h_{ef}$ ).

**Width (62)** – width of finishing ( $w_{ef}$ ); available only for height-width mode.

**Sides (63)** – sides of finishing: right, left, both (default).

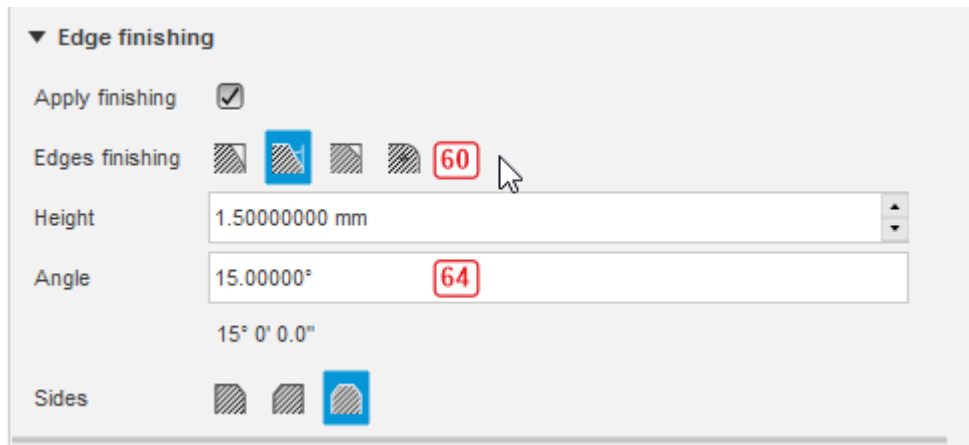


Figure 31. Edge finishing: height-angle.

**Angle (64)** – angle of finishing ( $a_{ef}$ ).

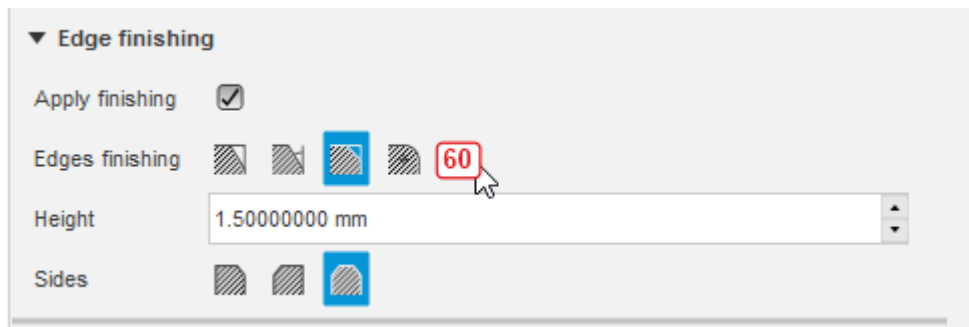


Figure 32. Edge finishing: equal sides.

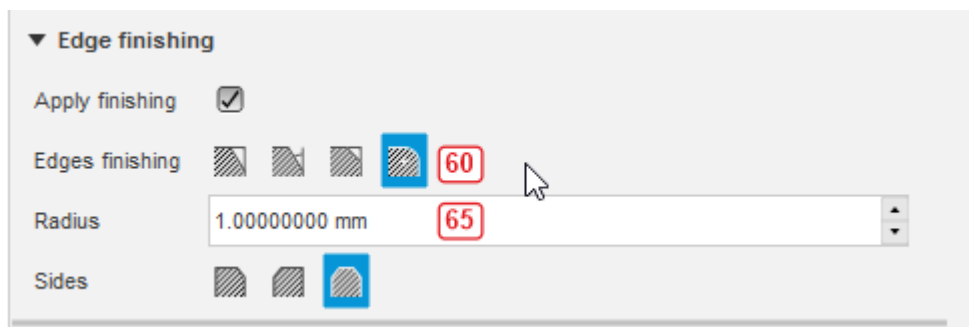


Figure 33. Edge finishing: radius.

**Radius (65)** – radius of finishing ( $r_{ef}$ ).

**Hole (50)** – adding hole; it is available only for external gears.

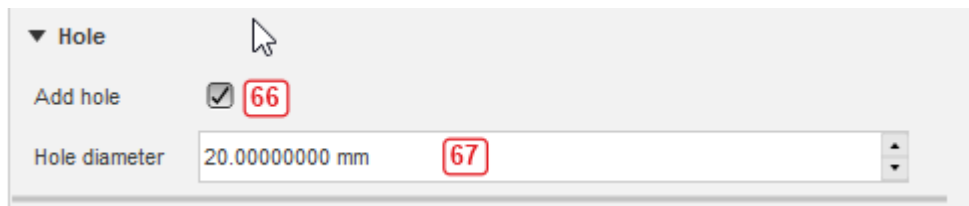


Figure 34. Hole options.

**Add hole (66)** – if this option is checked hole is added to external gears.

**Hole diameter (67)** – diameter of hole ( $d_h$ ).

## Option's tab

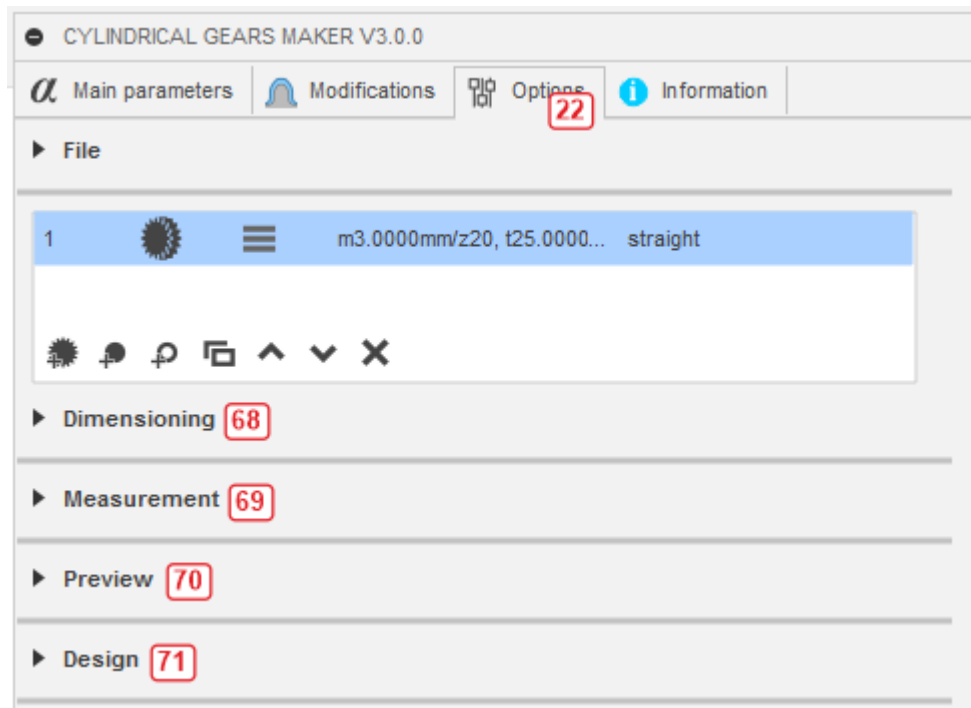


Figure 35. Option's tab.

**Dimensioning (68)** – settings for units, dimensioning of module, format of angles, precision of displaying numbers.

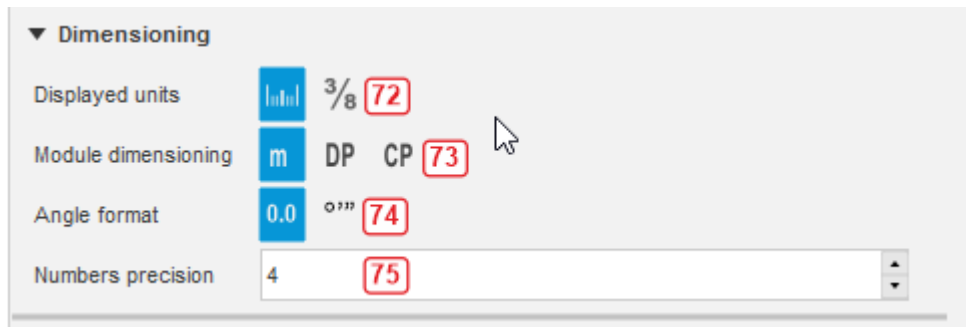


Figure 36. Dimensioning.

**Displayed units (72)** – options for changing units: millimeters (default) or inches.

**Module dimensioning (73)** – options for changing type of dimensioning between: module (default), diametral pitch, circular pitch; it is possible to display millimeters units for DP and CP.

**Angle format (74)** – options for changing way how angular values are set: as decimal (default) or HMS.

**Numbers precision (75)** – number of decimal digits for displaying values; it doesn't change precision of inputs.

**Measurement (69)** – setting for custom diameter of ball/pin; available only for gears.

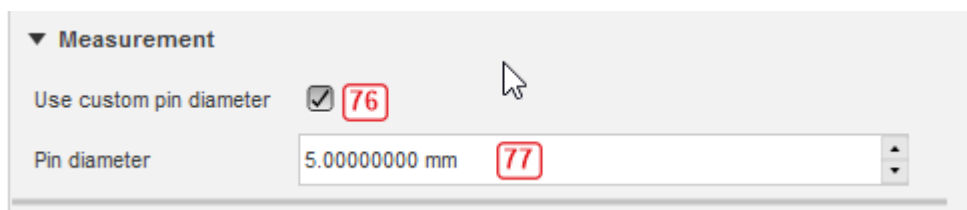


Figure 37. Measurement.

**Use custom pin diameter (76)** – if this option is checked, custom diameter of ball/pin is used to measure parameters.

**Pin diameter (77)** – custom diameter of ball/pin.

**Preview (70)** – settings of preview, used for displaying models of items before they are created.

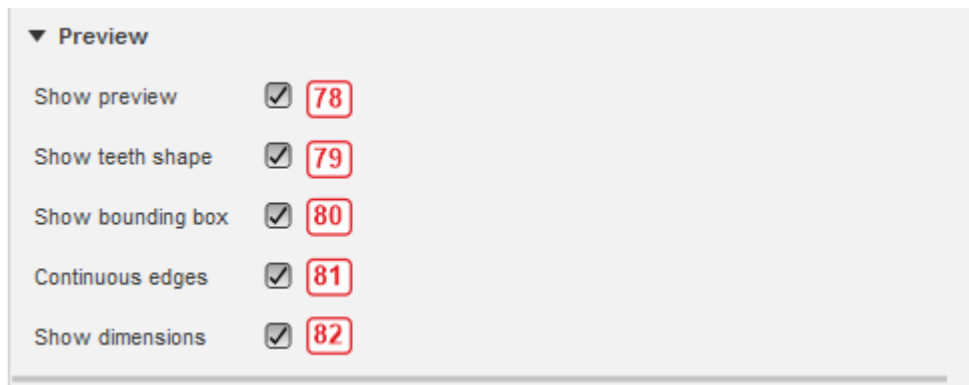


Figure 38. Preview.

**Show preview (78)** – if this option is checked, preview of items is shown.

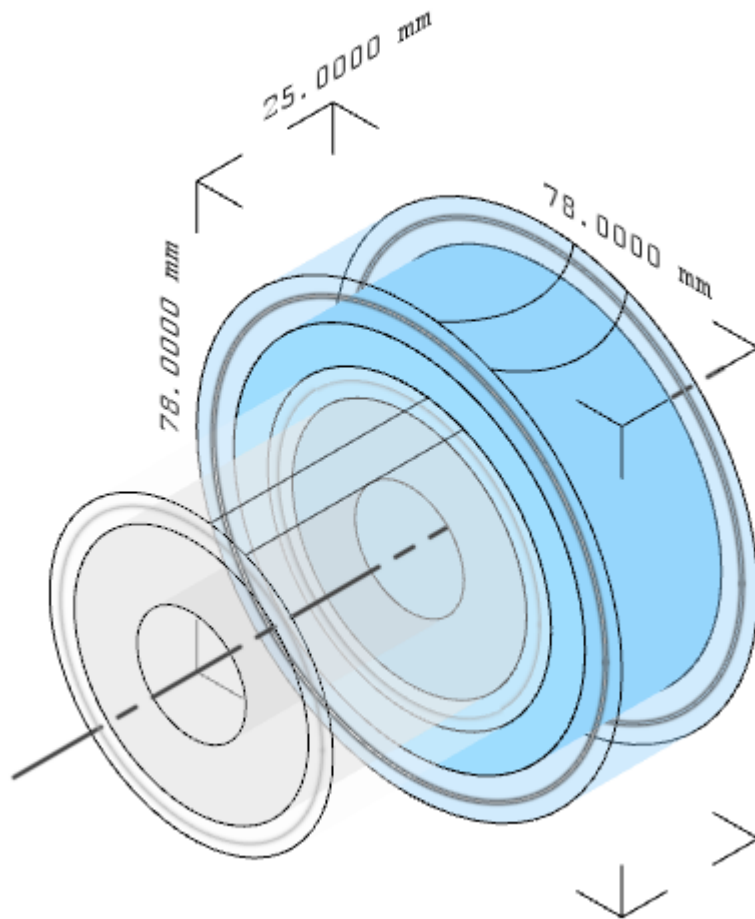


Figure 39. Sample preview of two gears: selected (blue) with arc teeth and the spur gear (grayed).



*Show teeth shape (79)* – if this option is checked, shape of teeth is shown in case of gears.

*Show bounding box (80)* – if this option is checked, minimum bounding box is drawn around the selected item.

*Continuous edges (81)* – if this option is checked, edges of bounding box are drawn as lines, otherwise only corners are marked.

*Show dimensions (82)* – if this option is checked, dimension of bounding box is drawn.

*Design (71)* – adding joint, rotation axis, mode of creating (current document or a new one).

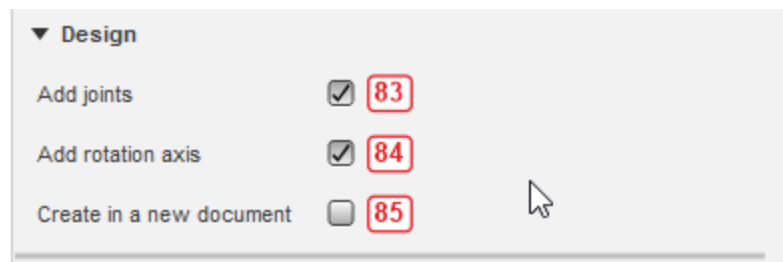


Figure 40. Design.

*Add joints (83)* – adds revolution joint to the created component.

*Add rotation axis (84)* – adds axis of rotation to the created component.

*Create in a new document (85)* – created items in a new document.

## Information tab

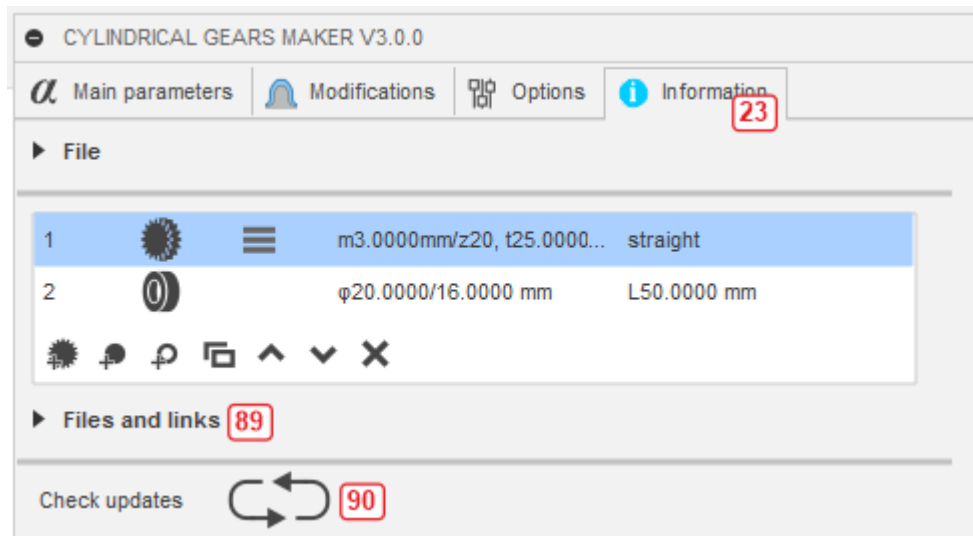


Figure 41. Information tab.

*Files and links (89)* – folders used by the plugin, links to documentation, privacy policy.

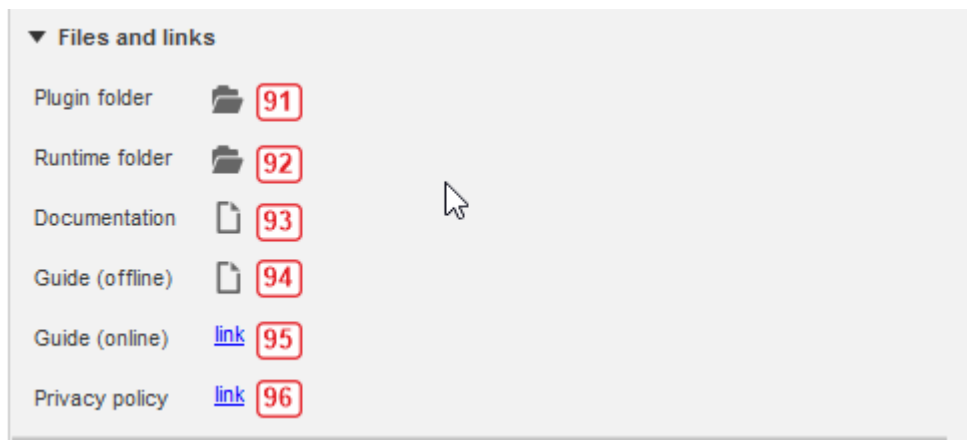


Figure 42. Files and links.

*Plugin folder (91)* – opens root directory of the plugin.

*Runtime folder (92)* – opens runtime directory of the plugin.

*Documentation (93)* – opens basic documentation, the same as on the website but available offline.

*Guide (offline) (94)* – opens this guide offline by the default PDF reader.

*Guide (online) (95)* – redirects to this guide by default web browser.

*Privacy policy (96)* – privacy policy (only online).

*Check updates (90)* – 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

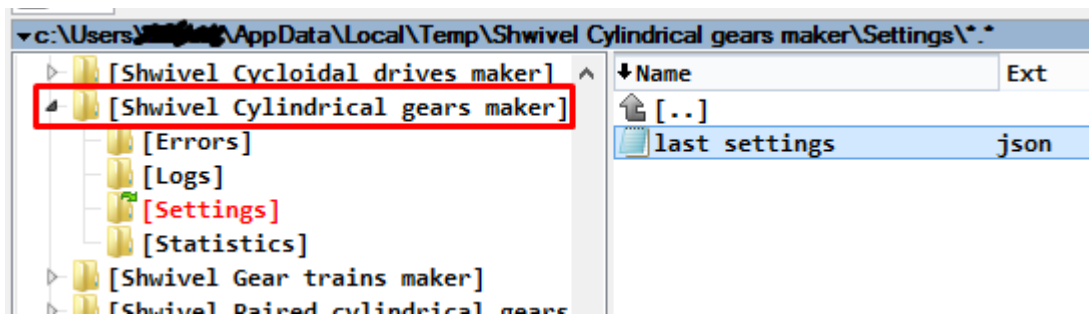


Figure 43. Runtime directory – example on Win machine.

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,

*Statistics.json* - contains numerical data 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

Most 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.

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