EUKLID GearCAM

The CAD/CAM Solution for

Flexible Gear Milling

For the usage on multi-task and universal milling machines for economical machining of

- **gear wheels in special materials**
- **small-sized batches**
- **replacements**
- **prototypes**

4- and 5-Axis Milling of Gear Wheels

The Easiest Way
To Manufacture Gears

- for spur and bevel gears
- for external and internal gears
- for double helical gears
- for special designs
- for short delivery times and fast responsiveness
- with standard milling tools

Source: Reiden Technik AG

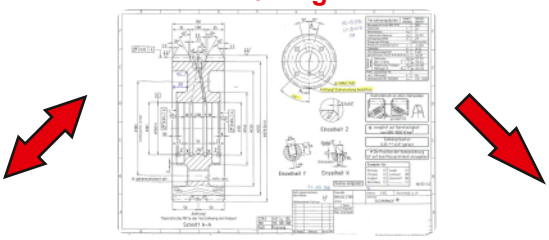
What to do if a gear tooth is breaken or a prototype is urgently needed?

EUKLID GearCAM is the convenient software solution that enables the economical production of gears on universal machining centres with uncompromising accuracy. Be it as a prototype wheel, as replacement for a large gear box or for special purpose wheels.

The manufacture of gear wheels is an extremely demanding process since high precision is requird. **EUKLID GearCAM** supports this production process effectively and dependably. Each type of gear is based on specific parameters, which must comply with different standards. In addition, a variety of modifications exist for the flanks of the tooth.

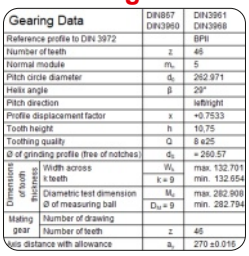
EUKLID GearCAM provides a simple way to enter the data and save any state of a project without loss of accuracy: This is the base for full control of the input, for simulation of gear wheel movements and for the machining process. The user can influence the largely automatic generation of the milling programs individually according to his own experience.

Drawing



Final Inspection

Gearing Data

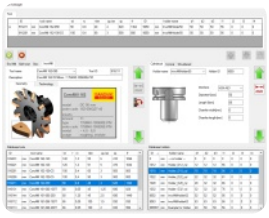


Gearing Data		DIN867 DIN3960	DIN3961 DIN3968
Reference profile to DIN 3972			BPI
Number of teeth		z	46
Normal module		m_n	5
Pitch circle diameter		d_0	262.971
Helix angle		β	29°
Pitch direction			left/right
Profile displacement factor		x	+0.7533
Tooth height		h	10.75
Toothing quality		Q	8 e25
Ø of grinding profile (free of notches)		d_N	= 260.57
Dimensions for tooth thickness	Width across k teeth	W_k k = 9	max. 132.701 min. 132.554
	Diametric test dimension Ø of measuring ball	M_R D_M = 9	max. 282.908 min. 282.794
Mating gear	Number of drawing		
	Number of teeth	z	46
	axis distance with allowance	a_0	270 ±0.016

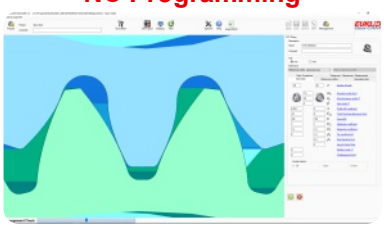
5-Axis-Milling


Source: Röders GmbH

Tool Selection

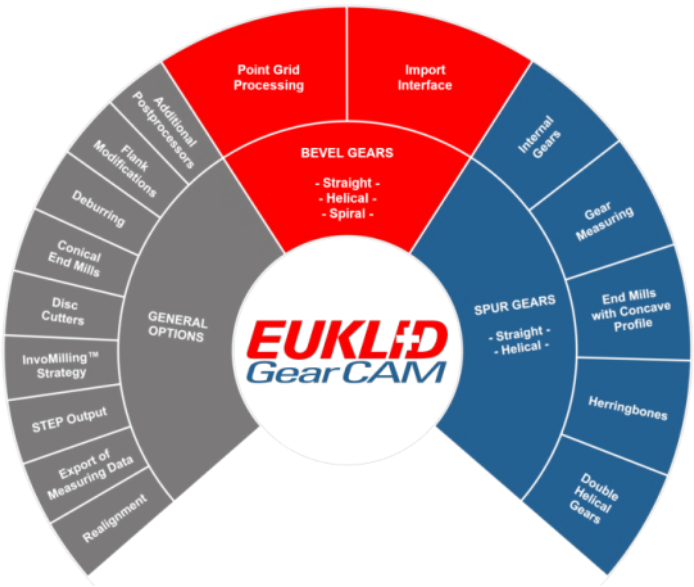


NC Programming



Modular Structure
Maximal Benefit

- **software scope as required**
- **grows with new tasks**
- **modules are easy to add**
- **for every type of control / machine**



EUKLID GearCAM works like a classic CAD/CAM system. In the CAD part, the geometry with all variants and corrections is entered or changed and **EUKLID GearCAM** uses it to produce surfaces that correspond exactly to the entries. On this surface data, paths are calculated in the CAM part, which give the user complete certainty.
EUKLID GearCAM has a modular structure and is configured individually to suit your requirements and your machinery. No matter how large your puzzle is, we have the right pieces. However, tasks can change - no problem. Further modules can be added at any time and can be activated if required, also for test purposes. No on-site appointment is necessary for this. Also the connection of additional machines to the software is usually fast and uncomplicated.
Basic functionalities such as the programming of gear segments, tool database, measuring grid output, etc. are available in every configuration. The same applies to an individual postprocessor and the corresponding machine simulation. The structure of **EUKLID GearCAM** is as follows:

BASIC MODULES define the central application areas of the software. The individual modules are described in more detail in the brochure.

- **Spur gear:** A module for straight and helical gears that is freely scalable according to workpiece size.
- **Bevel gear:** Straight, helical and spiral-toothed module, if necessary supported by external design software (KISSsoft).
- **Double helical gear:** Open and additionally closed toothed (herringbone toothing) available.
- **Internal gear:** One module for all supported types.

ADD-ON MODULES expand the range of possible milling tools (in addition to standard cylindrical end mills). The individual advantages come to bear to varying degrees depending on the application. On the other hand, there are options for different additional requirements.

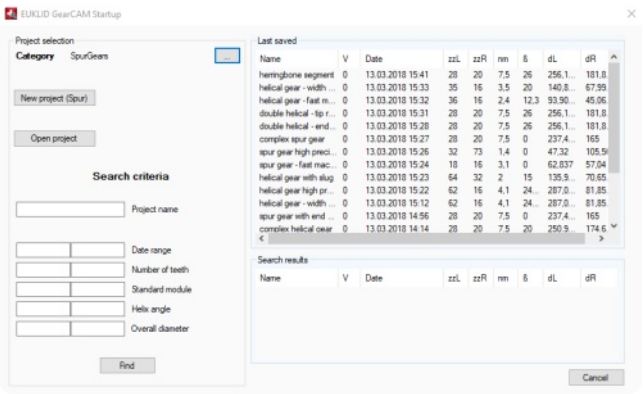
- **End mills with profile:** Expand the possibilities and save time. Modules are available for conical and/or concave ground end mills with radius or involute profiles.
- **InnvoMilling™:** A patented high-end process using special disc cutters.
- **Flank modifications:** Often required to optimize the gearing.
- **Deburring:** For deburring the face of the gears on the machine, including the turning contour.
- **Export of measuring data:** For workpiece alignment and standardized measuring grid output.

CAD - Mathematically Perfect

Clarity from the Beginning

- **uncompromising accuracy**
- **easy intuitive handling**
- **comfortable project management**

It all starts with a project that is either newly created or similarly loaded from the project management. Here **EUKLID GearCAM** supports your search by offering different selection criteria like number of teeth, module size etc.



In addition, **EUKLID GearCAM** bundles all relevant data. In addition to the obligatory input data, data for measuring machines, protocols for the workshop and NC programs are also stored in a project folder. Once generated, all data for similar projects is quickly available again.

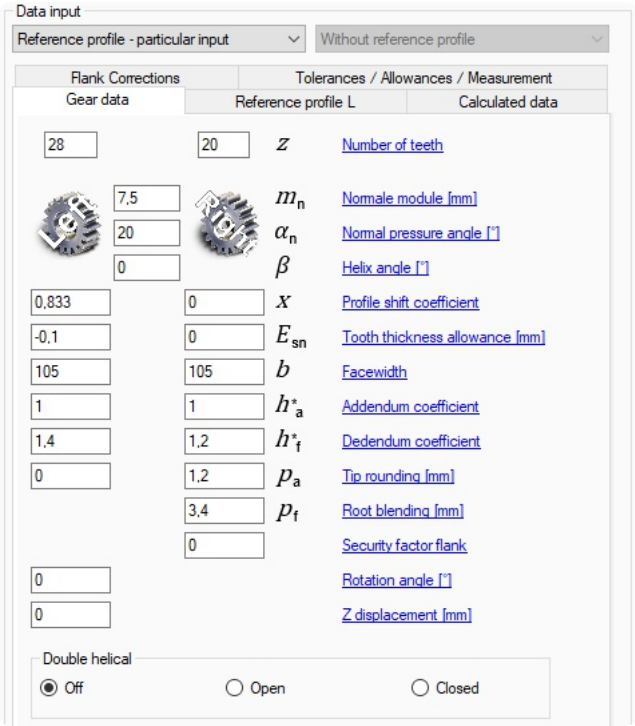
Gears of one type are often similar in many respects. Regardless of the standard or gear type - by adapting the design parameters, an already used geometry can be easily modified and then recalculated.

The NC programs are combined or managed individually for roughing and finishing. The versioning of the data ensures their compatibility.

Absolute CAD accuracy makes all the difference.

The entered geometry of the tooth gap to be milled with flank, head and foot can first be checked in the simulation of tooth rolling. With flank corrections, the function of the gear can be optimized for the intended application. The simulation is based on the same absolutely accurate data, which is then used for production.

The geometry is determined in a simple dialog, usually by a pair of gears. In addition to DIN profiles, the input of gear parameters can also be supplemented by reference profiles according to in-house standards. These can be provided with a protuberance for later finish machining or extended by tip chamfers.



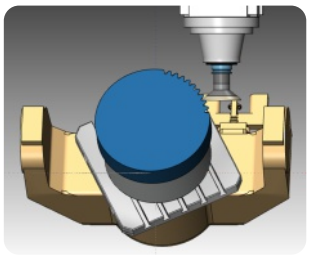
Spur Gears

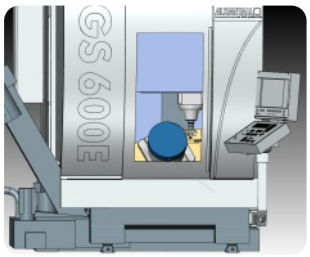
Perfect from the very First Piece

- **for spur gears of all kinds (straight, helical, double helical or herringbone)**
- **pure 4-axis machining**
- **for external and internal gears**

EUKLID GearCAM is subject exclusively to the design restrictions of the machine.
Regardless of your control and the type of machine you are using, our independently developed software and postprocessors support all standard machine / control combinations without restriction.

The creation of cylindrical gears is possible without a great deal of gearing knowledge. As a rule, less than 30 minutes are required from the design to the finished milling program.
If a 3D data model of the machine geometry is available, we integrate it optimally into the simulation (example in the picture: ALZMETALL GS 600E/5).



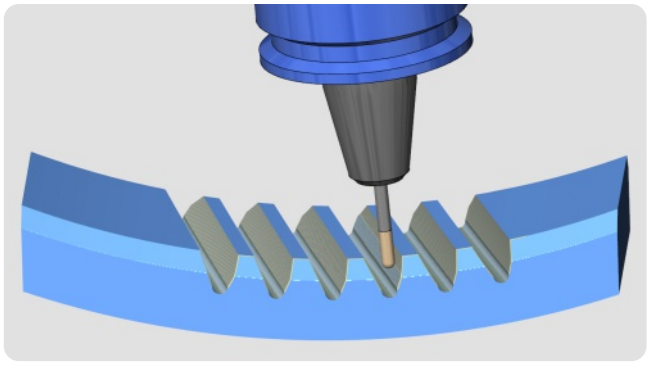


Internal Gears

As Wheel or Gear Segment

- **straight and helical gears**
- **flexibility through gear segments**
- **milling with standard end mills**

On request, **EUKLID GearCAM** also offers a solution for the milling of internal gears: On the one hand, the complete internal gear can be machined with an angular milling head using ball nose cutters. On the other hand, it is also possible to define individual segments first. These segments are then machined piece by piece. With this milling strategy, the significantly more stable spindle head of the machining center is used, so that better qualities can be achieved in the end result.



The upper picture shows the machine simulation during the machining of a hollow wheel segment. The concave flanks are clearly visible.

Open double helical gears (incl. deburring) can also be produced as internal gears. Provided that the space conditions allow this.

Double Helical Gears
Simply Created

- **with center groove**
- **without groove - herringbone**
- **pure 4-axis machining**

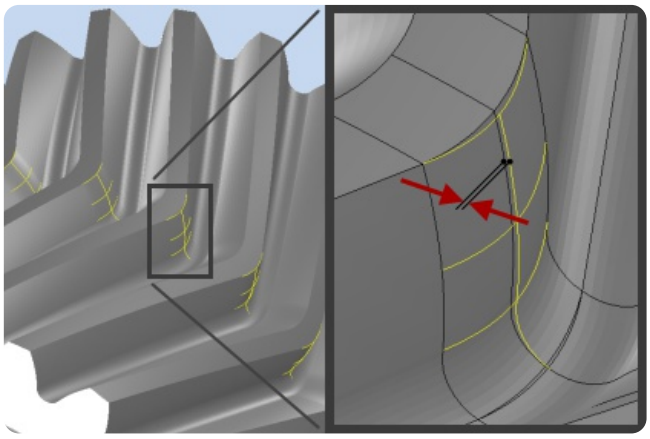
The problem: Until now, the machining of double helical gears was only possible with a sufficiently large groove due to production reasons. As a result, the gear width had to be designed much larger than actually necessary. The disadvantages are obvious. A wider design and the resulting higher weight considerably limit the development of the gear unit. A much too large installation space must be planned for the force to be transmitted, without having any scope for constructive solutions.

The solution: The use of **EUKLID GearCAM** and the use of end mills now makes it possible to optimize the design of a double helical gear and to reduce or completely eliminate the groove.

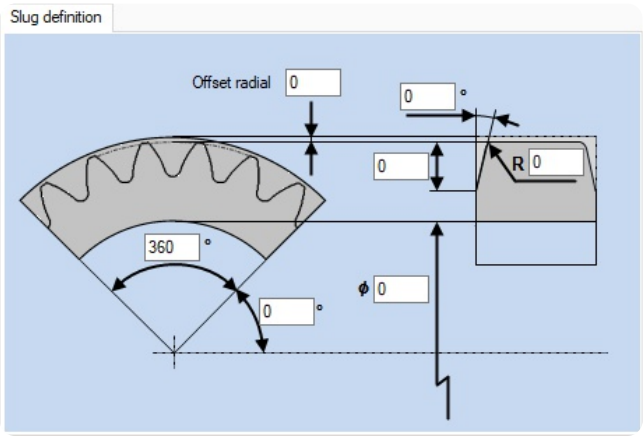
Manufactured with **EUKLID GearCAM**: Compressor shafts with arrow toothing made of 18CrNiMo7-6, approx. 60 HRC.

Source: GIF MBH & CO. KG

The yellow lines on the lower picture show the theoretical circle transition without gap (gap width 0). Shown in black: Reduced transition area, maximum distance (at the arrowhead) resulting from the value of the gap width.



The diameter of the end mill for finishing alone is the limit for the groove width or radius for herringbones. With the same width of the gear wheel, a considerable increase in force transmission is possible. At the same time, the now narrower design opens up the potential to reduce weight.
Flank corrections and deburring functions can also be combined with this module. Segment machining is also available as an option.



Bevel Gears - Success with 5-Axes

Can be Manufactured without Restriction

- **for bevel gears and bevel pinions**
- **for DIN bevel gears and according to Gleason and Klingelnberg**
- **for straight, helical and spiral bevel gears**

Grow with your tasks.

It used to be almost impossible to produce useful bevel gears on universal milling machines. The effort involved was disproportionate to the benefits.
In the meantime, 4- and 5-axis milling has clearly established itself as a production method. **EUKLID GearCAM** provides the gear manufacturer with a tool that enables him to mill the various gear types universally.

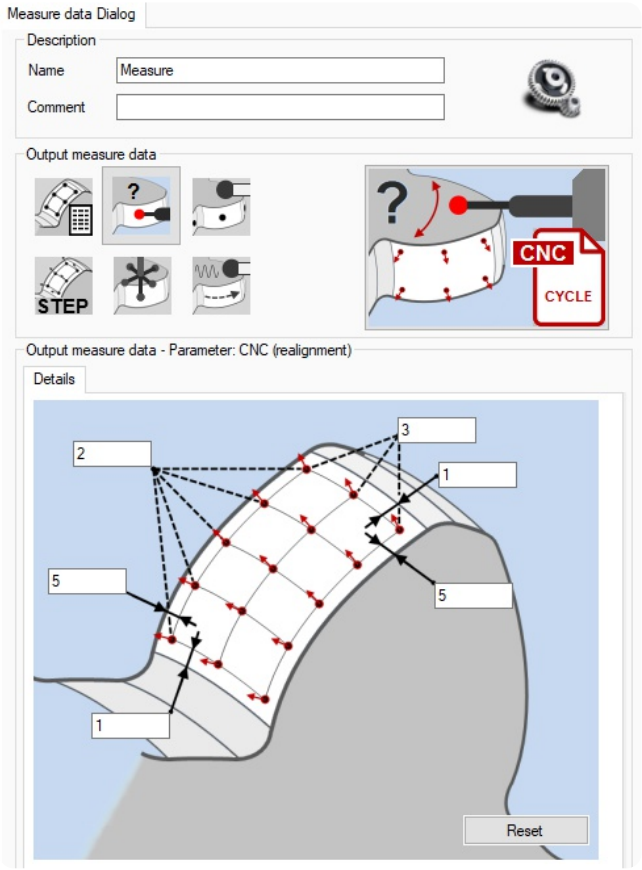
The design and final manufacture of spur and bevel gears varies in complexity. **EUKLID GearCAM** follows this idea and makes it possible to use only the initially required part (spur or bevel gear).

EUKLID GearCAM supports the definition of straight bevel gears. In order to machine helical or spiral bevel gears, the bevel gear geometry is defined externally in **KISSsoft** – a software for layout and calculation of the geometry of gears – and the .Z70 file generated there is imported into **EUKLID GearCAM**. The gear parameters are displayed for checking, but cannot be changed.
Individual flank modifications and mechanical deburring can also be carried out here. The **InvoMilling™** method is also available for straight bevel gears.

Source: GIF MBH & CO. KG

The bevel gear is produced using 5-axis simultaneous machining. Flank modifications are included in the geometry to be milled. This eliminates the need for correction grinding.

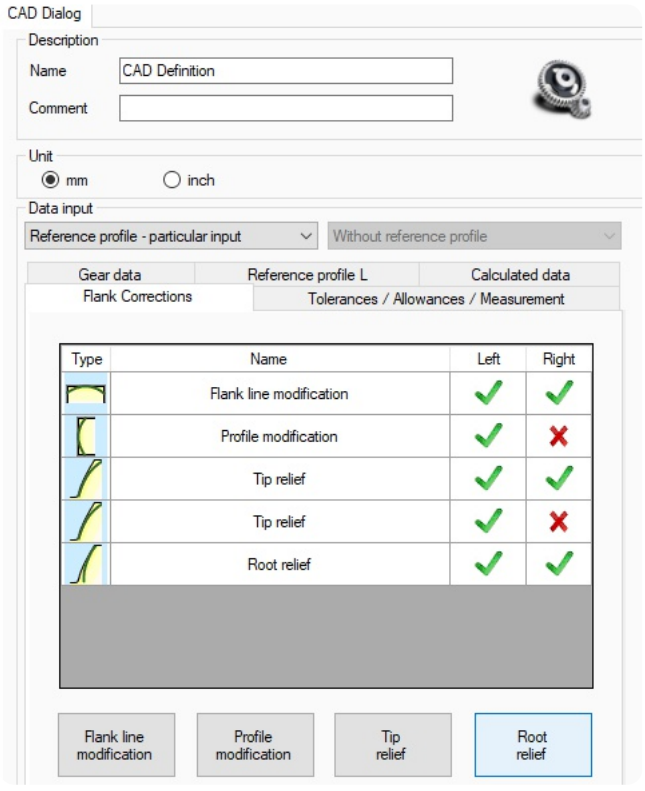
By providing exact measurement data for checking or realigning the workpiece (e.g. after an interruption for hardening), our quality requirements can be tracked at any time.



The µ Makes the Difference

Individual Flank Corrections

- **for all types of gear wheel**
- **flank line and profile modification**
- **tip and root relief**
- **asymmetrical and flank individual**
- **in any combination**
- **are added mathematically exactly and are applied in normal direction to the surface**



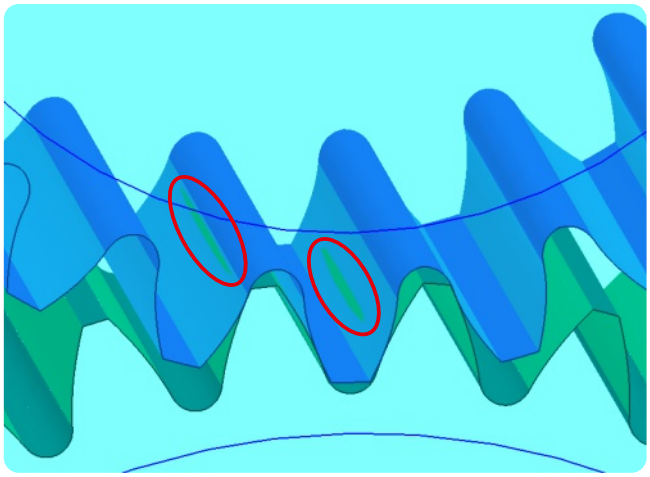
The clear design of the dialog window ensures clarity even with complex tooth flank topologies. Direct access via mouse click allows each correction to be defined in detail and quickly changed if necessary.

You have a choice!

Flank corrections (flank line and profile modification as well as tip and root relief) are an important topic when talking about gear manufacturing.
They can, for example, change the noise of a gear pair positively or influence possible force imbalances in a targeted way.

The extension flank corrections of **EUKLID GearCAM** is here free of restrictions. Tip and root reliefs can be combined as required and as often as required in succession or with the different forms of crowning. The corrections are taken into account in the calculation of the milling paths in accordance with the previously defined manufacturing tolerances and manufactured in one milling pass with exact results.

It is also possible to individually adjust all flanks of a double helical gear or an arrow toothed gear.
The corrections can – as always – be illustrated with the help of simulation. As shown in the picture below (marked red), it is also possible to check the rolling behaviour of the contact surfaces.



The Input Masks for Flank Modifications

With a Sense for the Essentials

The stringent structure of the input masks saves time and enables a uniform definition with only a few input values across all tooth flanks.

Alternatively, **EUKLID GearCAM** offers individual correction options. This can be done asymmetrically, on single sides or only on parts of the tooth flank. The design of the dialog windows has been reduced to the essentials, making it easy even for new users to find their way around quickly.

Four different flank modifications are available. These are subdivided according to the type of implementation.

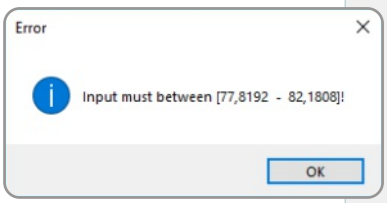
Flank line or profile modification can be influenced by three subtypes each:

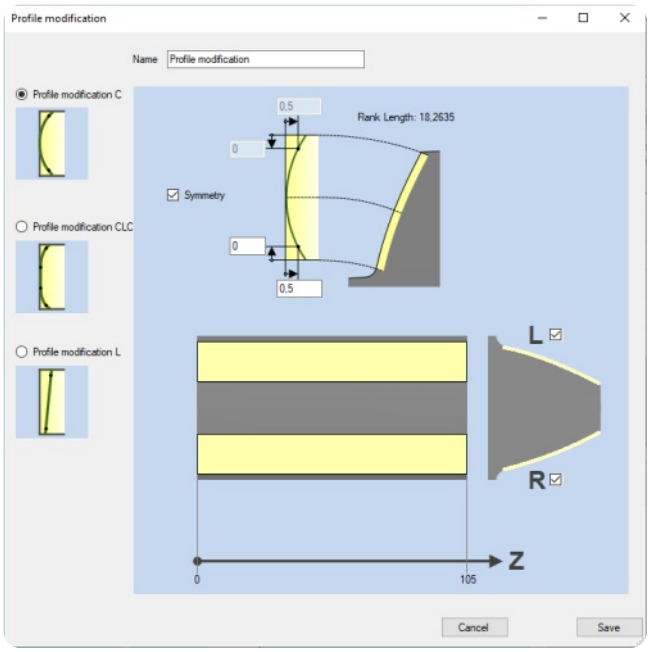
- arc circle
- arc circle - line - arc circle
- line

Tip or root reliefs have two possible subtypes:

- arc circle
- parabola

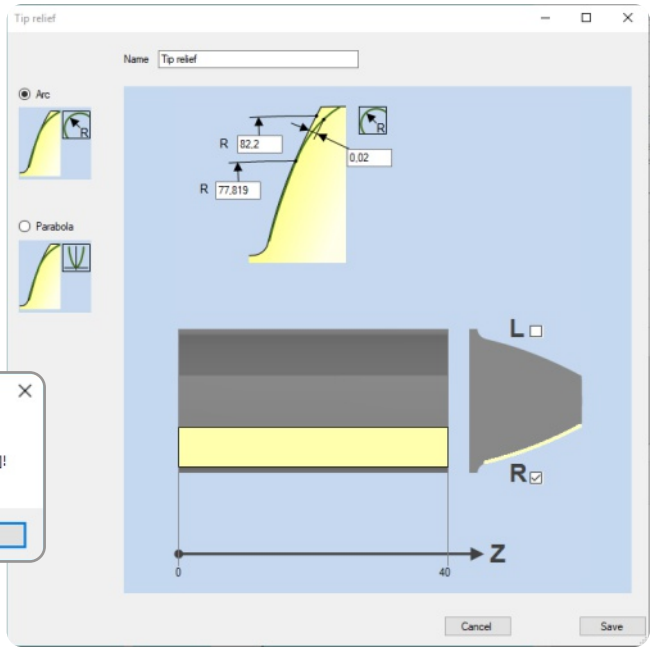
In order to avoid possible input errors, **EUKLID GearCAM** displays a feedback message if values not producible by the user are defined. In addition, the possible input range (see figure below) is output with the error message. This facilitates rapid input and thus saves the user valuable working time.





In the upper picture, the profile modification is entered symmetrically on both flanks (highlighted in yellow). The subtype used is the arc.

Below you can see a tip relief on the exclusively right tooth flank. The correction is also made here via the circular arc.

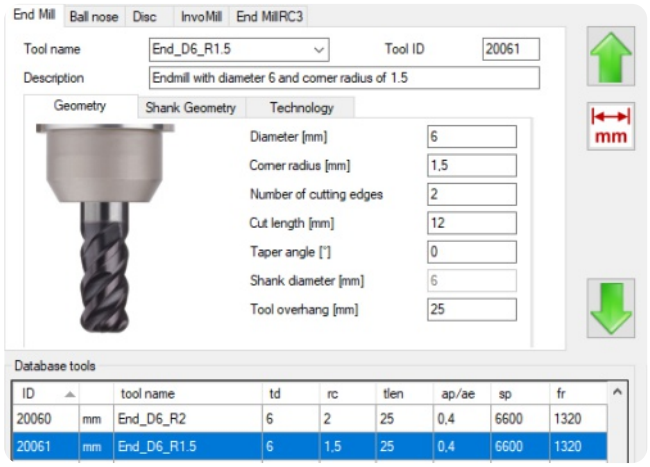


CAM - The Fast Way to the Goal

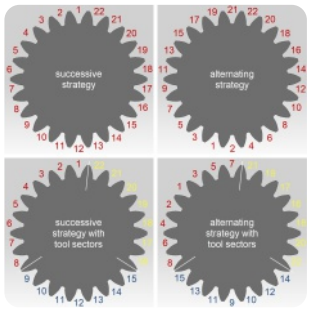
With Precise Data to the Machine

- **optimum travel distances**
- **special milling strategies**
- **internal tool database**
- **simple, fast and clear**

A gear wheel with its approximately 15 to 100 tooth spaces of identical geometry and properties, corresponds to a small batch in machining. Subject to the given tolerances, **EUKLID GearCAM** optimizes the milling paths to get a minimum number of passes while strictly adhering to the tolerances.
The cutting and performance data may be transferred from the integrated tool database.



Various strategies for processing the individual teeth are freely selectable. The gaps are milled either in a row or right / left alternation.

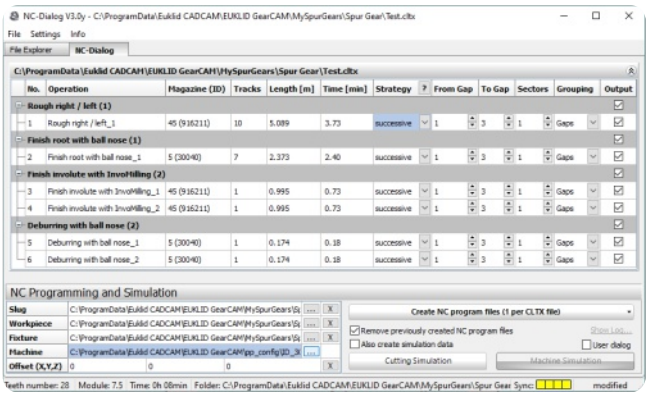


For working with sister tools, the gear can be divided into any number of sectors.

The CAM part or the ease of 5-axis gear milling.

The toolpaths are calculated mathematically exactly on the basis of the entered gear parameters. The selection of methods, parameters and tolerances gives you full control over the mathematical accuracy.

In the roughing dialog (top left) and the finishing dialog (top right) you will find optimized strategies to choose from.
The machining time is displayed regardless of the tool type and the procedure. The influence of the currently selected settings is therefore immediately apparent and can be optimized if necessary.



Special Tool Shapes and Strategies

Disc Cutters and End Mills with Profile

- **disk cutters - additional strategies**
- **conical tools - flexibility and stability**
- **end mills with profile - save time**

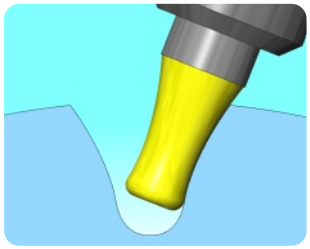
As with conventional milling, there are two relevant work steps: Roughing and finishing. These can be extended as required. Several tool types - in addition to standard cylindrical end mills - are supported:

Disc cutters extend the strategy options for finishing. For example, in the flank line direction for cylindrical gears, ideal for very hard materials in the range > 60 HRC. The InvoMilling™ process is explained separately on the next page.

With **conical tools**, limited traverse and/or swivel ranges can be compensated for individual machine types. They also help to save milling paths and time. Conical microtools in particular are also significantly stiffer and less susceptible to breakage.

Concave end mills are available with radius or involute profile. In the ideal case of finishing process, the milling paths of the tooth flank can be limited to one path (time savings of up to 60%). To help your tool manufacturer, the required profile end mills can be exported as a dxf graphic file. This simplifies procurement.

The graphic shows a conical end mill with suitable involute profile.



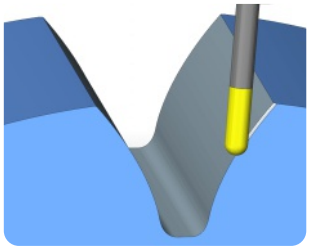
Without Corners and Edges

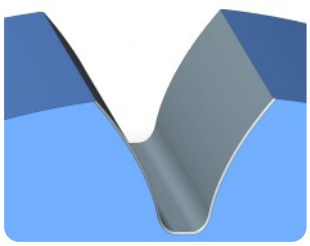
Deburring

- **high precision due to path-precise deburring, also along the turning contour**
- **increased process safety**
- **shortened lead times**

The benefits of **EUKLID GearCAM** and the automation of production can be further increased via the deburring function.

After gear milling, the gear wheel is deburred in the same clamping. At the bottom left you can see how the ball cutter deburrs the tooth gap along the turning contour. To the right, the finished result.



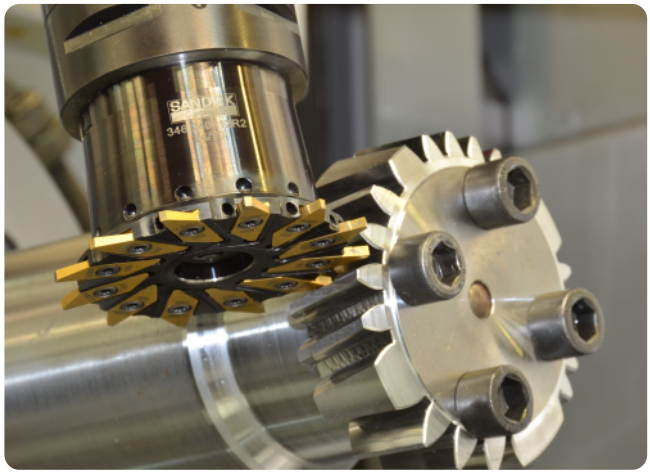


Performance Plus
InvoMilling™

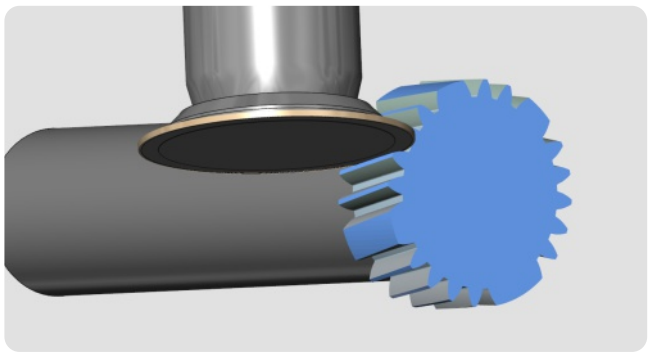
PATENTED

- **for external spur gears**
- **for straight bevel gears**
- **flexible, efficient programming and production of gears**
- **one milling tool for different gearing modules**

A helical spur gear is machined with a **Sandvik Coromant** CoroMill® 161 tool using the **InvoMilling™** method.



Source: Sandvik Coromant



The patented **InvoMilling™** process was integrated into **EUKLID GearCAM** in collaboration with **Sandvik Coromant** experts and is available as an extended function.

InvoMilling™ enables the user to produce external gears and splines for a wide variety of applications even more efficiently using multi-task machines. **InvoMilling™** is the ideal solution for:

- individual prototypes
- small and medium batch sizes
- replacement gears in case of repair
- for highest quality requirements

In addition to dry machining, the manufacture of special designs in special materials or high degrees of hardness is also possible.
The largest gear wheel currently manufactured using this process has a diameter of 800 mm and a module of 18.

InvoMilling™ combines the most important features of gear manufacturing. Be it the very high demands on accuracy and quality, the economic efficiency of the production or the simple handling.

The definition of the gear parameters as well as the tool selection (an internal database is already equipped with standard milling tools) and NC programming are also carried out quickly and user-friendly in this module.

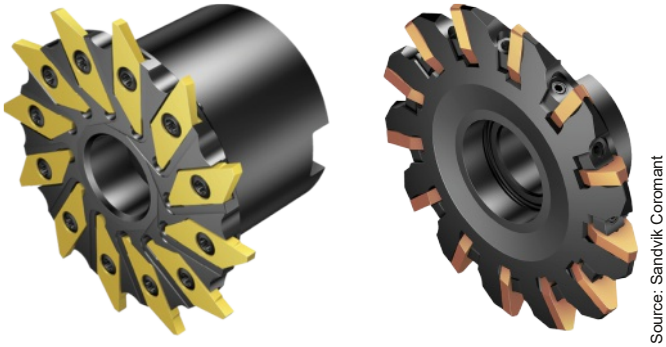
Sandvik Coromant is the global market leader for tools, tool solutions and know-how in the metalworking industry. With over 8,000 employees and represented in 130 countries, the Swedish company is a strong partner for **Euklid CAD/CAM AG**.

Precision Tools CoroMill® 161 and 162

Tools Available from Stock

By using the **CoroMill® 161** and **CoroMill® 162** tools from **Sandvik Coromant**, which are suitable for the **InvoMilling™** process, different module sizes can be processed with the same tool.
The optimum stability and long service life of these tools enable the production of high gear tooth qualities.
Long delivery times for special module milling cutters are also a thing of the past, as standard indexable inserts are used for milling.

CoroMill® 161 (left) and **CoroMill® 162** (right).

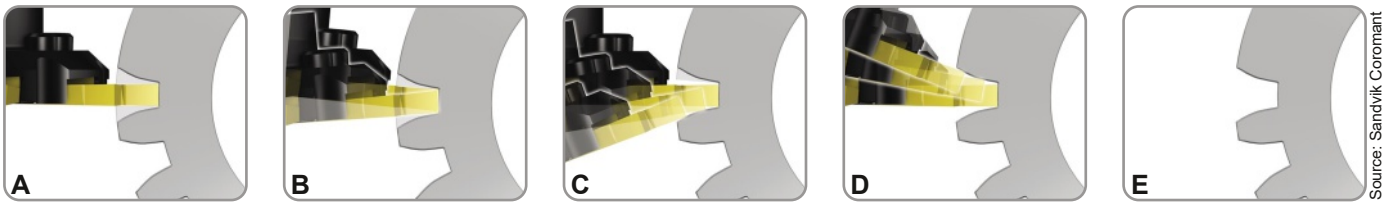


Source: Sandvik Coromant

So how does it work?

InvoMilling™ combines groove and turn milling with the multi-axis function of the machine

First, during roughing, a groove is milled in axial direction to the workpiece **(A)**. The tooth gap is then approached radially by the tool and the tooth base is milled **(B)**. Then the workpiece or the rotary axis cooperates so that the renewed radial immersion of the cutting tool produces the desired involute curve shape **(C and D)**. As a result, the variants of the gear shape are created by the path of the tool and not by its shape. Larger modules or wider gears may require several milling passes. In the end, however, the result is always the same: perfect tooth shape with high profile fidelity **(E)**.



Source: Sandvik Coromant

A: Roughing the tooth gap

B: Milling the tooth base

C: Milling the lower tooth profile

D: Milling the upper tooth profile

E: Finished tooth form

Performance Plus:

Different protuberance angles, profiles and radii at the tooth root - everything is possible. The required grinding allowances can also be easily implemented with **InvoMilling™**. Small chip cross sections and minimal lateral pressure prevent the development of vibrations and allow you to work with higher cutting data.

Preconditions:

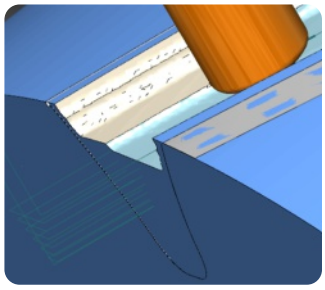
In addition to true 5-axis simultaneous machining, a negative swivel range is required for milling the lower tooth profile **(C)**.
Our experts will be happy to advise you on the suitability of your machine for the **InvoMilling™** process. Please contact us.

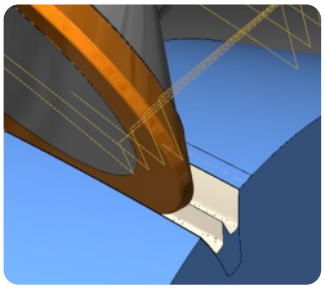
Highly Accurate Simulations

Know in Advance What Happens

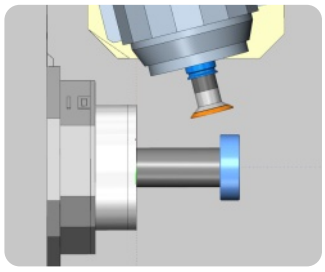
- **fast cutting simulation**
- **accurate machine simulation**
- **ideal set-actual comparison**

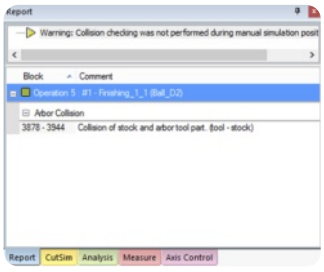
The **cutting simulation** is the perfect tool to quickly check calculations and inputs. Collisions or inaccuracies can be immediately analyzed and corrected.
During roughing, an optimal result is achieved through the graphic control of the tools. In finishing, the focus is on exact adherence to the tolerance values with optimized path setting.





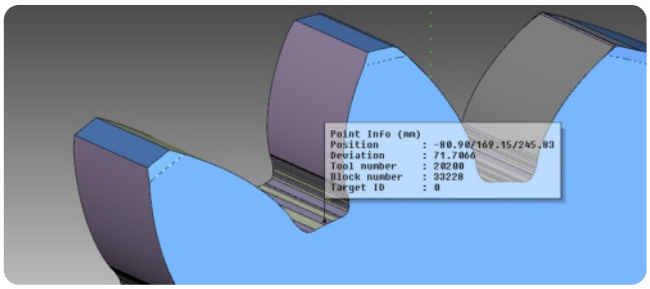
The **machine simulation** focuses on the movements of the machine tool, which is particularly important for 5-axis milling. In addition to the collision control of workpiece, tool and holder, all relevant machine parts are now included, e.g. clamping devices or the milling head. Results and collision messages are displayed both graphically and in tabular form in a report window (bottom right).



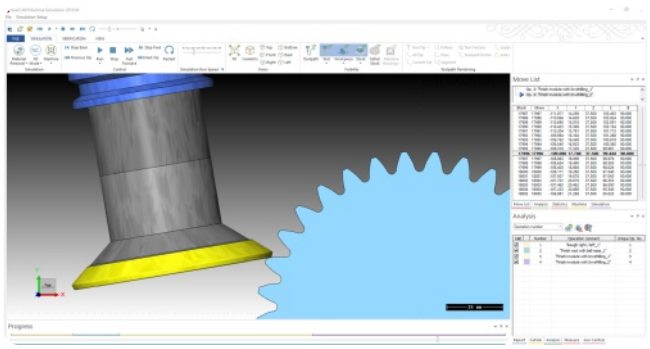


Simulation means to visualize the outcome of the NC programm.

Simulations provide certainty about the correctness of the operating sequences. Cutting and machining simulation are established methods thereto. These are limited in their accuracy and require considerable computing times with extremely small tolerance values.
With **EUKLID GearCAM**, however, accuracy in all areas is a central feature. The possibilities of the software therefore go much further than in simulation.
The software allows a set-actual comparison at any point with the highest accuracy. In fractions of a second. The calculation of the surface to be milled and the comparison with the CAD surface thus show precisely – even in the thousandth range – how the workpiece should look after machining.



Complete view in the cutting simulation, the disc cutter rolls over the involute.



Interlinked with our Customers
Good Customer Service

- **EUKLID GearCAM includes a service package upon purchase**
- **EUKLID GearCAM is programmed in-house, which guarantees flexibility and real expert knowledge**
- **EUKLID GearCAM is constantly being improved and further developed**

Euklid is a regular exhibitor at **EMO** in Hannover and **AMB** in Stuttgart. In 2017, the US-American **GEAREXPO** in Columbus, Ohio was visited for the first time. Come and visit us, we are looking forward to seeing you.

At trade fairs there is often not enough time to present all functions of the software comprehensively. We would therefore be pleased to show you the many possibilities of **EUKLID GearCAM** at a targeted online presentation (e.g. based on your own gear data) or at an appointment on site. Just as you like it.

We help you with your task!

It goes without saying that Euklid's philosophy is to provide you with optimum support before and after your purchase. All our products offer you ideal conditions for smooth production.

- user friendliness
- a good documentation
- comprehensive training

In our customer-specific training courses you and your employees will acquire all the necessary basics to use our software effectively and economically in the shortest possible time. All training measures are carried out by experienced specialists.

In addition, application engineers are available to answer any questions you may have by telephone or e-mail. Together with our experts, a solution is quickly found, especially in the initial phase or for new tasks. In addition to remote maintenance, we are also available on site at your request or as required - e.g. support during trial cuts or machine acceptance tests.

We will be happy to advise you on the possibilities of special solutions, the conditions for our follow-up maintenance contracts - one year of service is already included - or provide information on the latest updates and innovations.

EUKLID
Solutions for CAD/CAM

Machining Free-Form Surfaces.

As precise, as a Swiss watch!

Some CAD/CAM visions can only be understood by experts. Our visions make you an expert: EUKLID has been offering solutions since 1970. Solutions which other producers have been unable to develop.
Today 5-axis milling machines are common, but it is difficult to find 5-axis milling experts.The EUKLID CAD/CAM software and our specialists make it easier for you to work with the milling machine ... because nearly 50 years of expert knowledge pays off!

Ask EUKLID, ask us. Challenge us! Each surface-milling job, even the most complicated ones, has its solution. It's only a question of the correct software and of the experts supporting you.

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