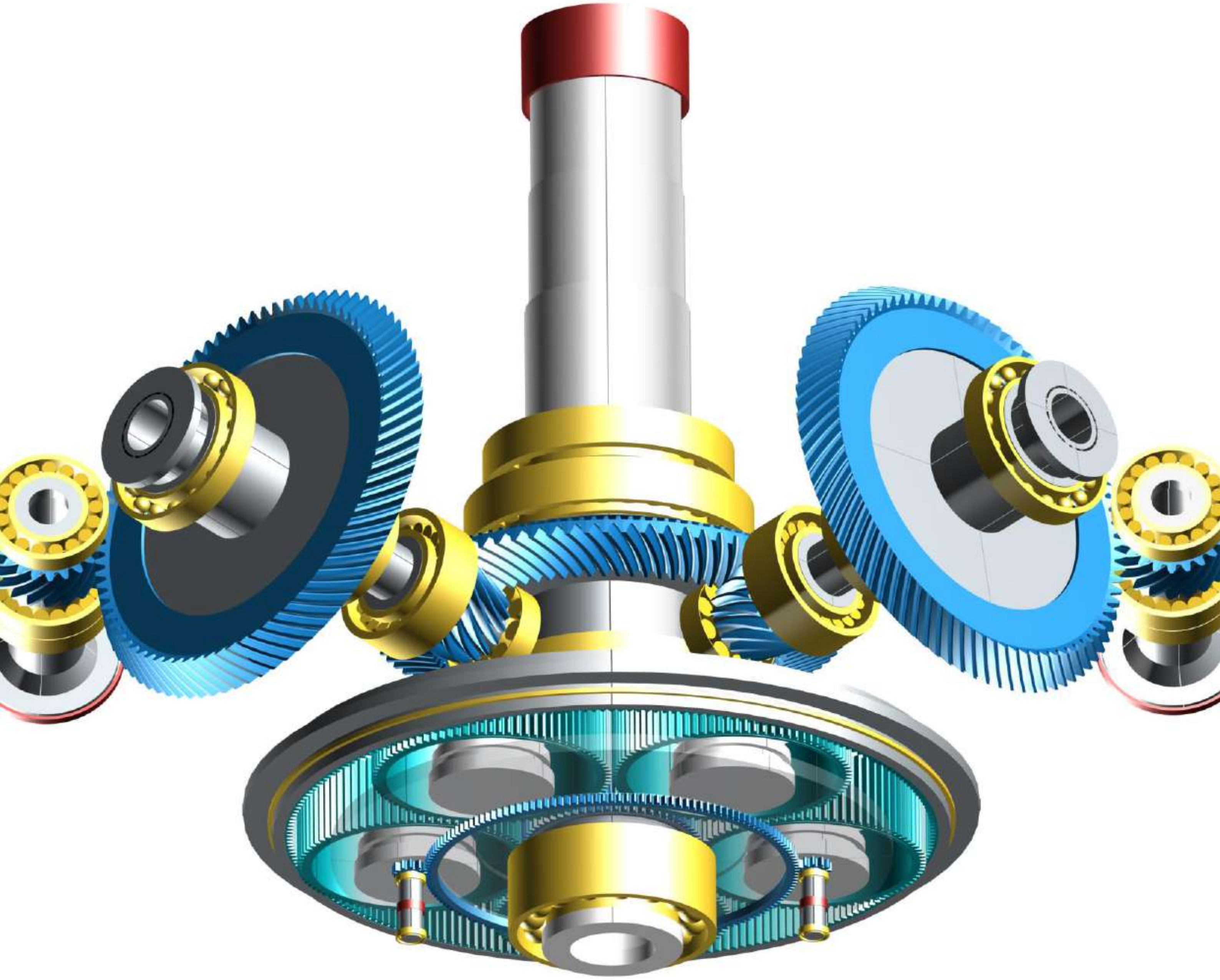


KISSsoft is used wherever there are gears!

KISSsoft covers all common gear types, shafts, bearings, shaft-hub connections, bolts, springs etc. It is used for the analysis of a single element and to design complex transmissions and drive trains. Training and consultancy services provided by KISSsoft AG complement the software business.

Join some 4000 licensees and benefit from 40 years of experience in gear software.

Gears keep track of time.

Non involute gears of low friction are needed to drive watches, clocks, and timepieces accurately. KISSsoft works with proverbial Swiss watch accuracy, keeping you up with time.

8 billion humans need food.

Tractors and other agricultural equipment are one of the pillars on which food security is based. KISSsoft is used by most of the top tractor manufacturers to design and strengthen transmissions and axles.

You like to go to the dentist?

KISSsoft helps to reduce the noise and vibration in the gears used in dental drills. Lower noise level means less nervous patients and therefore less pain during the treatment.

Whether you play the violin or do water skiing, gears drive your hobby.

Any hobby relying on a vehicle or a mechanism (think of the worm gear in a violine to tune it) features gears. KISSsoft makes hobbies fun and affordable.

Sometimes, trains are delayed.

KISSsoft ensures that the root cause for a delay is not a gearbox failure in the locomotive. The high reliability and lifetime needed in rail transport, for example in high-speed trains, is achieved through detailed life and failure probability calculation methods.

The center of the milky way is 25’000 light years away.

KISSsoft is used to maximize the slewing bearing stiffness to maintain antennae and telescope elevation accurately. Highly detailed images of our solar system are the result.

We all pay water bills.

Sensors, like fluid flow sensors, required high ratio, low friction geared transmissions to drive clocks metering usage. KISSsoft allows for optimization of the gears to achieve high metering precision at low cost.

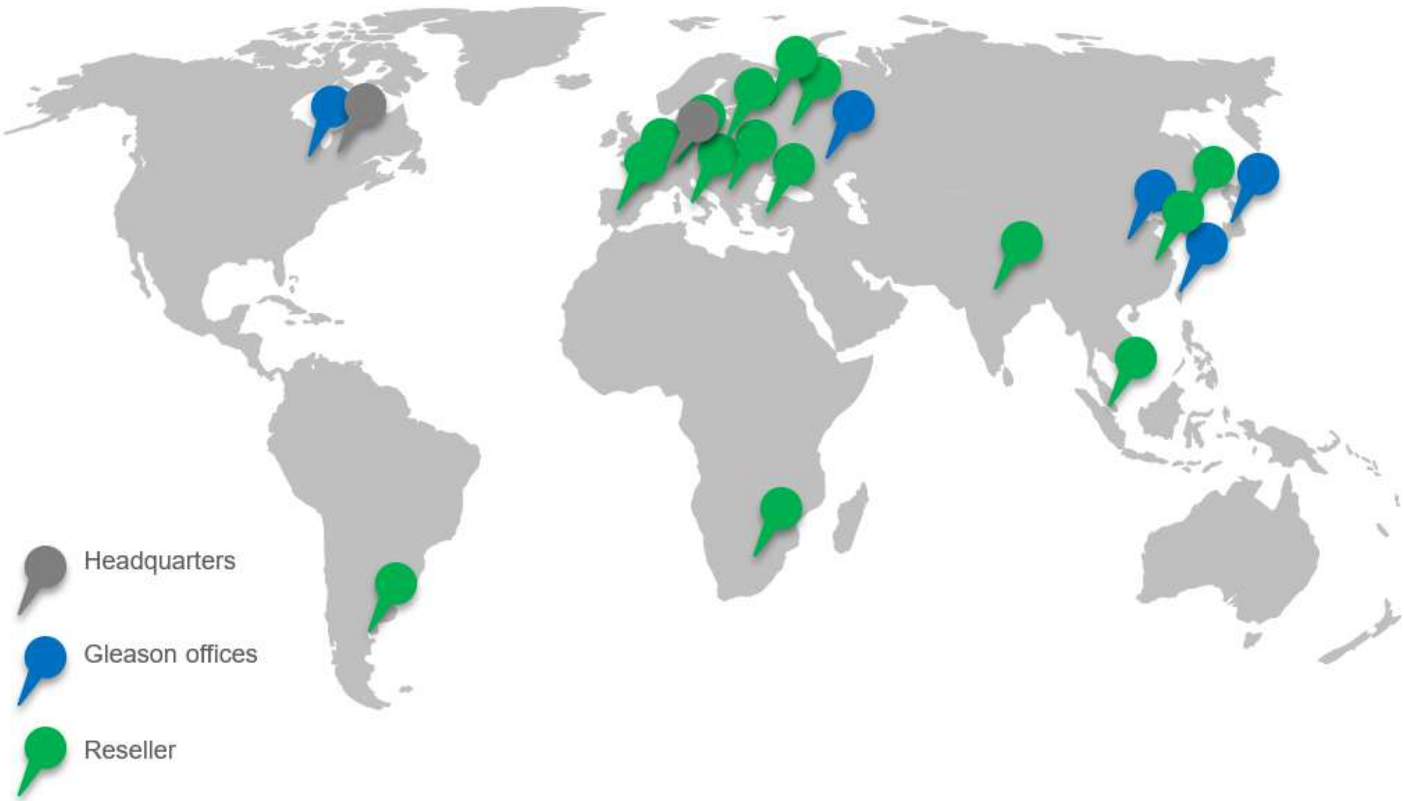
Space travel. The hobby of the ultra-rich.

And yes, there are gears used in rovers, satellites, rockets and their actuators. And of course, KISSsoft is used for the design for highest reliability at lowest mass.

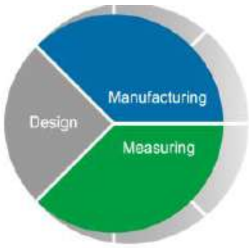
Gears are everywhere and every day, new applications of this time-tested machine element are found.

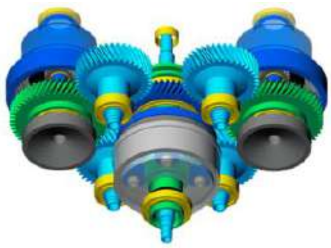
In what application do you use gears? Ask for our assistance in your gear design and verification process, be it through our software, training, or consultancy services.

Global presence

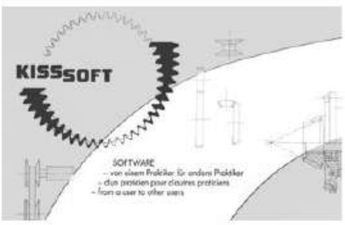


40 years KISSsoft





- 1980 — Calculation program L. Kissling & Co. AG
- 1986 — Sale of first KISSsoft license
- 1998 — KISSsoft AG, Switzerland
- 2005 — KISSsoft USA LLC, USA
- 2012 — KISSsoft China Pvt., Ltd., China
- 2016 — Global partner network
- 2017 — Gleason Corporation acquires KISSsoft AG



Applications

Fine pitch, plastic, and sintered gearing

- Printers, copiers, tray drives
- Geared motors, gearheads
- Automotive actuators
- Medical, building automatization, HVAC
- Power tools, kitchen appliances
- Watches, meters, and sensors
- …

Energy generation

- Turbo gears
- Wind turbine main gearboxes
- Generator shafts
- Engine gear trains
- Pitch and yaw drives
- …

Aerospace

- Rovers, satellites
- Geared turbo fans
- Helicopter MGB, IGB, TGB transmission
- Fuel, oil pumps, alternator drives
- Turbine power take off, starter gears
- Civil and military drones
- Flap actuators, unmanned aerial vehicles
- …

Industrial

- General purpose and heavy-duty gearboxes
- Mining and raw materials handling
- Cranes and winches, mill drives
- Servomotors, geared motors
- Robotics, spindle drives
- Open gears, girth gears
- 5 axis CNC milling of gears
- Bearings, slewing bearings
- …

Vehicles

- EV transmissions, E-axles
- Cars, trucks and buses
- Tractors, harvesters
- Motorbikes, three wheelers, RVs
- Motorsport
- Military, tracked, armored vehicles
- Construction equipment, forklifts
- Engine drive trains, valve drive train
- ...





Modules

General

- KISSsoft module as individual modules
- KISSsys module requires KISSsoft
- CAD and FEM modules require KISSsoft

KISSsoft

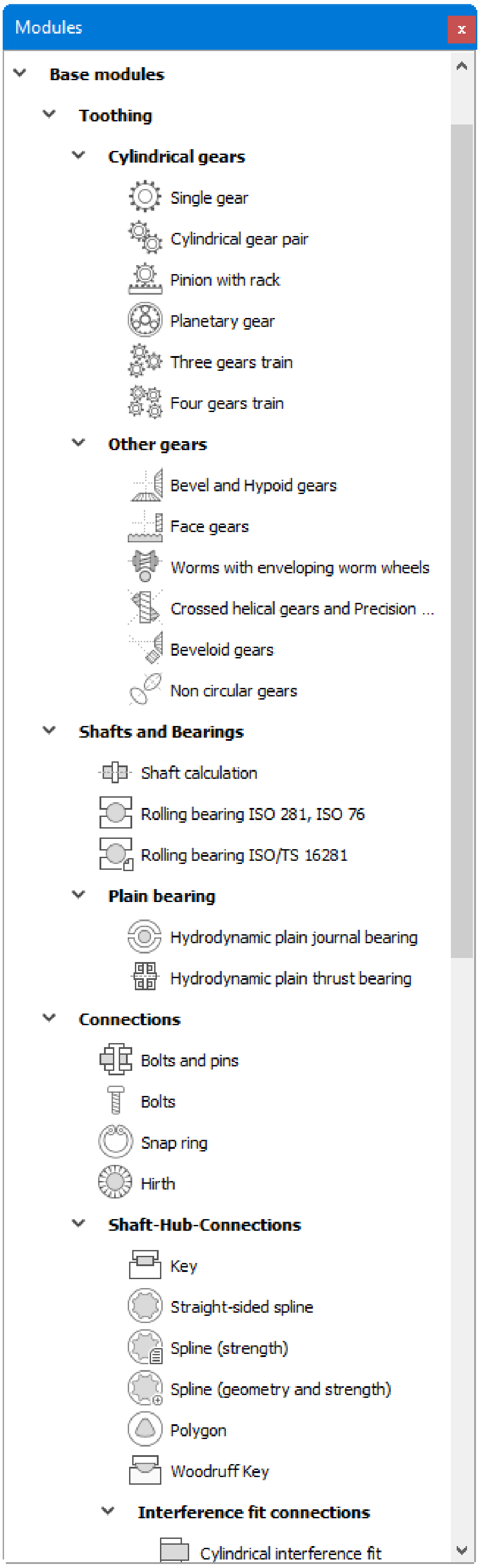
- Cylindrical, rack & pinion, bevel and hypoid, beveloid, worm, face gears, crossed axis helical, non-circular gears
- Shafts and rolling element bearings, hydrodynamic bearings, coaxial shaft systems, bearing stress and load distribution
- Shaft modal analysis and unbalance response
- Shaft-hub connections, bolted connections
- Spring analysis, chains and belts, clutches
- Tolerance stack-up, local stress analysis, Hertzian contact stress, spindles
- Plastic gear materials manager
- Load spectrum from time series
- Gear body deformation

KISSsys

- Library of gearbox models for typical designs
- Machine element library to build own models
- Programming language module
- Suitable for virtually any gearing system
- Housing stiffness import from FEM (ABAQUS, ANSYS, NASTRAN, …)
- System efficiency calculation, thermal rating
- Load spectrum rating on system level
- Modal analysis / natural frequencies calculation on system level

CAD interfaces and supported formats

- Interfaces to other Gleason software like GEMS®, GAMA®
- 2D CAD export in neutral / graphic formats
- 3D export to CAD systems (gear geometry)
- Interfaces to multi body systems software



Databases

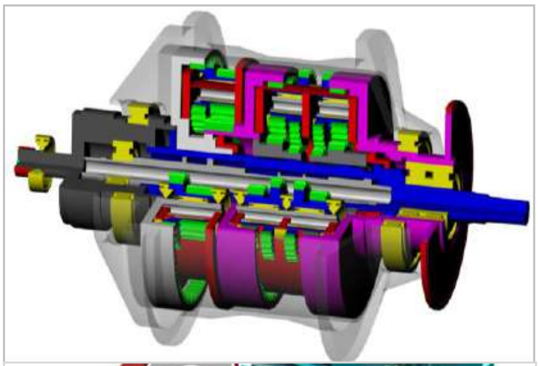
General

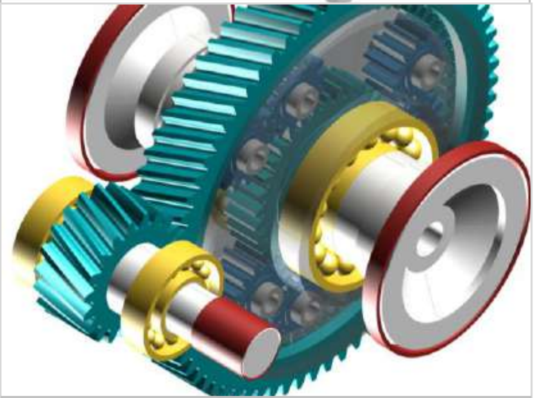
- Database is user editable and can be transferred from one release to next
- FAG / INA, SKF, Koyo, Timken, …
- For standard bearing data and bearing inner geometry (only through user input)

KISSsys, systems module

Overview

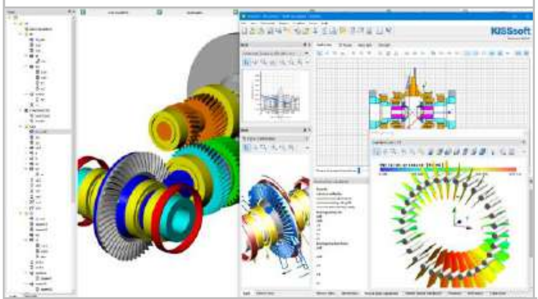
KISSsys software combines kinematic analysis, lifetime calculation, 3D graphics, user defined tables and dialogs with a programming language. It is the tool of choice for strength and lifetime analysis of various kinds of drive trains and gearboxes. KISSsys lets the user do quick yet detailed parametric studies of a complete power train in very little time to compare different variants of a concept or to analyze a given design for different loads.





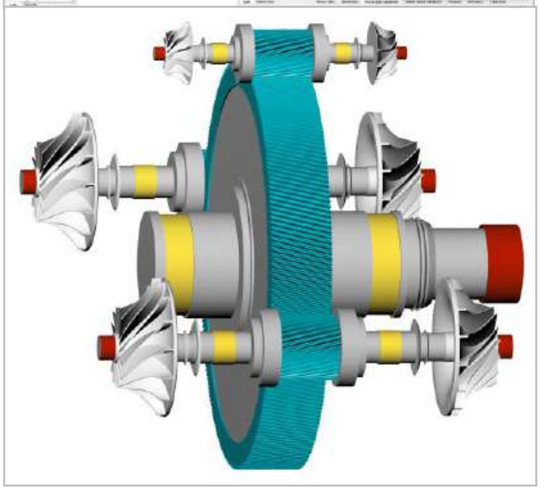
In KISSsys, all parts (gears, shafts, bearings, connections) of the gearbox are linked and the strength / lifetime analysis is performed simultaneously for all elements. A three-dimensional graphical presentation of the current state of the system immediately shows the geometrical influence of every change in parameters. This approach greatly accelerates the design process and results in a much more balanced design even during the concept phase.

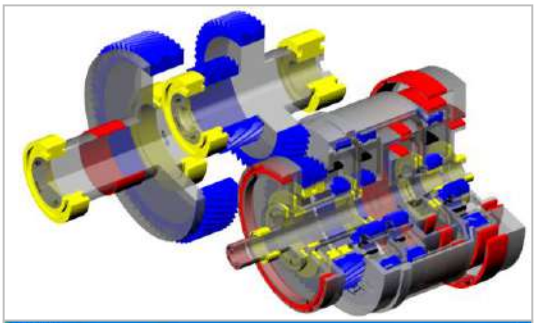
The machine elements calculated range from gears, shafts, bearings, shaft-hub connections to bolts. This will result in a more balanced starting design and fewer modifications will be necessary further down in the design process to reach an optimized design. Furthermore, documentation of the calculation is simplified and all calculation data for a whole drive train or gearbox is stored in a single file. KISSsys uses KISSsoft for the strength and lifetime calculations of the various machine elements.



Kinematics Calculation:

- Power flow / speed with spur, bevel, worms and face gear stages
- Modelling of rotational mechanisms (planetary, Ravigneaux, Wolfrom, Wilson, …),
- Differentials, (with bevel or spur gears), chain and belt transmissions
- Couplings can be activated and deactivated, slippage taken into account

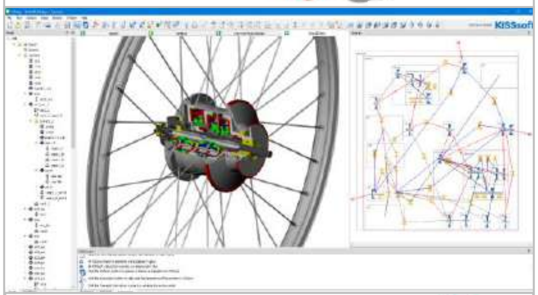




Calculations in KISSsys

Integrated strength and lifetime calculation:

- With integrated KISSsoft calculation modules
- System deflection is considered in tooth contact analysis



Machine element library

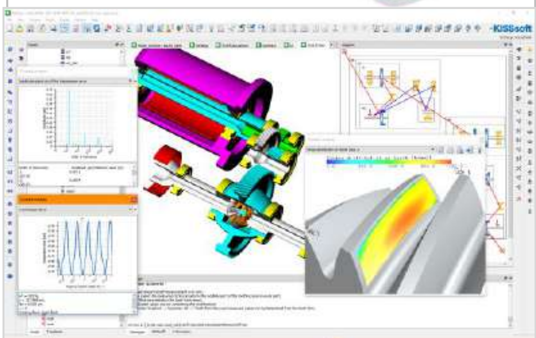
- Spur / helical gear pair and chain of gears
- Planetary gears, compound planetary gears
- Bevel and hypoid gears, beveloid gears
- Worm gears, crossed axis helical gears
- Face gears with and without offset
- Shaft-bearing systems, coaxial shafts
- Shaft-hub connections
- Synchronizer

3D representation

- Automatic 3D-display (based on the data defined in KISSsoft),
- 3D-model export to CAD platforms, gearbox housing import, (*.step / *.iges),
- Collision check with imported CAD geometry

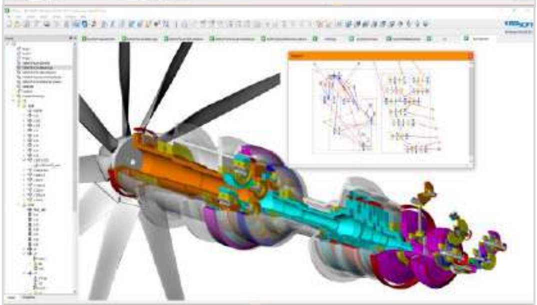
Special features

- Calculations with load spectra for all machine elements in the model
- Integrated programming language for implementation of special functions
- Animation of gear movement
- Cut view and deformed systems display
- Wizards, libraries and toolboxes for quick modelling



Typical applications

- Analyze wind turbine gearboxes for different loading conditions
- Ensure that the design of a plastic gear set for an automotive actuator fits into a given design space
- Calculate power flow in CVT transmission
- Maintain a database of geared motor gears
- Estimate the manufacturing cost of a gearbox even during the design phase
- Optimize bearing lifetime by variation of the gear's positions on a shaft
- Create specific reports e.g., for certification
- And many more …



Housing stiffness import

The housing stiffness and the housing deformation may be considered for the loaded tooth contact analysis in KISSsys by means of

- Input of housing deformation values in a table
- Import of housing stiffness matrix / reduced stiffness matrix

Supported FEM codes

- ABAQUS
- ANSYS
- NASTRAN

Features

- Node mapping: connect master nodes of stiffness matrix to KISSsys model bearings
- Deformation vector is calculated inside KISSsys using bearing forces and stiffness matrix
- Automatic alignment of stiffness matrix coordinate system to KISSsys model coordinate system

Modal analysis

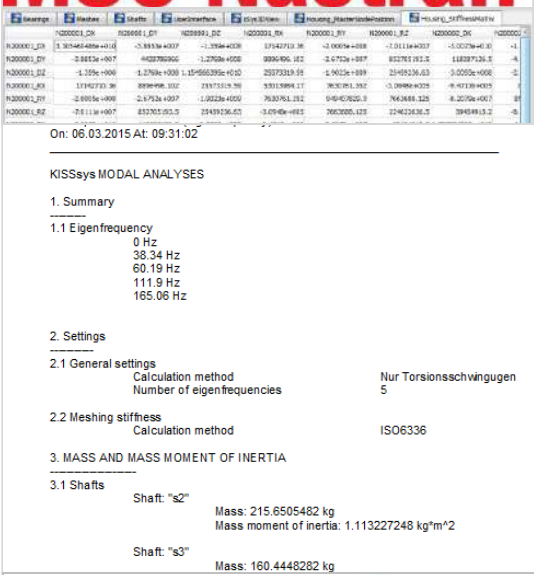
- Calculate system natural modes and natural frequencies
- Considers bearing operating stiffness matrix
- Considers gear mesh stiffness
- Considers shaft stiffness, inertias and masses
- Animation of modes on system level
- Comprehensive report

Thermal rating

- Calculates power losses due to gear meshes, bearing friction, churning and seal friction torque
- Based on ISO/TS 14179-1 / ISO/TS 14179-2
- For oil bath or forced lubricated systems
- Calculates and lists individual power losses and system efficiency
- Sizing of cooler, calculation of thermal equilibrium, calculation of required oil flow

Gleason GEMS® interface

- Export EPGΣ data from KISSsys
- Interface to GEMS® and GAMA®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KISSsys MODAL ANALYSES

1. Summary

1.1 Eigenfrequency
0 Hz
38.34 Hz
60.19 Hz
111.9 Hz
165.06 Hz

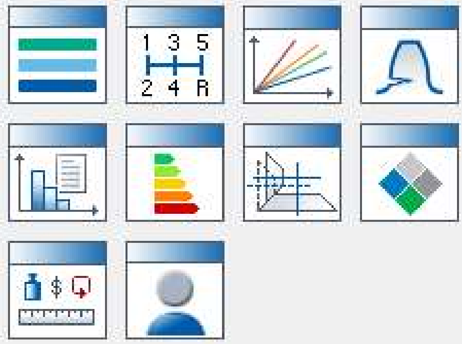
2. Settings

2.1 General settings
Calculation method Nur Torsionsschwingungen
Number of eigenfrequencies 5

2.2 Meshing stiffness
Calculation method ISO6336

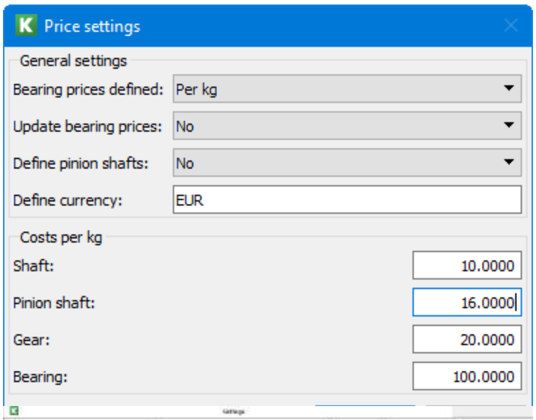
3. MASS AND MASS MOMENT OF INERTIA

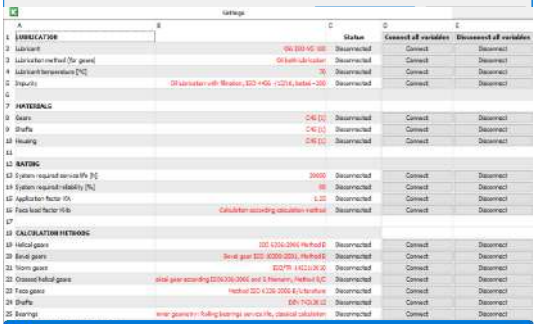
3.1 Shafts
Shaft: "s2"
Mass: 215.6505482 kg
Mass moment of inertia: 1.113227248 kg*m^2
Shaft: "s3"
Mass: 160.4448282 kg

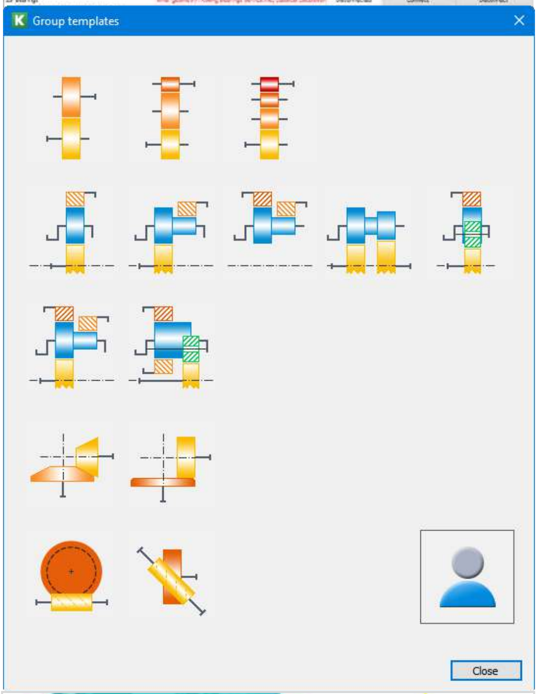


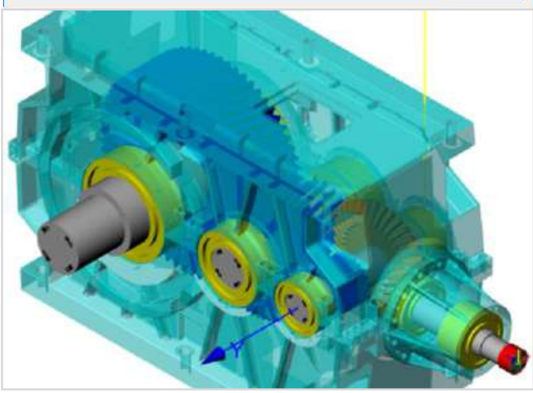
GPK module

GPK module is a set of readymade KISSsys models. The models are provided to the customers as a library to be used in KISSsys. The models made available cover the most typical industrial gearboxes. The models feature advance level functions to accelerate the design process of standard industrial gearboxes. The need for the user to build his own models is eliminated and detailed reporting functions further reduce the time to document the design. Automatic sizing functions for the gears, bearings and shafts result in a well-balanced gearbox. Price calculations based on user defined cost per mass data allow for constant control over gearbox costs.









Types of gearboxes

- Helical gearboxes
- Bevel, helical-bevel gearboxes
- Worm, worm helical gearboxes
- Planetary gearboxes

Configurations

- One, two, three, four or five stage helical gearboxes, with or without roller bearings
- One bevel without, with one, two or three helical stages, all with roller bearings
- One worm without, with one, two or three helical stages, all with roller bearings

Functions

- Sizing of gear stages (distribution of ratio among the stages, sizing for given center distance)
- Sizing of shafts and bearings (based on stress levels and required bearing life)
- Cost estimation (considering bearings, shafts and gears)
- Report generation (summary, pricing and detailed report)
- Detailed gear, bearing and shaft design through KISSsoft
- Free arrangement of shafts in space
- External forces on input and output shaft
- Settings for lubrication, temperature, orientation of gearbox in space, materials, calculation methods and graphics

Cylindrical gear basis modules

Configurations

- Spur or helical gear, herringbone gear, considering face width offset
- Grease or oil lubricated or dry running gears
- Metallic or plastic gears
- Involute or non-involute gears
- Any number of teeth, any type of tooth height, internal or external gears

Gear geometry calculation

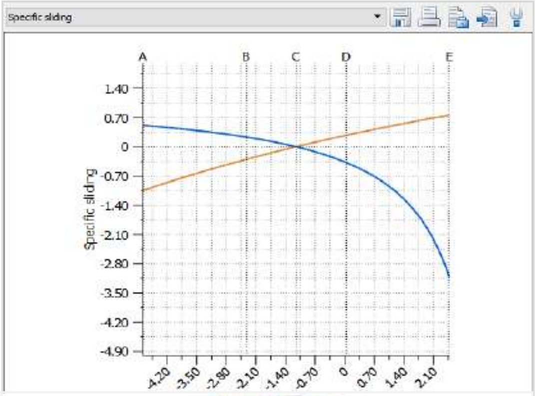
- Gear geometry along ISO 21771
- Reference profile along ISO 53.2, DIN 867, JIS, BS5482 or own input
- Tolerances along DIN 3967, ISO 1328, own input or for theoretical gearing
- Centre distance along ISO 286, ISO 7168, DIN 58405 or own input
- Gear quality along ISO 1328, AGMA 2015-1-A01, DIN 3961, DIN 3961, DIN 3963, DIN 23961, DIN 23962, DIN 23963, AGMA 200-A88

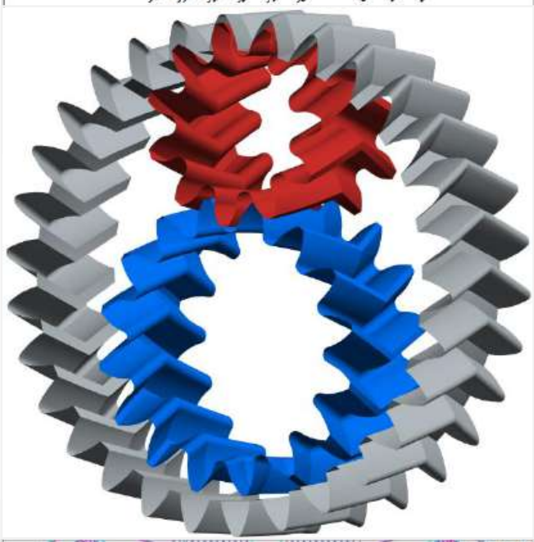
Gear rating

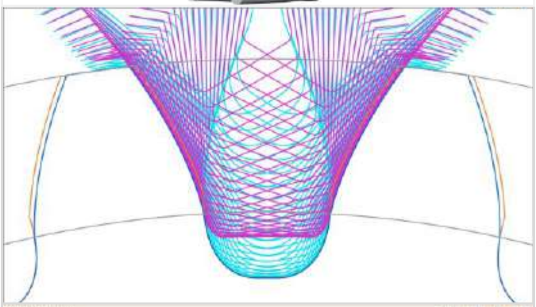
- DIN 3990 method B, DIN 3990 method B with YF along method C, DIN 3990 Part 41 (vehicles) method B
- ISO 6336:2006 and ISO 6336:2019
- Static rating against yield
- AGMA 2001-B88, AGMA 2001-C95, AGMA 2001-D04, AGMA 2101-D04 metric
- AGMA 6004-F88, AGMA 6014-A06, AGMA 6011-I03, AGMA 6015-A13
- GOST 21354-87
- Plastic gears along Niemann, VDI 2545, VDI 2545 modified, VDI2736
- As FVA software for DIN 3990
- BV / Rina FREMM3.1, Rina 2010, DNV41.2
- ISO 13691:2001 (high speed gears)
- For nominal load or load spectrum

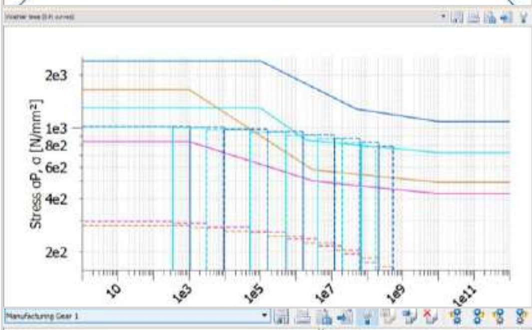
Reports

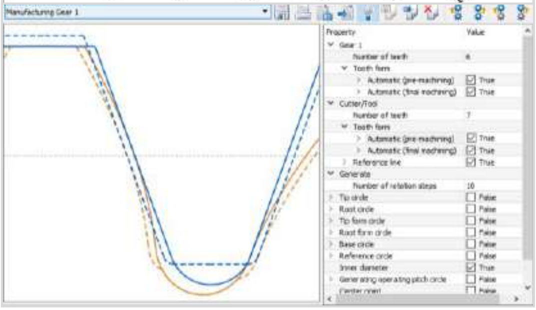
- For default report or user specific template
- Geometry and strength reports
- Tooth scuffing, micropitting and wear
- Tooth thickness dimensions, tooth tolerances
- Modifications, manufacturing



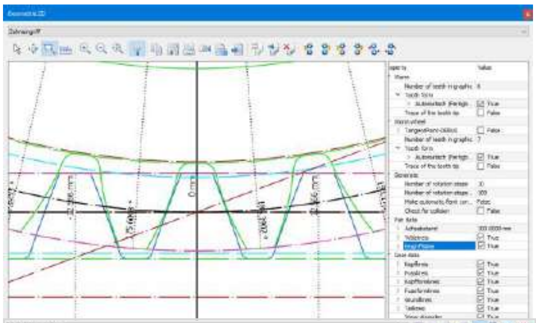


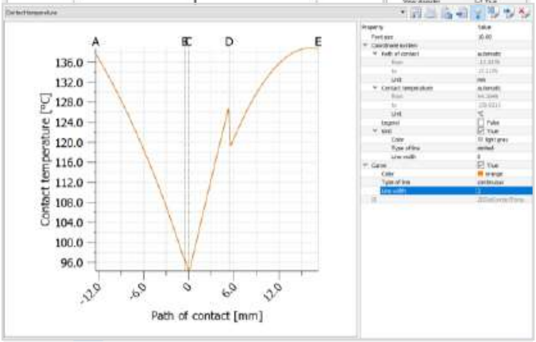


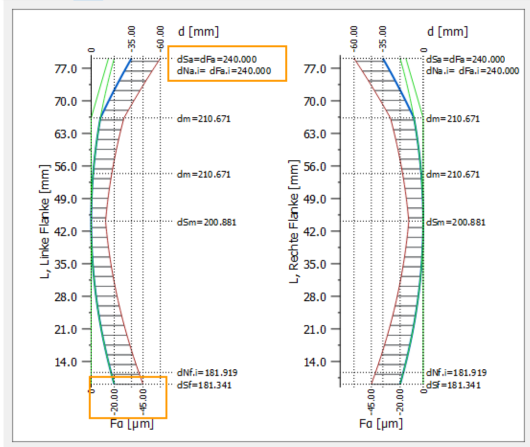


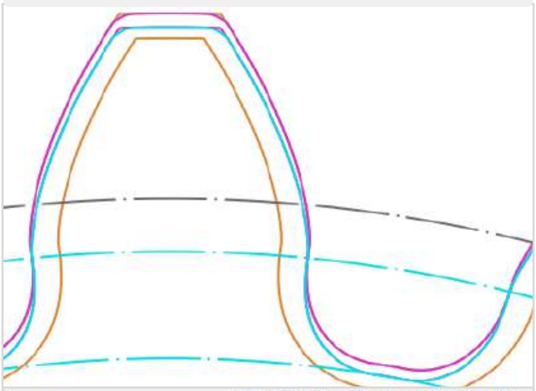


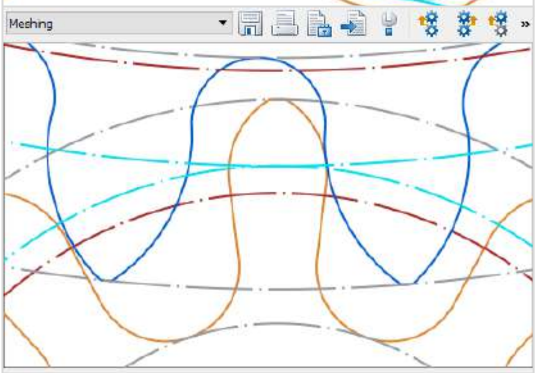
Cylindrical gear general modules











Gear geometry calculation

- Calculation based on gear or tool reference profile
- Calculation based on true tool geometry
- Calculation based on mating gear geometry
- Import and export of gear or tool geometry from CAD system
- Calculation of theoretical, acceptance and operating backlash for metallic and plastic gears and housings

Load spectrum calculation

- Direct input of load spectrum or import from text or Excel file
- Calculation of lifetime based on required safety factor, safety factors based on required lifetime and permissible torque based on required safety factor and lifetime
- Calculation of partial damages
- Calculation of equivalent torque
- For DIN 3990, ISO 6336 and AGMA 2001

AGMA925 calculations

- Calculation of scuffing safety
- Calculation of contact stress, lubricant film thickness

Micropitting and scuffing calculation

- Micropitting rating along ISO/TR 15144
- Specific lubricant film thickness calculation along AGMA 925
- Lubricant film thickness calculation along ISO/TR 15144 based on true contact stress
- Scuffing rating along ISO 6336-20, ISO 6336-21, DIN 3990-4

Flank fracture calculation

- Along ISO/DTS 6336-4 or Annast method
- Along method A (based on LTCA) or method B (based on formulas)
- Case crushing calculation along DNV 41.2

Master gear calculation

- Calculation of master gear geometry
- Meshing of master gear with gear

Cylindrical gear sizing modules

Configurations

- Sizing functions to find optimized gears (in terms of mass, power density, stiffness, space requirements)
- Functions to reverse engineer gears
- Functions to optimize gear properties

Rough sizing

- Proposal of several gear solutions for required power rating, required ratio, given material
- Considers gear quality, permissible ratio error
- For single load level or load spectrum

Fine sizing

- Define permissible ranges for module, pressure angle, helix angle, center distance and profile shift
- Define target ratio and permissible deviation
- Define maximum number of solutions
- Set maximum permissible tip diameter and minimum permissible root diameter
- For pre-defined number of teeth or varying number of teeth
- Different filter and sorting functions
- Report with assessment of solutions for different criteria

Macro geometry sizing

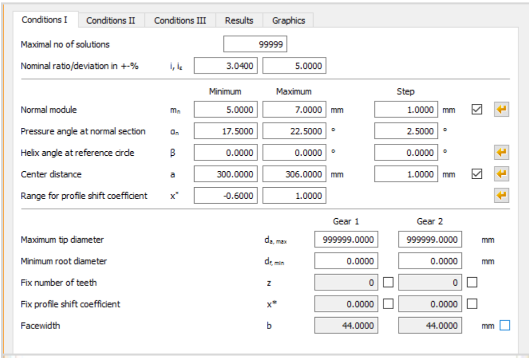
- Sizing from gear pair data
- Sizing for target profile shift sum
- For balanced specific sliding / speed increaser
- To avoid pointed tooth or undercut
- For maximized strength on flank or root or maximized scuffing strength

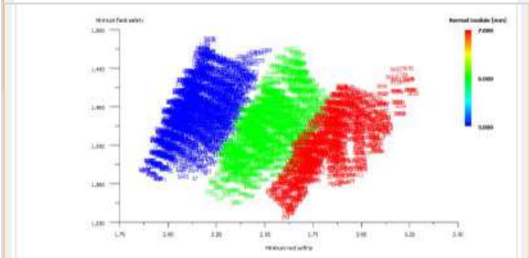
Sizing of tooth height / reference profile

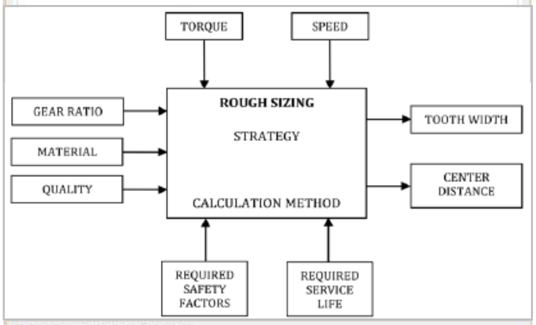
- Sizing of reference profile for target transverse contact ratio
- Sizing of maximum possible root radius

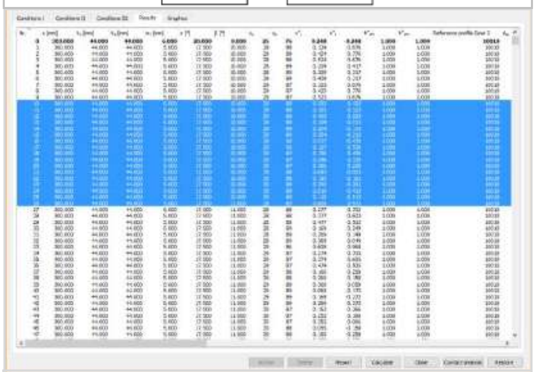
Sizing of profile and lead corrections

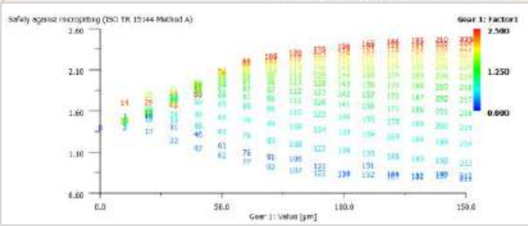
- Sizing of tip and root relief Sizing of end relief and crowning
- Automatic search for optimum corrections

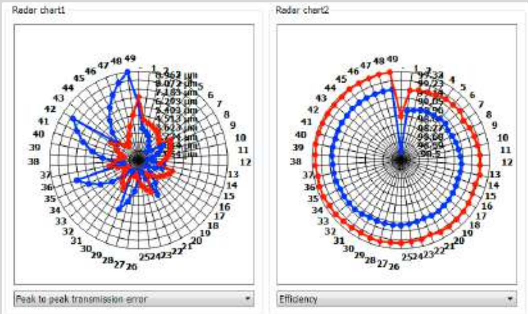




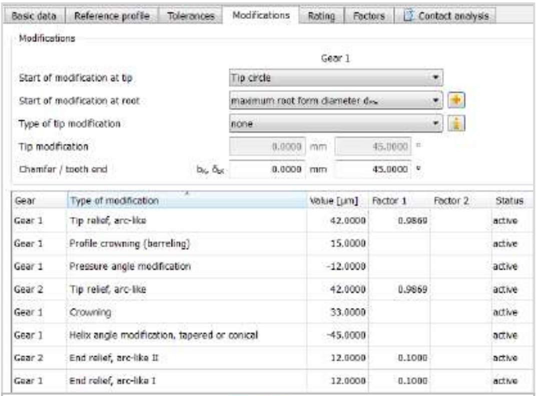


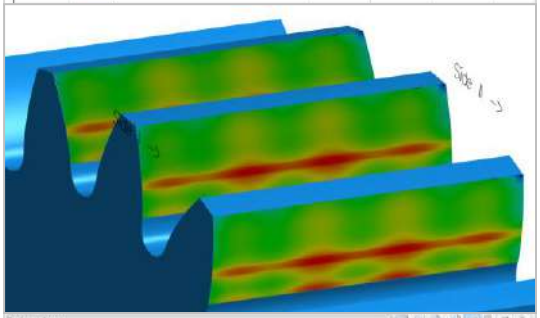


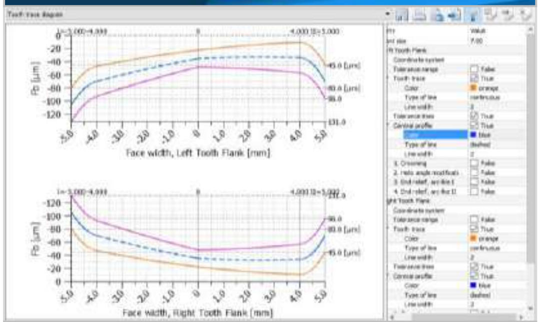


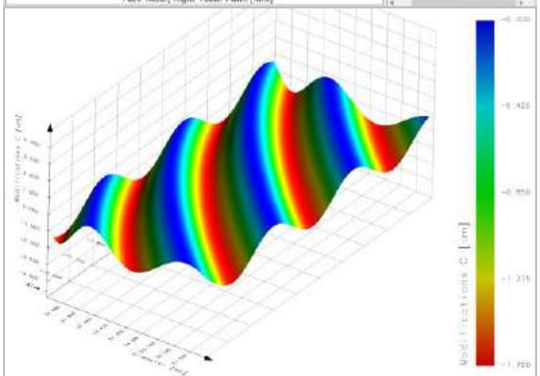


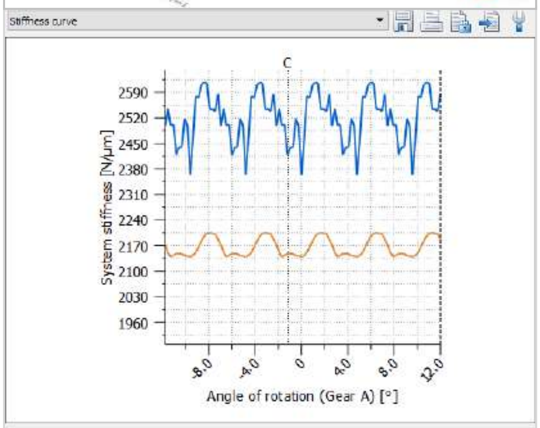
Cylindrical gear modifications











Configurations

- Considers all modifications in profile and lead direction
- Calculation based on 41 or more gear sections
- Pitch errors may be considered in part or fully
- Calculation for nominal or operating center distance
- Calculation for nominal or partial load level
- Meshing friction considered in calculation
- Considers true gear geometry from manufacturing simulation

Output

- Calculation of load distribution in profile and lead direction
- True stress levels compared to stress levels calculated along standards (ISO / DIN / AGMA)

True root stress calculation

- Calculation of YS and YF along full tooth root
- Considering true root geometry from manufacturing
- Root geometry optimization for minimized root stresses

Micropitting along ISO/TR 15144

- Calculation of specific lubricant film thickness λ along g ISO/TR 15144
- Considering true contact stress, temperature in contact, surface roughness and lubricant properties
- Calculation of micropitting safety, method A and B

Lead and profile modifications

- End relief (left and right end), crowning
- Helix angle modification
- Linear and progressive tip / root modification
- Profile crowning (barreling)
- Pressure angle modification
- Tip chamfer or rounding
- Grinding disk plunge depth
- Graphical output in involute diagram
- Flank twist
- Triangular end relief (left and right end)

Gear body influence

Modelling and FEM

- Hub / web / rim arrangement
- Parametrized geometry
- Automatic meshing with parabolic tet elements
- Calculation of deformation and stiffness matrix
- Stiffness matrix connected to shaft calculation
- Geometry preview
- In combination with LTCA

Tooth geometry export

Configurations

- With or without profile / lead modifications
- Modifications may be different per tooth
- Modifications may be different per flank
- Output in transvers, normal and axial section
- Output of tooth or gap, single or half tooth
- Output as x,y format to use e.g., in spreadsheet calculations
- Output as x, y, z format in line with Gleason or Klingelnberg format for measuring machines
- Considers true gear geometry from manufacturing simulation

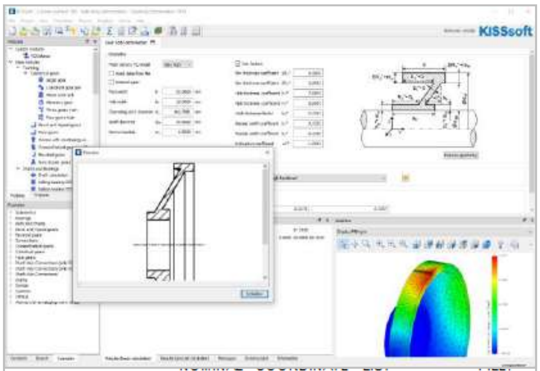
Load rating with time series

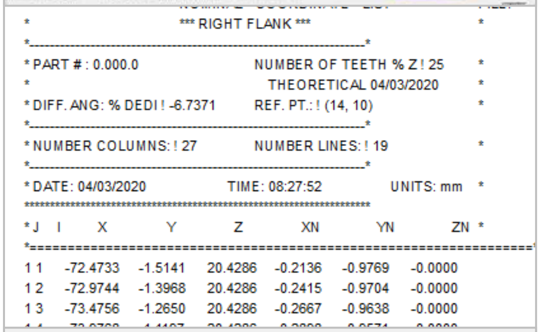
Import and conversion

- Import time series of speed and torque from text file
- Convert to load duration distribution load spectrum (LDD), save LDD for gear rating
- Considers changes in torque direction
- Considers changes in speed direction
- Graphical display of resulting load and speed distribution

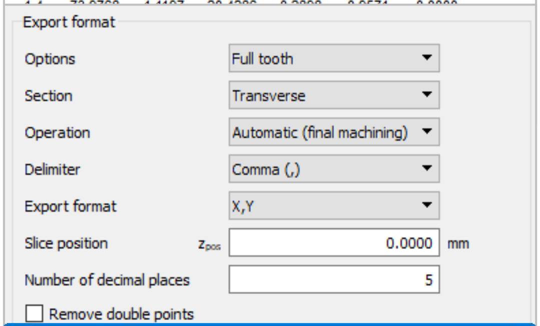
Configurations

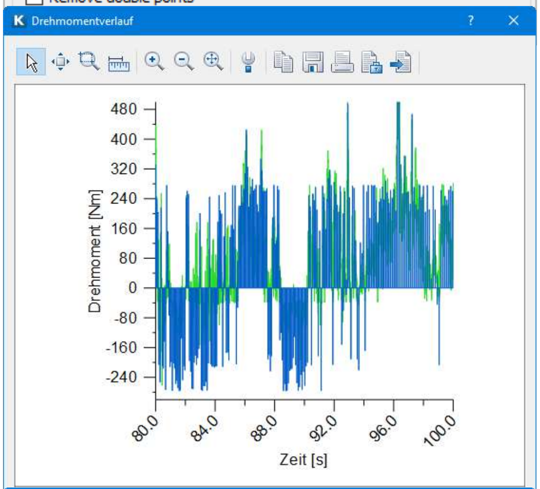
- Rain flow count method according to Amzallag or ASME
- Simple count method

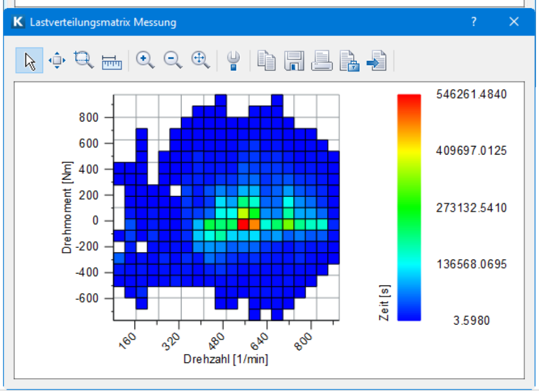



*** RIGHT FLANK ***
---
* PART # : 0.000.0   NUMBER OF TEETH % Z ! 25
*   THEORETICAL 04/03/2020
* DIFF. ANG: % DEDI ! -6.7371   REF. PT.: ! (14, 10)
---
* NUMBER COLUMNS: ! 27   NUMBER LINES: ! 19
---
* DATE: 04/03/2020   TIME: 08:27:52   UNITS: mm

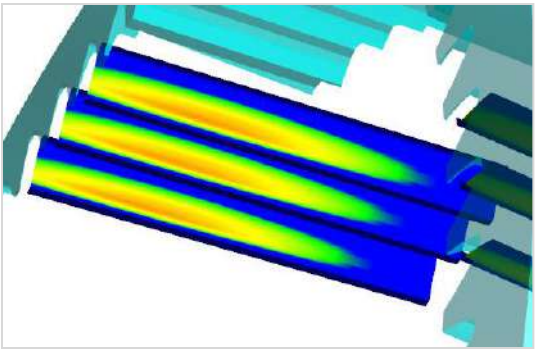
*J	I	X	Y	Z	XN	YN	ZN *
1	1	-72.4733	-1.5141	20.4286	-0.2136	-0.9769	-0.0000
1	2	-72.9744	-1.3968	20.4286	-0.2415	-0.9704	-0.0000
1	3	-73.4756	-1.2650	20.4286	-0.2667	-0.9638	-0.0000

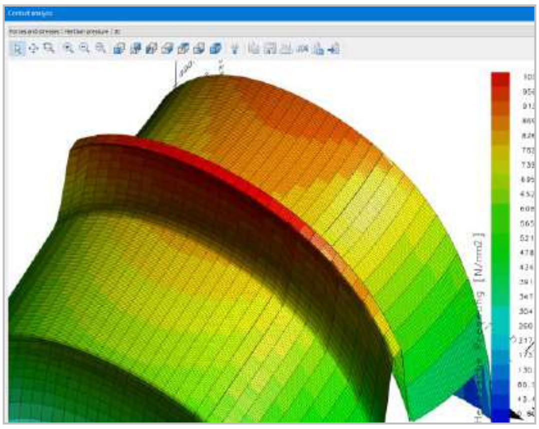


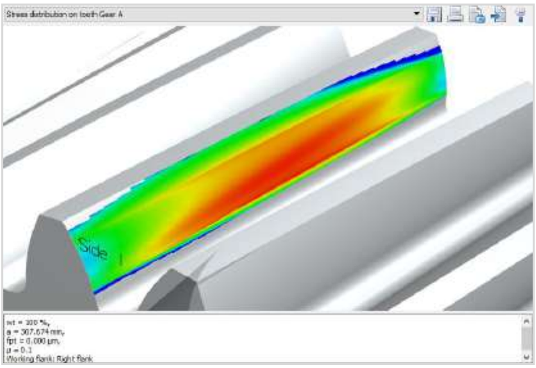


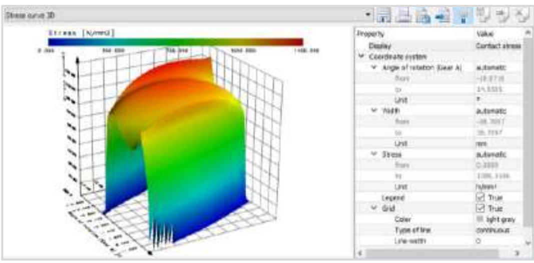


Loaded tooth contact analysis









Configurations

- Considers all modifications in profile and lead direction
- Calculation based on up to 41 gear sections
- Pitch errors may be considered in part or fully
- Calculation for nominal or operating center distance
- Calculation for nominal or partial load level
- Meshing friction considered in calculation
- Considers true gear geometry from manufacturing simulation
- For internal and external gears
- User defined accuracy level in calculation
- Line load calculation along ISO 6336-1, Annex E with consideration of manufacturing errors

Mesh stiffness calculation

- Calculation of Transmission Error for spur and helical gears, showing peak to peak transmission error, average and standard deviation
- Calculation of normal force, torque variation, contact stiffness, bearing forces, kinematics, specific sliding and local heat generated over meshing cycle
- Results displayed vs. roll angle, pinion diameter, length on line of action, pinion angle of rotation
- Calculation has been verified in benchmarks against reference software, practical experience in full load tests and FEM calculations

Output

- Graphics, exportable as graphic format or *.dxf
- Report including calculation settings and results summary
- Report including all graphics

True contact ratio calculation

- Calculation of true transverse contact ratio under load
- Calculation of true total contact ratio under load

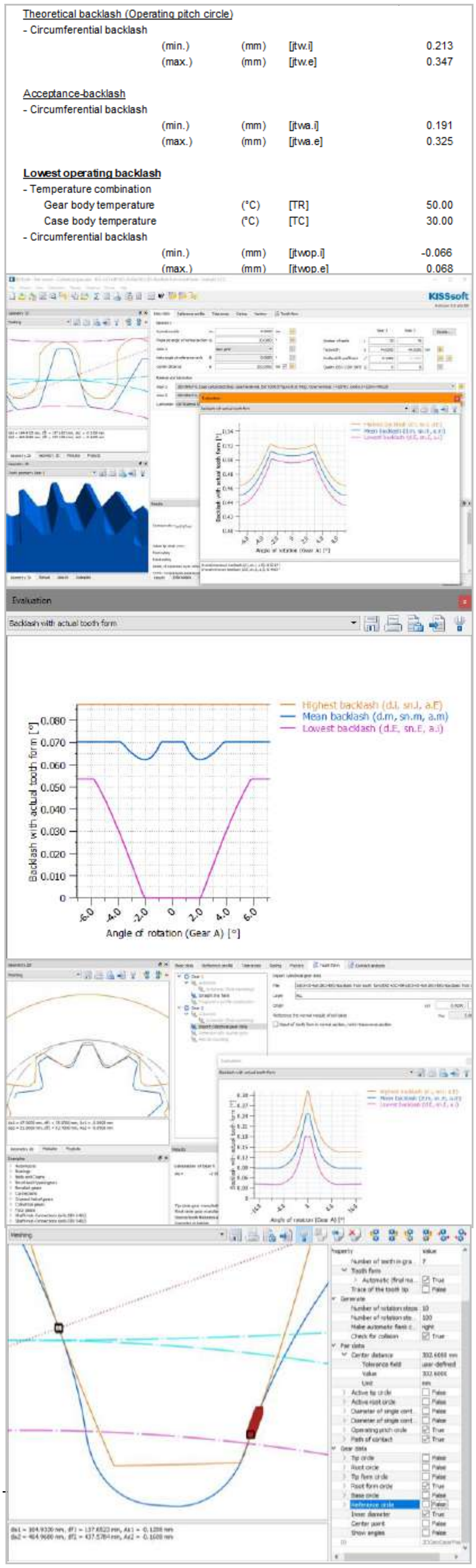
Detailed backlash calculation

Backlash from true tooth form

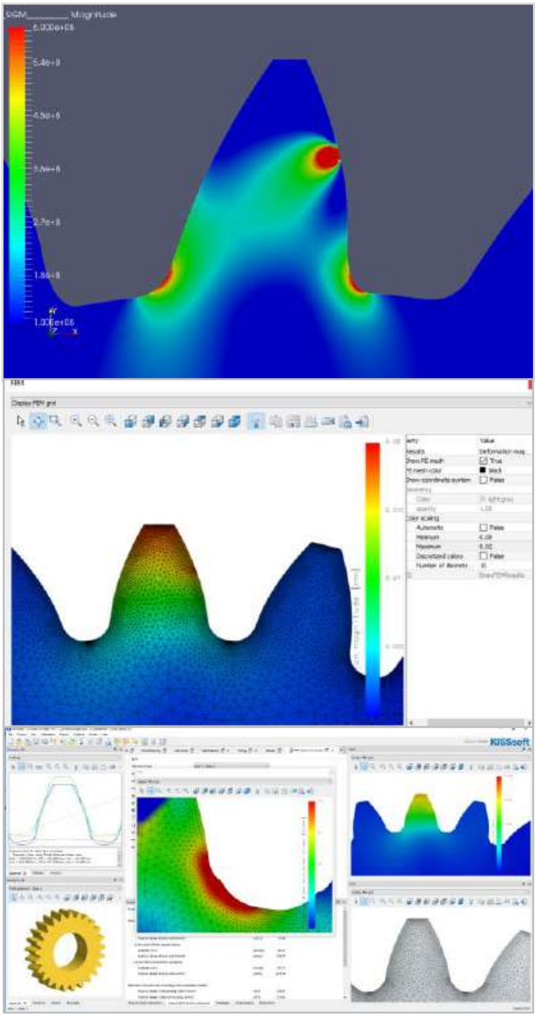
- Backlash is calculated as an angular backlash.
- Theoretical backlash is calculated based on true tooth form. Tooth form may be involute, involute with modifications or non-involute. For non-involute tooth form or involute tooth form with modifications, backlash is not constant over meshing cycle.
- Backlash is calculated for highest, lowest and mean tooth thickness / diameter / center distance combination, resulting in three curves.
- Collisions and tip to root interferences are indicated by zero backlash condition.
- Gear modifications in lead direction are considered, backlash is calculated for a number of slices along the face width.
- Tooth deformation and temperature influence are not considered.
- Works also for tooth form from imported *.dxf files.

Backlash, acceptance backlash, operating backlash

- Theoretical backlash in transverse and normal section, chordal and arc value, considering tooth thickness and center distance tolerances.
- Acceptance backlash considering runout, manufacturing errors and axis misalignment.
- Operating backlash considering housing and gear temperatures and moisture absorption.
- Contact and collision check in 2D graphic in transverse section for any tooth thickness, diameter and center distance tolerance combination.
- Recommendation of tooth thickness tolerances in case of gear jamming.
- Backlash definition through manufacturing profile shift or tooth thickness tolerances.
- Calculation of tooth thickness / backlash from span measurement or from diameter over pins.
- Strength calculation on theoretical gear or on gear with backlash.



2D FEM of virtual spur gear



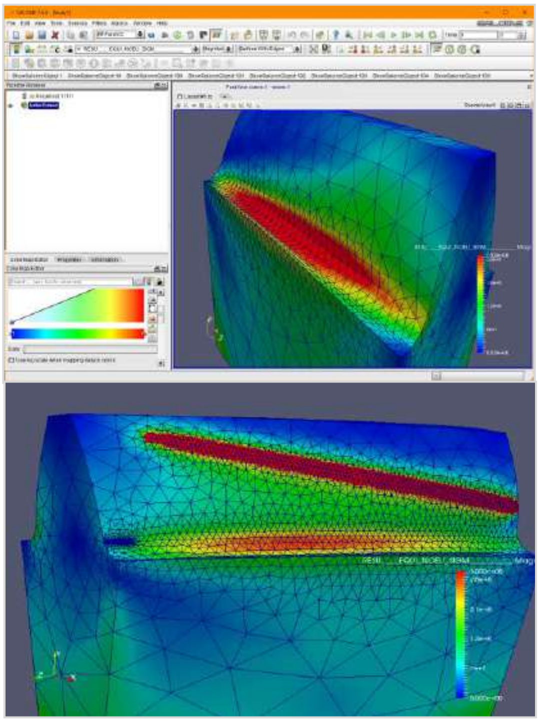
FEM models

- 2D plane stress model using parabolic triangular elements with variable mesh density
- Mesh density is maximized for critical area in the root
- Resulting stress levels are calculated for contact point of 30° (60°) tangent to theoretical tooth form, for contact point of 30° (60°) tangent to actual tooth form and for point with highest stress
- Stress levels are reported and compared to nominal stress calculated along ISO 6336
- FEM pre-processor (Salome) and solver (Code Aster) are remote controlled requiring no interaction.
- Pre- and post-processor may be opened after calculation to check mesh, boundary condition and results
- Different stress values like von Mises, max and min principal and others may be shown. Different color bars may be used.

Root stress calculation

- For standard gear geometry with trochoidal fillet based on circular tip of tool
- For non-standard gear root geometry including machining notches / grinding notches
- For non-trochoidal, e.g., circular or elliptic root shape
- Also, for cycloidal and circle shaped (non-involute) gears
- For asymmetrical involute gears

3 FEM



FEM model

- For spur and helical gears
- Using non-linear tetraeder elements

Planetary gears

Overview

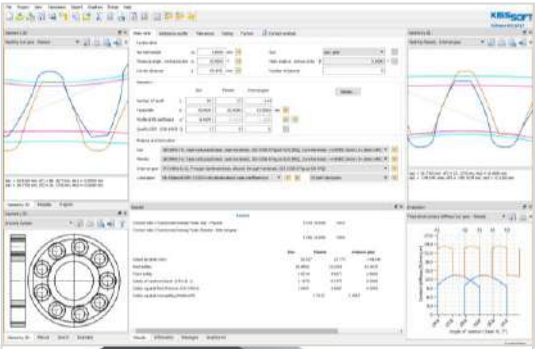
- Based on helical gear calculation modules
- Calculation of planet pin location for non-evenly spaced planets
- Influence of rim thickness of ring gear and planet gears considered
- Assembly check
- Sizing function for load distribution factor along AGMA 6123
- Rough and fine sizing function

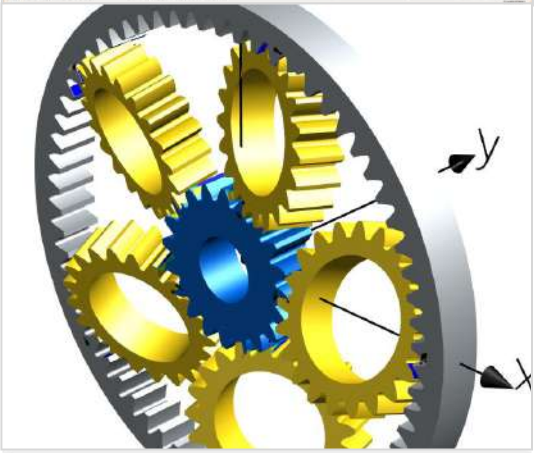
Strength rating, planets

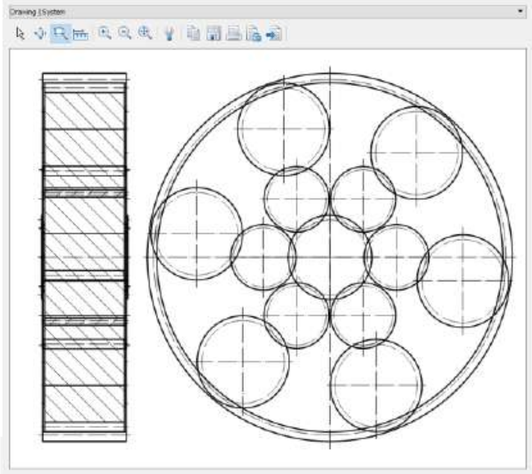
- DIN 3990 method B, DIN 3990 method B with YF along method C, DIN 3990 Part 41 (vehicles) method B
- ISO 6336
- Static rating against yield AGMA 2001-B88, AGMA 2001-C95, AGMA 2001-D04, AGMA 2101-D04 metric
- AGMA 6004-F88, AGMA 6014-A06, AGMA 6011-I03
- GOST 21354-87
- Plastic gears along Niemann, VDI 2545, VDI 2545 modified, VDI 2736
- As FVA software for DIN 3990
- BV / Rina FREMM3.1, Rina 2010, DNV41.2
- ISO 13691:2001 (high speed gears)
- For nominal load or load spectrum
- Planet system reliability
- Micropitting rating along ISO/TR 15144, scuffing rating along ISO 6336-20, ISO 6336-21, DIN 3990, AGMA 925
- Flank fracture rating along ISO/DTS 6336-4 and case crushing rating along DNV 41.2

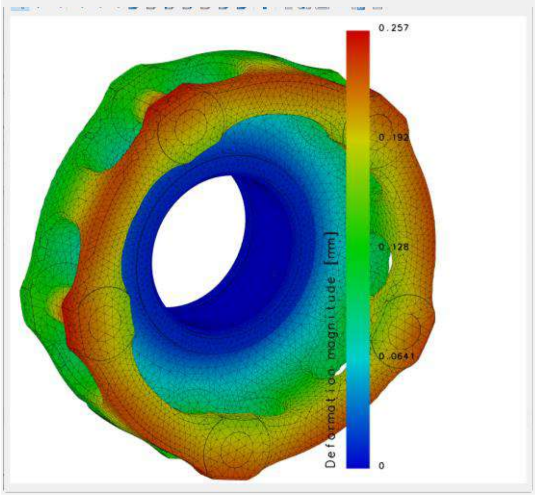
Kγ calculation

- For systems with perfect pin position or for pins with positioning error
- Quasi-static load distribution neglecting dynamic effects
- Sun may be floating or stationary
- Kγ is calculated for momentary force equilibrium for different meshing positions
- Considering system equilibrium for in-phase and out-of-phase systems

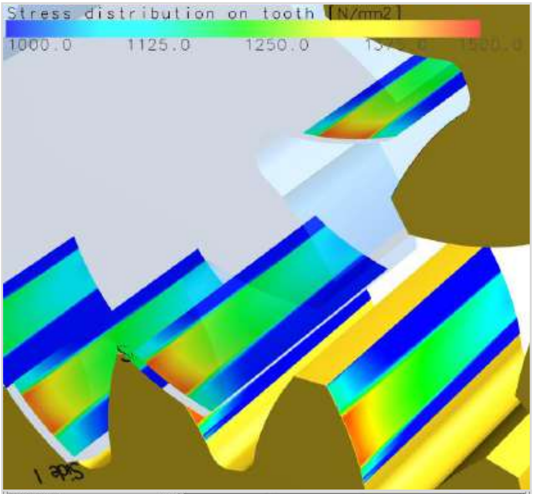


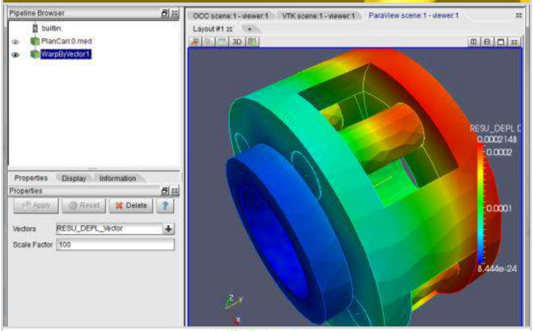


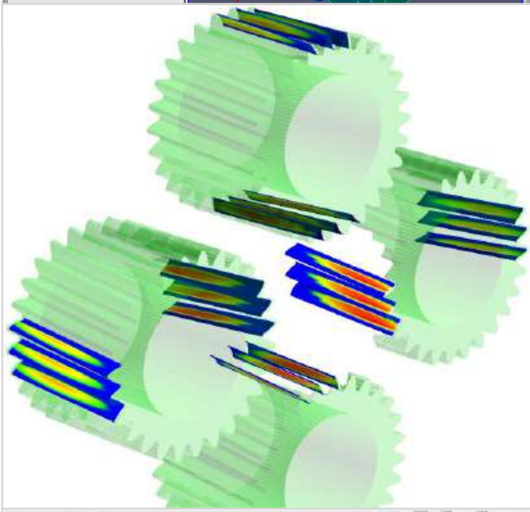


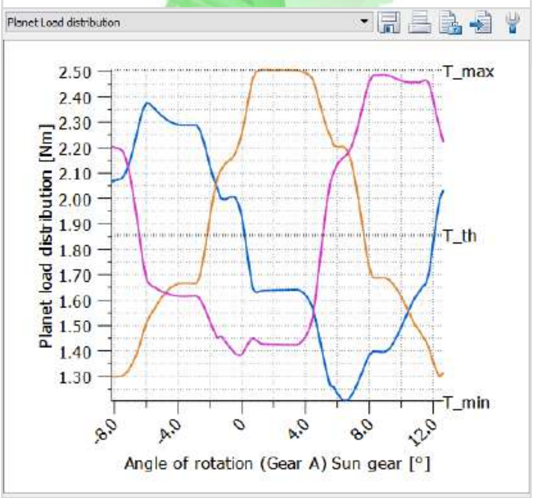


Planetary tooth contact analysis









FEM calculation of planetary carrier

- Planetary carrier torsion is calculated inside KISSsoft with FEM
- Salome / Code Aster is used as pre-processor and solver, using Python scripts
- Based on parameterized model of the carrier (import of carrier geometry is not directly possible)
- Mesh generation is automatic
- Includes sizing function for planetary carrier geometry
- Results may also be directly imported from FEM results file

Ring gear deformation

- In case of ring gears supported only on one side, the conical deformation may be considered for the planet – ring gear mesh

Sun gear arrangement

- Floating or fixed sun gear
- In case of floating sun gear, quasistatic momentary equilibrium is calculated

Link to shaft calculations

- Planetary carrier tilting in carrier bearings or due to manufacturing errors may be considered from shaft calculation
- Sun shaft twist, sun shaft tilting may be considered in LTCA with planets
- Planet pin deformation and planet bearing deformations is automatically imported from shaft calculation
- Planetary tooth contact analysis may be integrated into KISSsys models

Rack and pinion modules

For spur, helical or double helical arrangement

Strength rating

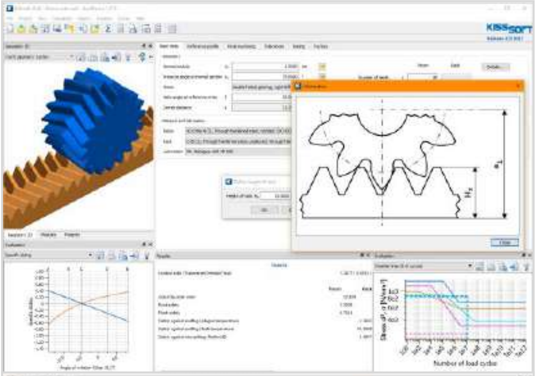
- Along ISO 6336, DIN 3990, AGMA2001, AGMA6004, BV / Rina FREMM 3.1 for metallic gears
- VDI 2736, VDI 2545 and Niemann for plastic gears

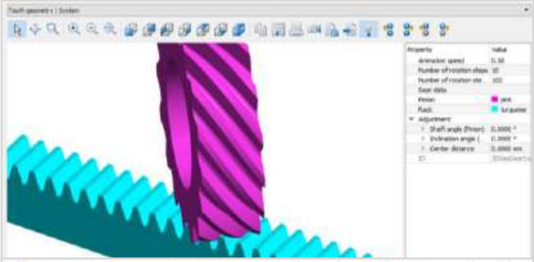
Output

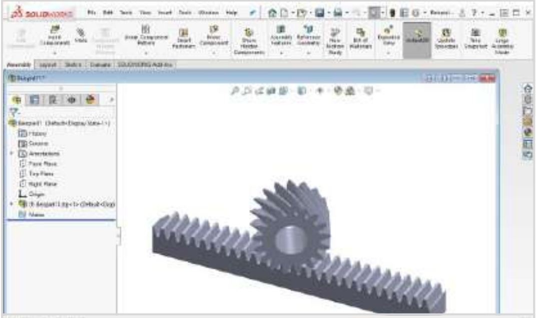
- Reports for manufacturing tolerances, drawing data, hardness depth proposal
- Life and strength results
- 2D and 3D gear geometry

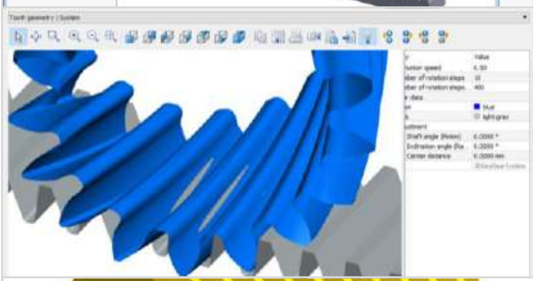
Crossed axis rack and pinion

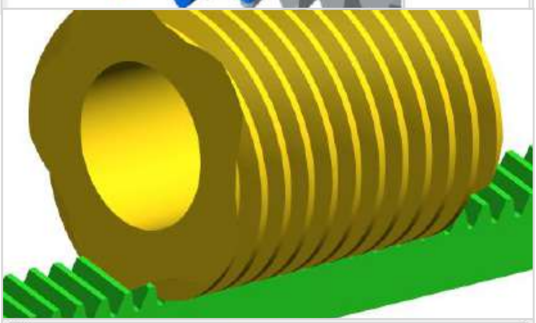
- Axis angle ≠ 0°
- Calculation of geometry
- Calculation of contact ellipse size
- Stress calculation, strength rating
- No load contact pattern
- Considering lead and profile modifications on pinion
- Export of 3D geometry in neutral format
- Not for double helical
- Part of crossed axis helical gear modules











Elliptical gears

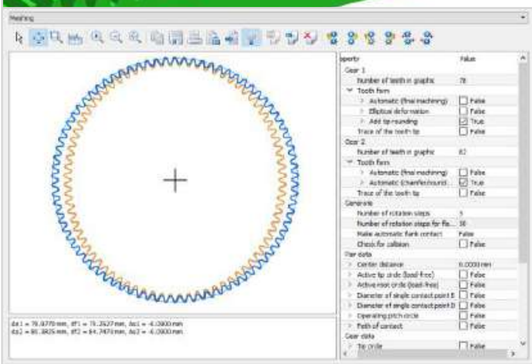
Mesh calculation for wave gears

Geometry

- Definition of elliptical external gear
- Definition of circular internal gear
- With low number of teeth difference

Output

- Graphical representation of mesh

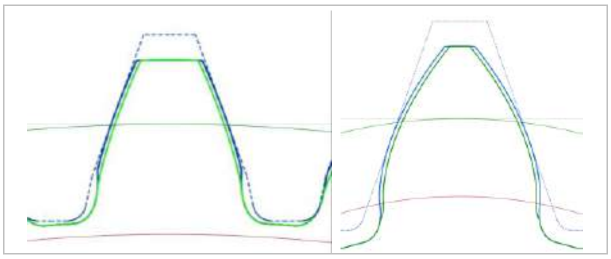


Functions related to cylindrical gear manufacturing

Pre-maching tool

- How to define the tool addendum length, to achieve the required gear dedendum?
- Which protuberance amount is needed to avoid the grinding notch with certainty?
- Can I use any existing tool for pre-manufacturing a new gear?

When pre-machining is applied, the tool addendum needs to be enlarged to compensate the manufacturing profile shift. To avoid grinding notches, the protuberance is applied on the pre-machining tool, to avoid the increased stress concentration.

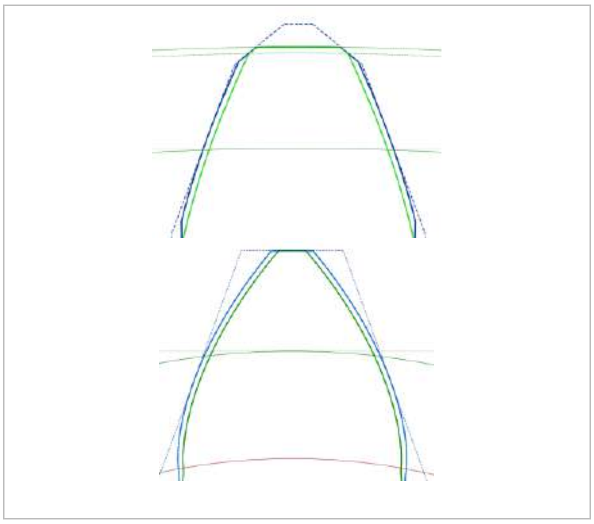


The root radius is applied as large as possible to reduce the root stresses ("full fillet" design), but to be checked for root form diameter.

Chamfering and topping tools

- What is the contact ratio change due to a chamfer?
- Is the noise behavior still ok with the reduced contact ratio due to chamfer?

The chamfering of the gear when pre-machining requires an individual tool. KISSsoft allows the definition of the ramp angle and chamfer size.

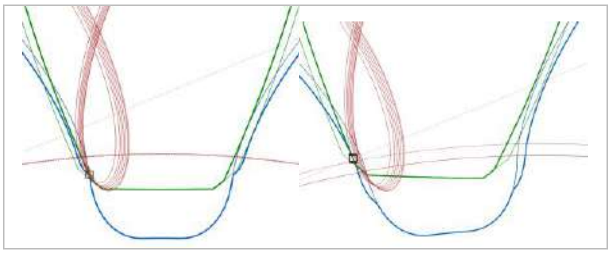


As a result, the tip form diameter is shown. Also the reduced contact ratio is shown, what affects also both the noise and strength rating of the gear and has to be documented for further processing. As pre-machining tools, hobs and pinion type cutters are available.

Grinding depth

- What minimum grinding depth (root grinding, flank grinding) is required?
- Is the grinding depth sufficient to avoid interference / collision when meshing?
- What is the trace of tooth tip when meshing?

The addendum of the hard-finishing tool is calculated for required minimum active root diameter, maximum root form diameter or to avoid grinding the root etc.



Left: Tool workpiece interference,
Right: No interference

The simulation of rolling the gears shows interference for several tolerance conditions. The trace curve of the tooth tip shows the potential collision clearly.

Grinding dresser

- Can we reuse a grinding dresser for another workpiece?
- What is the effect on the gear design if we use an existing grinding dresser?

KISSsoft checks whether, for a given gear design, an existing grinding dresser can be used or re-used.

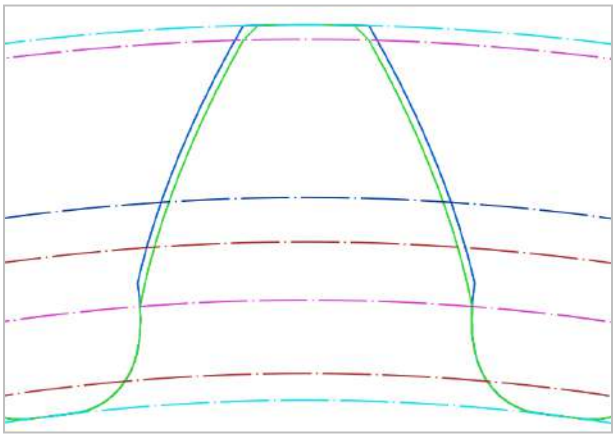
The software shows the resulting gear modifications if an existing grinding dresser is used, reducing tool costs and eliminating tool lead time. The difference between the designed modifications and the machined modifications is evaluated and the effect can be checked using KISSsoft functionality.

Diameters, meshing interference and collisions

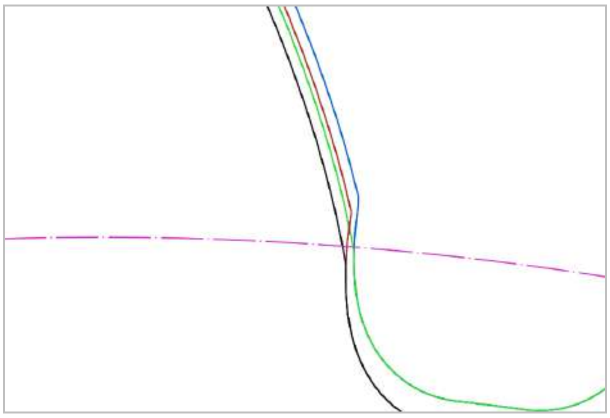
- How does the tooth thickness tolerance range affect the range for dFf, dFa and df?
- What is the influence of machining stock and tool tip shape on the upper root form diameter?

The manufacturing profile shift of the pre-machining and final machining tool affect the form diameters and thereby the available involute length. A display of all relevant diameter, for different tolerance conditions, and for different machining steps visualizes the calculated values. Meshing

interferences, safety distances and collisions may be detected in high resolution graphics with animation functions.



Form diameters, active diameters, tip and root diameter, reference circle / base circle, operating pitch diameter and diameter for DOP measurement.



Influence of tooth thickness on dFf (green / blue: tooth form, pre- and final machining, highest xE value, red / black: lowest xE value).

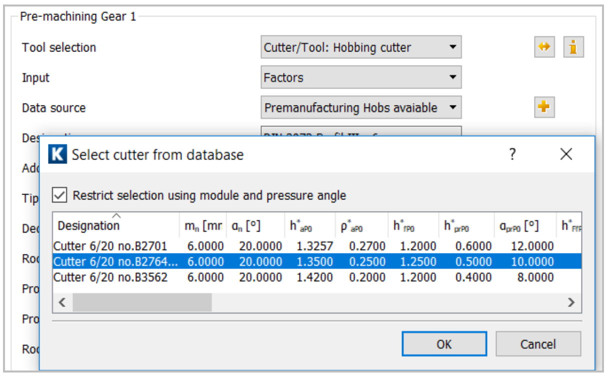
Hob database

- How can we ensure that gear designers consider existing tools when choosing a workpiece design?
- How can I request for a new tool based on the current gear design?

The reference profile, pressure angle, module and a tool reference number can be imported into KISSsoft

database from a text file. The tool inventory is then reflected in the gear design software.

Gear designers may then check on the availability of a suitable tool for a gear design and reducing the number of new tools needed. If a new tool is required, the gear profile data can be exported and sent to Gleason tool manufacturer on one click.



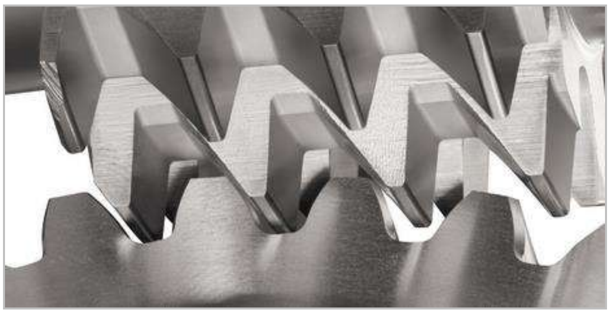
Hob and shaping cutter data imported in KISSsoft

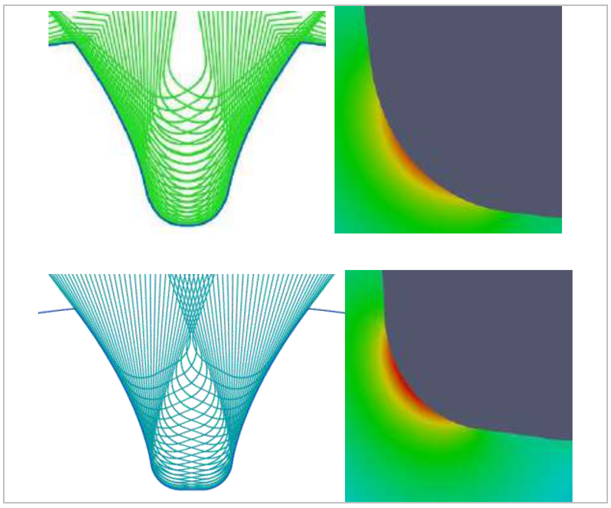
Short lead hob

- What is the influence of the hob module on the workpiece root shape?
- How does a short lead hob affect the gear strength?

Short lead hobs create a different root shape resulting in different stress levels that cannot be assessed using DIN, ISO or AGMA gear rating standards. When using a short lead hob, it is then recommended to use the FEM calculation in KISSsoft considering the root geometry and

curvature as manufactured. A comparison of stress levels for different hob modules allow for an approval of a certain hob design.





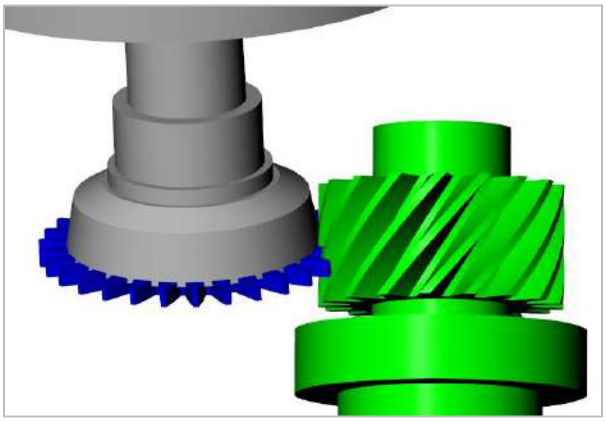
Upper image: Root shape hobbed with standard hob. Lower image: Root shape hobbed with short lead hob.

Power skiving

- Can a tooth profile be manufactured with power skiving?
- Is there sufficient runout for the tool regarding the shaft shoulder?

KISSsoft allows to estimate the manufacturability of gears using power skiving. On one hand, the tooth geometry is checked regarding machine and tool limitations, on the other hand, the gear can optionally also be checked for collisions with the tool. Collisions scenarios which shall be checked can be activated.

In addition, it is also possible to export the corresponding tool-gear helical calculation as a KISSsoft file which can then be opened separately and may be used for visualization or problem-solving purposes.

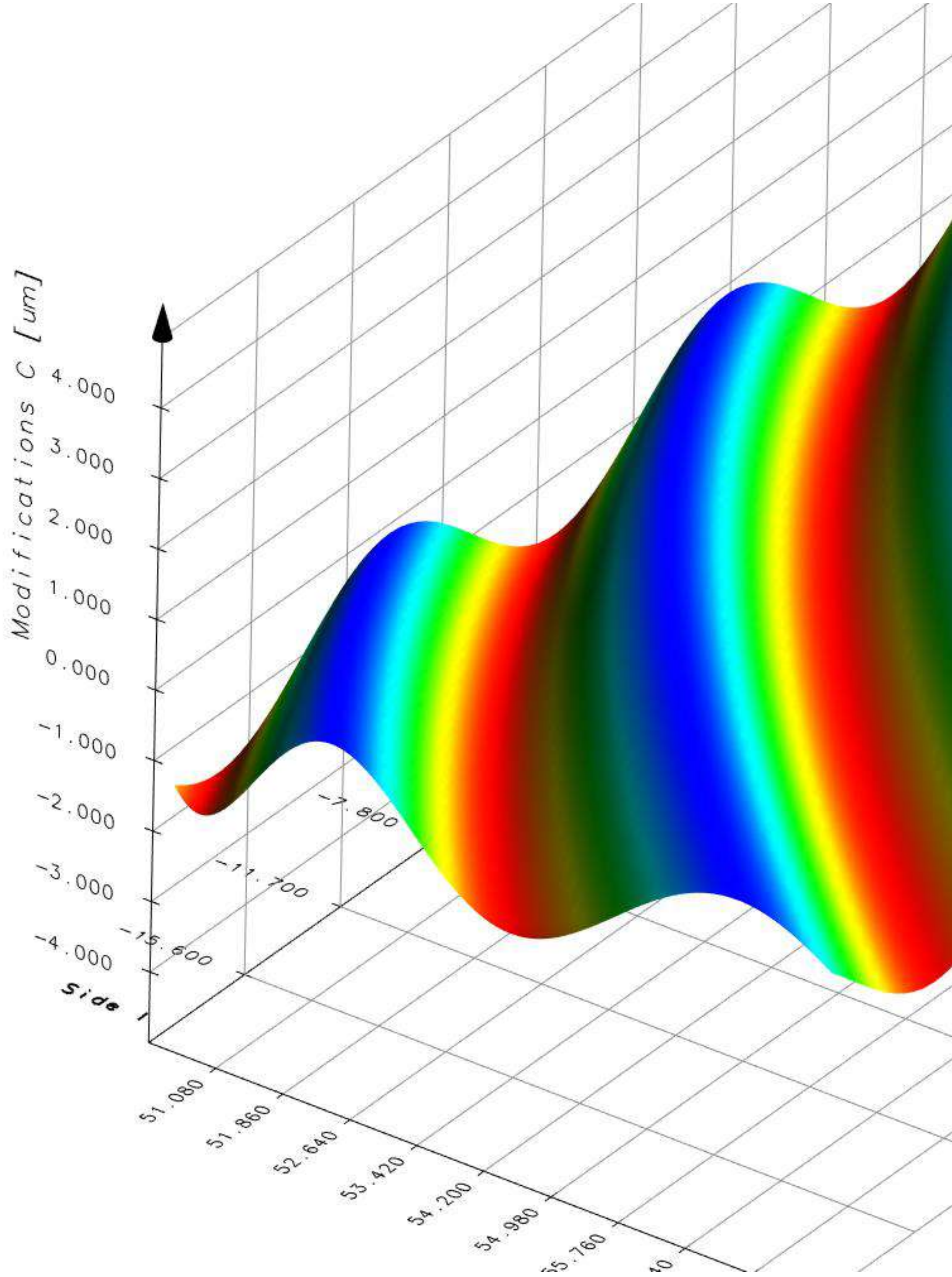


Forming and generating final machining

- How can we avoid grinding notches for generating and forming grinding operation?
- For a given final machining stock on the flank, how can we achieve a desired material removal in the root?

In different industries, different grinding techniques and strategies are used. While in industrial gears, the root is typically not ground, it is ground in most cases for aerospace gears. For large gears, a forming final machining process (e.g., hard hobbing with form cutter) may be used whereas for e.g., car transmission gears, a generating grinding process is common.

Grinding notches should be avoided for high performance application while they may be found in gears produced with small batches. KISSsoft allows to tune the stock removal on the flank and root separately and final machining tool runout is checked.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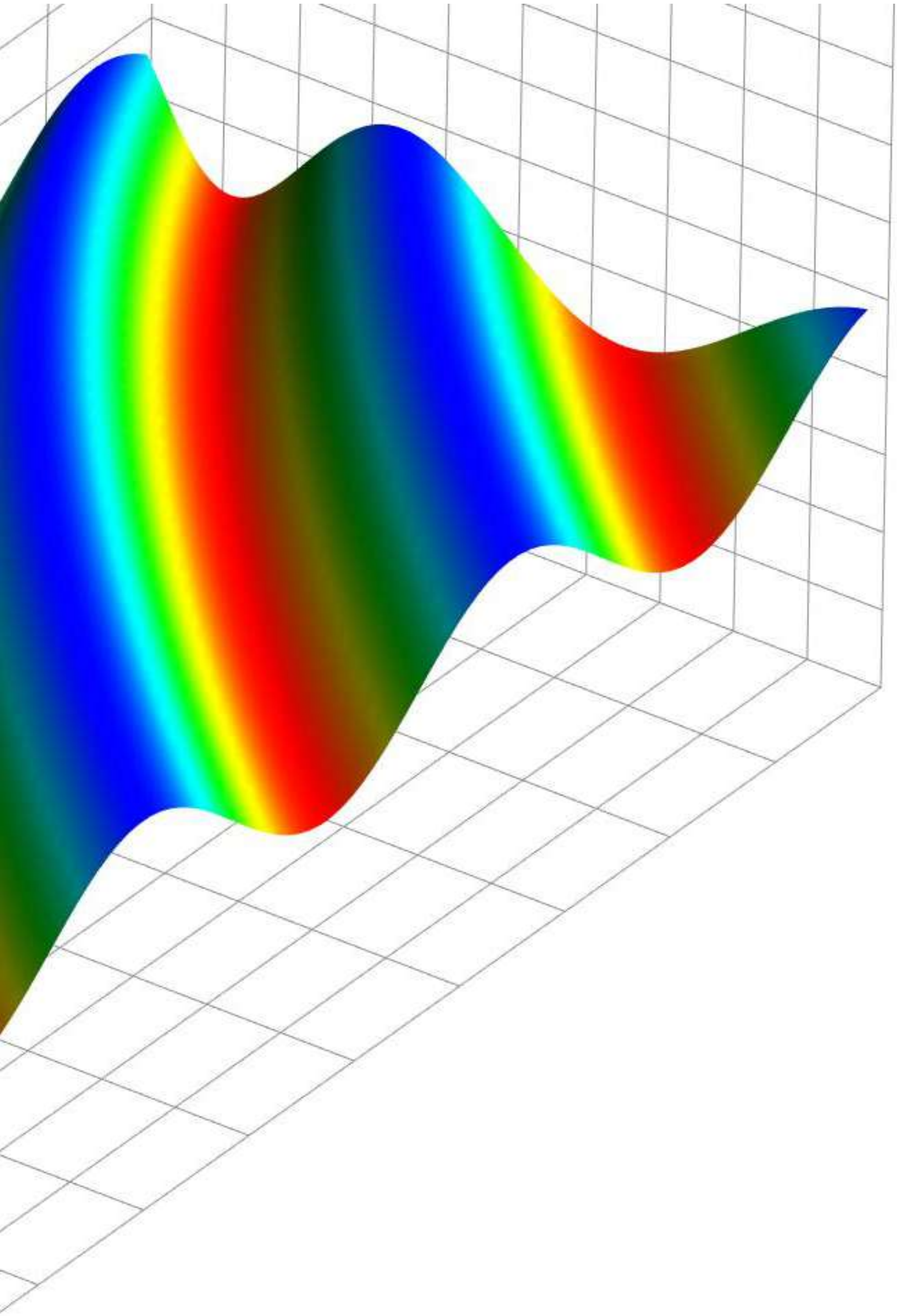
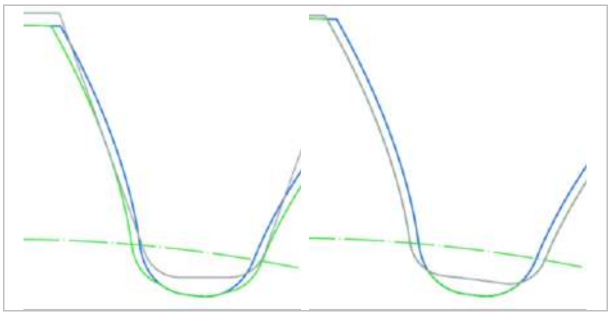
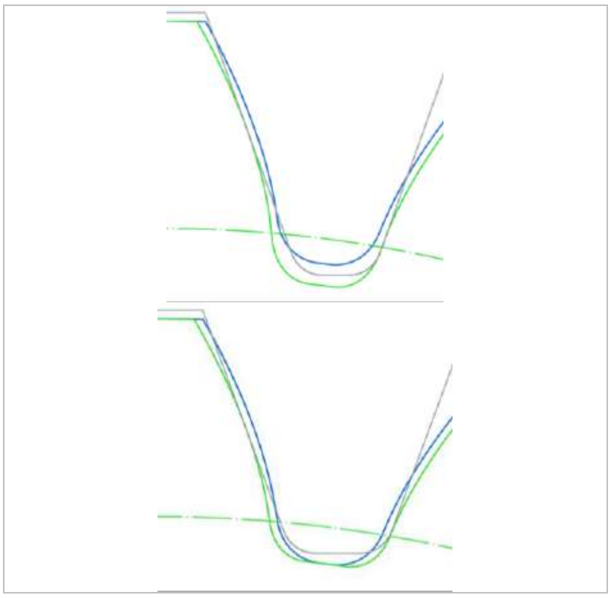




Left: Generating grinding with grinding notch. Right: Form grinding with grinding notch.

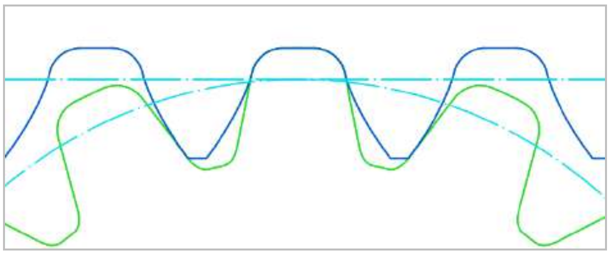


Left: Root and flank both ground. Right: Grinding depth = hobbing depth. Blue: gear after pre-machining, gray: grinding disk, green: gear after final machining + root form diameter

Tool profile for non-involute gears

- How can we determine the tool profile for non-involute gears?
- Is the workpiece profile manufacturable with a generating process?

Non involute gears with positive radius of curvature on the flank can typically be manufactured in a generating process using rack type or pinion cutter type tools. KISSsoft calculates the gear reference profile through a reverse generating process. The rack profile may then be exported as 2D *.dxf for tool production.



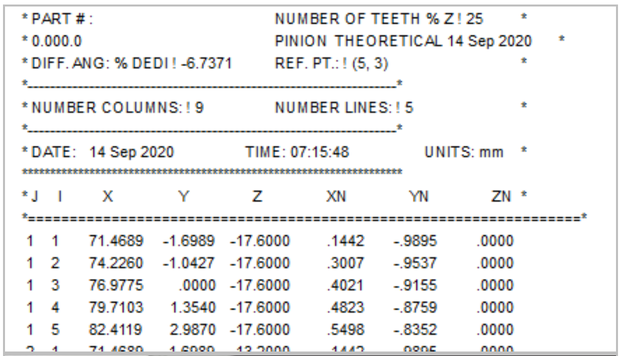
Green: Non-involute gear with circular tip area
Blue: Basic rack of tool

Measurement and quality

Measurement grid coordinates

- 3D models as STEP and measurement grid
- Data export in GDE and GAMA® format
- Including microgeometry and tolerances

To control a CMM or for the sake of verification, the measuring grid coordinates, and the normal vectors are calculated and reported in KISSsoft for a user defined number of flank points.



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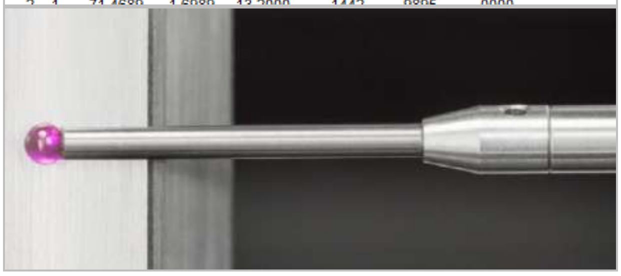
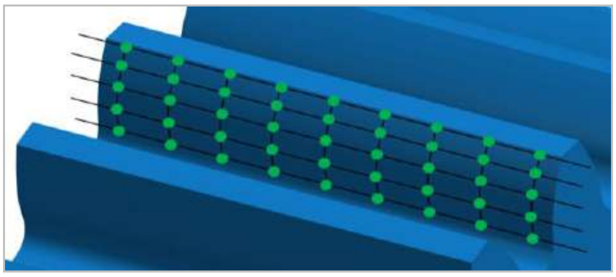


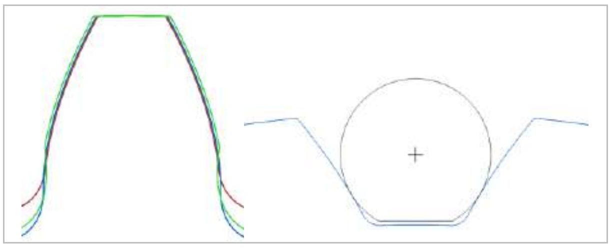


The export formats for GDE and GAMA® are available. They allow for a fast and safe data transfer between various manufacturing and measurement machines.

Tooth thickness and span width

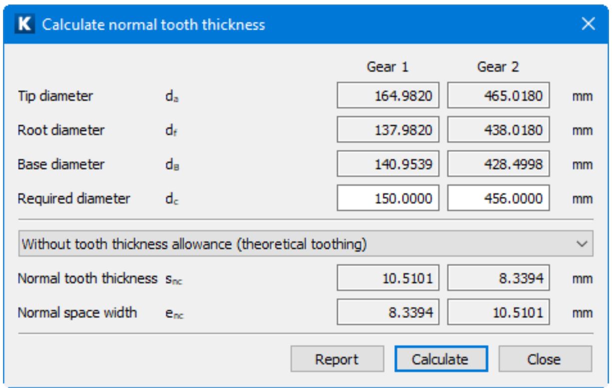
- What are the required tooth thickness values for pre-machining and final machining?
- What are the permitted tooth thickness values including the tolerances?
- Flattened ball for splines

The gear tooth thickness and span width can be determined for any manufacturing step. Using the tooth form analysis in KISSsoft, the analysis of tooth thickness at any position of tooth height is possible.



For involute splines, flattened ball needs to be applied to avoid the touching of the gear root.

Tooth thickness is calculated for a given diameter, for theoretical gear or considering tooth thickness allowances.

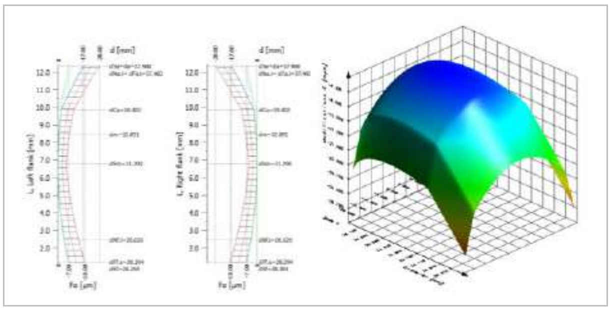


Calculated diameter over pin for theoretical, mean, upper and lower value may then be compared to measured DOP using Gleason over pins gauges.

Profile and tooth trace modification

- Lead, profile and combined modifications
- Topological modifications
- Tabular, graphical data for manufacturing drawings

Various gear modifications can be defined for right and left flanks independently for optimum running performance for each flank.



The K-charts are provided in KISSsoft for reference of the measurement machine. Also, the cumulated modifications per flank are available in 3D graphics.

GDE format for data exchange

- How do we communicate gear data easily and error free between different departments or companies?
- How do we get relevant gear geometry data that is missing on a drawing?

A unique, simple, accurate and flexible way to describe gear geometry and manufacturing data is implemented in KISSsoft based on VDI/VDE 2610 guideline. The data exchange between

design department, production and quality inspection group, or with customers, is thereby simplified and accelerated. It serves as a digital gear table and is used in parallel to a drawing.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Master gears

- Can we use an available master gear or is a new one required?
- Which area of the involute is checked?

Based on a given workpiece design and the required diameters to be in contact with a master gear, the suitability of a given master gear is checked. Alternatively, a new master gear design is calculated considering workpiece diameter tolerances. Master gears may then be used on Gleason and other testers.

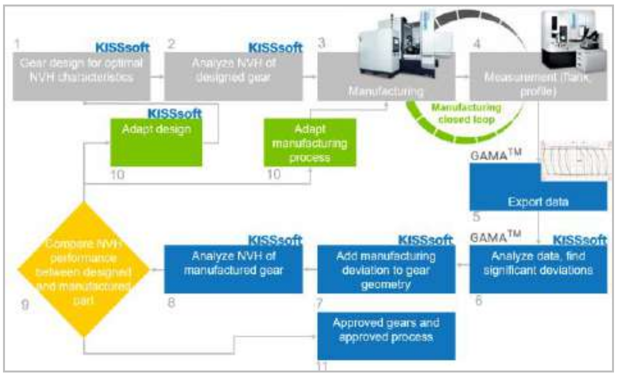
MASTER GEAR CALCULATION FOR DOUBLE FLANK TEST	(for Gear 1)		
Check of introduced Master Gear with da	228.3600 mm		
Master gear:	[zM]	36.0000	
	[Q]	3	
	[betaM]	0.0000	°
	[dM]	216.0000	mm
	[xM]	0.0300	
	[x.eM]	0.0254	
	[x.iM]	0.0254	
Data when pair gear/master gear is running (no backlash situation):			
Center distance	[aMin]	184.4047	mm
	[aMax]	184.4956	mm
Restrictions for Master gear tip diameter da:			
Optimum diameter (for dNf of gear)	[daopt.e]	229.5148	mm
	[daopt.i]	229.2804	mm
Maximal diameter (for dFf of gear)	[damax]	230.5777	mm
Maximal diameter for tip clearance 0.0060 mm	[damax-cl]	231.0764	mm

Lower image: Calculated master gear properties for a given workpiece, considering tip and root form diameter tolerances.

Analysis of manufactured gears

Design-manufacture-measure

- What is the vibration characteristic of the machined gear compared to the designed gear?
- How do machining errors influence the contact pattern under load?



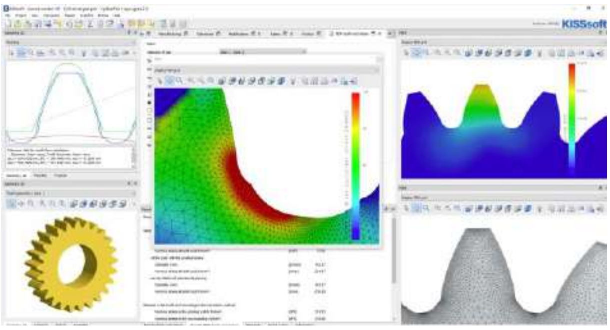
The design-manufacture-measure loop integrates KISSsoft, Gleason gear machines and metrology solutions. Machining errors may result in elevated noise levels or poor contact patterns in operation. To predict if the performance characteristics of a machined gear are satisfactory, the measured flank deviations are imported into KISSsoft.

There, the designed and the measured geometry are analyzed (contact pattern under load, transmission error, force excitation, …) and performance characteristics are compared in parallel. Based on this, the manufacturing process with its deviations may be approved or the need for a more accurate or stable process may be identified.

Root radius and tooth root stresses

- What is the stress concentration due to a grinding notch?
- How can we assess root stresses for non-trochoidal root shapes?

Gear root strength is usually assessed using applicable DIN, ISO or AGMA rating standards. However, in the case of nonstandard root shapes or grinding notches, a FEM calculation is required.

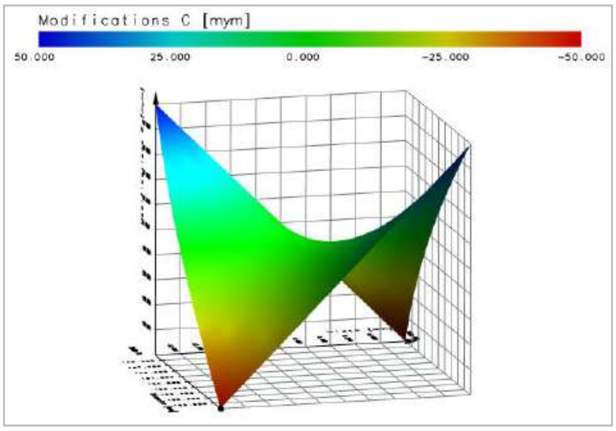


When grinding notches or other machining errors are created, KISSsoft provides a 2D FEM calculation where the stress increase is shown. Based on the stress level, gears may be safe for operation or need to be scrapped.

Natural and designed twist

- What amount of natural twist results from threaded wheel grinding?
- What are the resulting deviations from the designed flank geometry?

In threaded wheel grinding process for helical gears with lead modifications, a natural twist results (unless it is compensated). Its effect on the contact under load and the vibration excitation may be assessed using KISSsoft. Furthermore, a desired twist amount to mitigate the negative effect of gear misalignment under load may be designed and optimized.

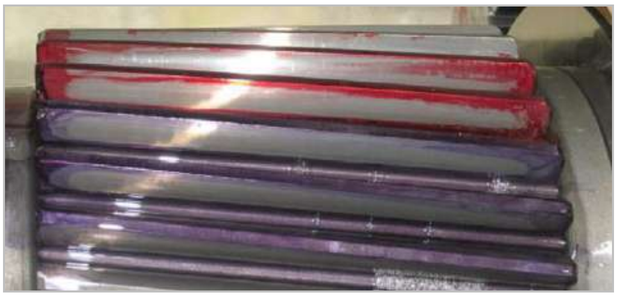


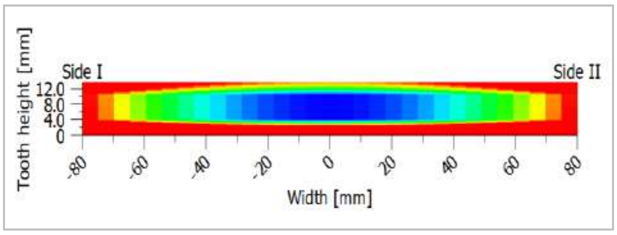
Sizing functions in KISSsoft automatically find the optimal flank twist amount to achieve optimal contact pattern under load. It then needs to be checked by the production engineers whether the calculated twist amount can be manufactured.

Assembly contact pattern

- How can we check that a contact pattern after assembly is as required?
- How do bearing play and assembly tolerances influence the contact pattern?

No load contact patterns after assembly are typically available towards the final phase of the gearbox assembly only. The contact pattern at no load, but considering bearing clearances, can be predicted with KISSsoft. It then serves as a basis for the acceptance of the unit under assembly. The marking compound thickness may be given in the calculation as an additional parameter.





Above: Contact pattern after spin test during gearbox assembly
Below: predicted contact pattern considering gear microgeometry and bearing clearance influence.

Bevel gear modules

General

- Strength rating for nominal load or load spectrum
- Database for reference profile and tolerances
- Different geometry configurations with uniform tooth depth, constant slot width, modified slot width, different root and tip apex positions
- For spur, helical or spiral bevel gears
- Rough and fine sizing function
- Calculation of measurement grid for Klingelnberg, Gleason or Wenzel gear tester

Strength rating

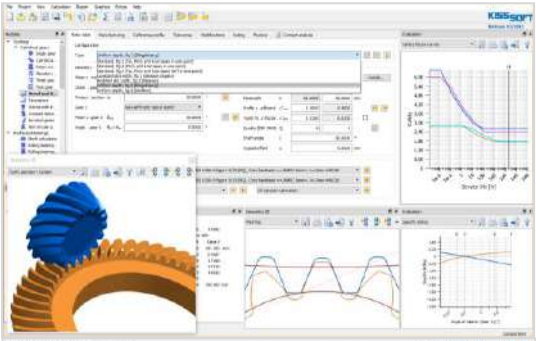
- Strength rating along ISO 10300, Method B and C, DIN 3991, AGMA2003, CN3028 / KN3030 for Cyclo-Palloid gears and along KN3025 / KN3030 for Palloid gears
- Hypoid gear calculation along KN3029 / KN3030 for Cyclo-Palloid gears, KN3026 for Palloid gears, ISO 10300
- Plastic gear rating along VDI 2545 or Niemann
- Static strength rating and rating of differential planetary gears, efficiency along Wech
- Flank breakage calculation along Annast and ISO/DTS 6336-4, scuffing rating along DIN 3990-4, ISO/TS 6336-20, ISO/TS 6336-21

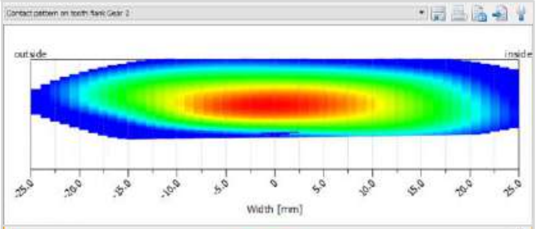
Manufacturing

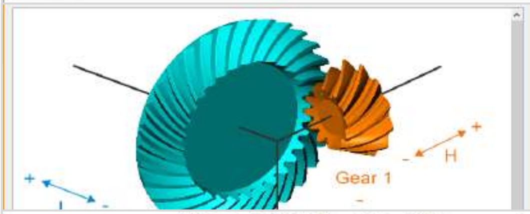
- For face hobbed or face milled gears
- Considering Klingelnberg machine list
- Accurate 3D gear geometry for CNC machining
- No load tooth contact analysis considering lead and profile modifications

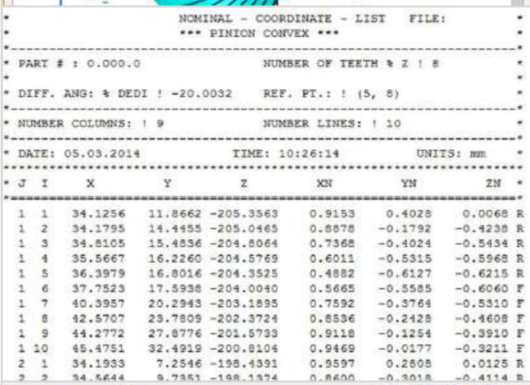
No load tooth contact

- Calculated of loaded tooth contact with low load
- Considers all gear modifications
- Direct input of misalignment values
- For verification of contact patterns after manufacturing









NOMINAL - COORDINATE - LIST FILE:
*** PINION CONVEX ***

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DIFF. ANG: % DEDI ! -20.0032 REF. PT.: ! (5, 8)

NUMBER COLUMNS: ! 9 NUMBER LINES: ! 10

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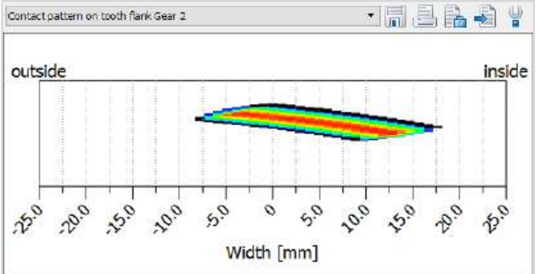
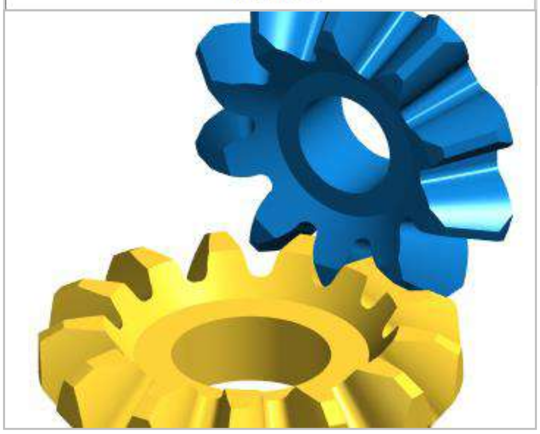
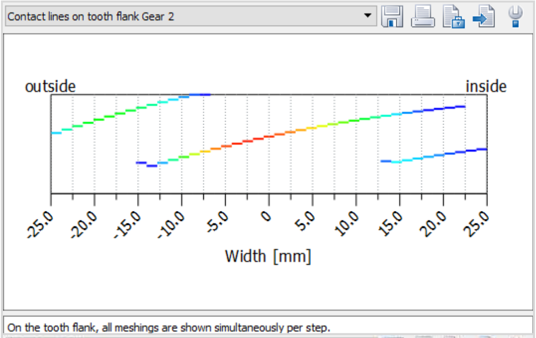
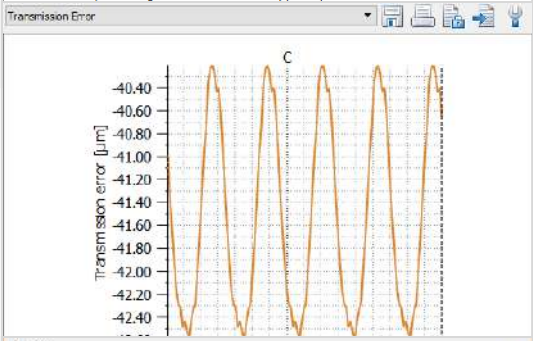




Loaded tooth contact analysis

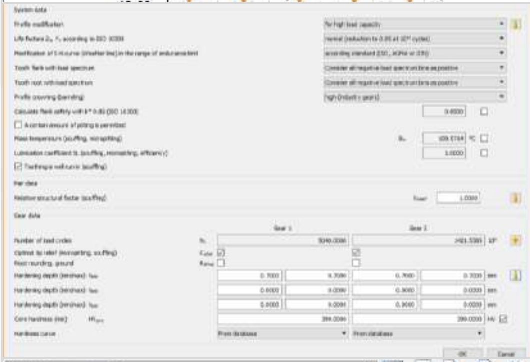
- LTCA of spur, helical and spiral bevel gears
- For nominal load or with consideration of KA and Kv and for load spectrum
- Using slice model
- Line load distribution over whole face width (contact pattern under load)
- Momentary line load distribution as contact lines for different mesh positions





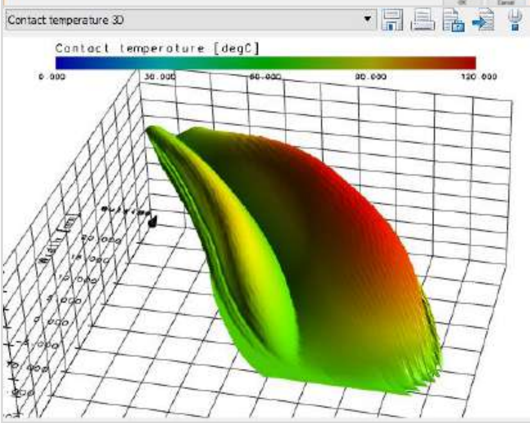
Bevel gear transmission error

- Loaded or non-loaded (lightly loaded) TE
- PPTE values
- FFT of transmission error



Further load distribution-based results

- Flash and contact temperature
- Scuffing safety factor
- Flank fracture safety factor
- Micropitting (adapted from cylindrical gear calculation)



Contact for misaligned systems

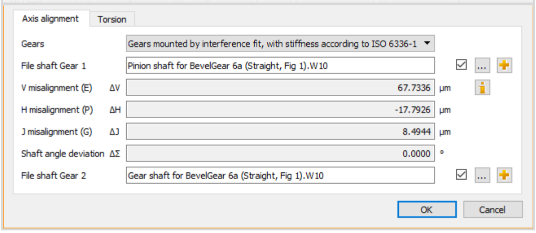
- Input of HGV misalignment
- Input of shaft angle deviation
- For drive and coast side
- Considering housing, bearing and shaft deformation

Tooth flank fracture calculation

- Calculated hardness distribution
- Hardness distribution input from measurements
- Calculation along ISO/DTS 6336-4 and Annast

Differential gears

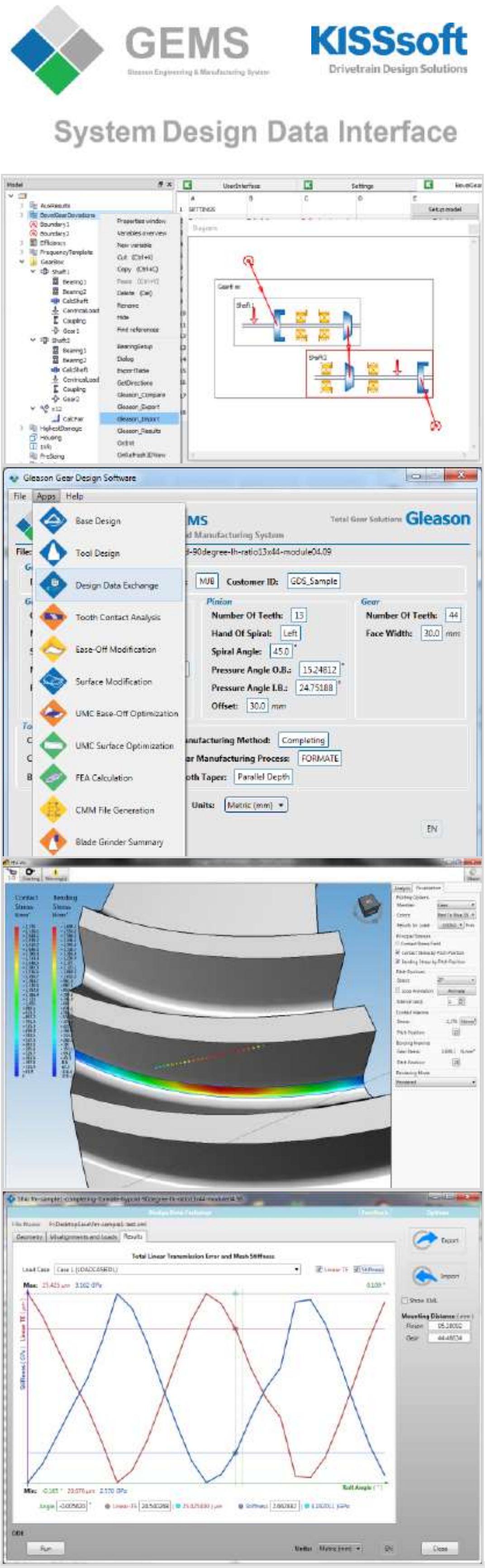
- Fine sizing of differential gears
- LTCA for spur gears with modifications



Gleason GEMS® – KISSsoft / KISSsys interface

Two software solutions, one common goal

- KISSsys: Design, optimization and analysis of systems. Considering power losses, load spectra, housing deformation …
- GEMS®: Design, optimization and analysis of spiral bevel and hypoid gears, preparation of data for Gleason gear production machines
- KISSsys: System deformation (EPG / VHJ values) for pinion and wheel considering housing, bearings, shafts.
- GEMS®: 2D / 3D LTCA including interactive root bending stress and contact stress output with S-N curves.
- Interface for gear data and displacement values between GEMS® and KISSsys



Value proposition

- Improved customer experience, human efficiency and part quality by connecting system design, gear design and gear manufacturing software systems
- Closed loop to manage manufacturing process using GEMS® based on gears sized and designed in KISSsoft
- Gear micro geometry preliminary design in KISSsoft and final design in GEMS® / CAGE®
- Flank and root strength, scuffing resistance, micropitting safety, flank fracture risk and static strength calculation in KISSsoft

KISSsoft

- Flank and root strength, scuffing resistance, micropitting safety, flank fracture risk, life rating with LDD and static strength
- Rough and fine sizing, modifications sizing
- 3D geometry export

GEMS®

- Transfer data with, CAGETM®, UNICAL®R, and common design software
- Import design data files from CAGE® and UNICAL
- Connect with GEMS® on-line via web app
- Generate data for blade grinding machines
- Closed loop to manage manufacturing process

Worm gear modules

General

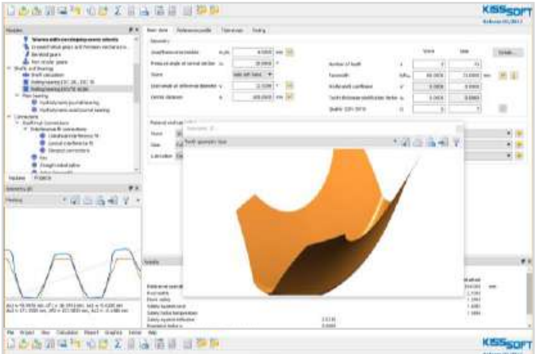
- For ZC, ZI, ZA, ZN, ZK, ZH geometry
- Includes rough and fine sizing function
- Accurate 3D geometry

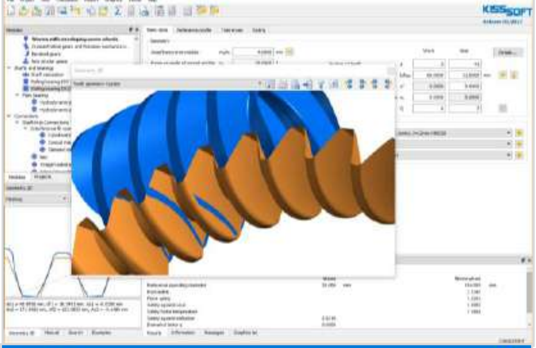
Strength rating

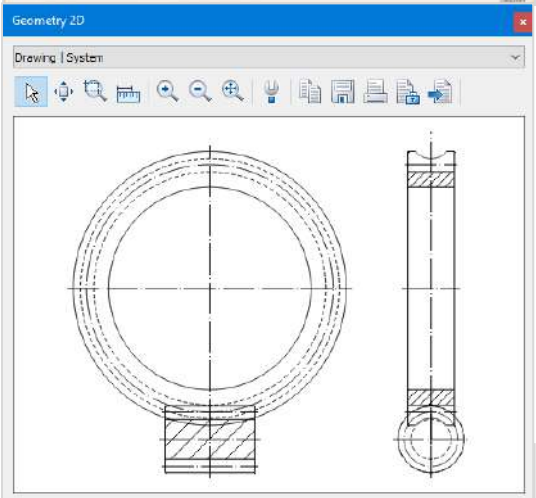
- Based on E DIN 3996:2012, DIN 3996:1998, ISO/TR 14521:2010, AGMA 6034, AGMA 6135
- No load contact analysis

System data

- Considers drive direction, bearing power loss, seal loss, permissible wear
- Considers cooling through housing and lubricant and running time







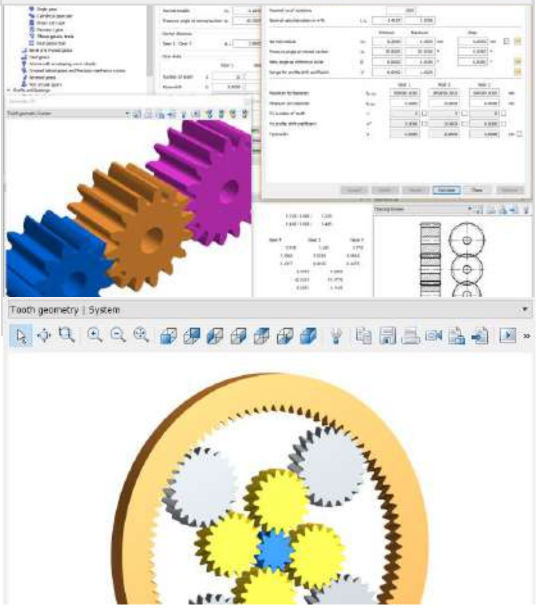
Chain of gears / idler gears

Configurations

- Three gear chain with one idler gear
- Four gear chain with two idlers
- Input on first and output on last gear
- Alternating bending is considered on idler
- Definition of two or three center distances

Calculations

- Same calculations as for gear pair and planetary gears
- Independent hardness definitions
- ISO 6336-3, Annex B mean stress influence
  Fine sizing function
- Calculation as double planet for several strands
- Definition of fourth gear in the chain as
  internal gear
- Including assembly condition and collision
  check



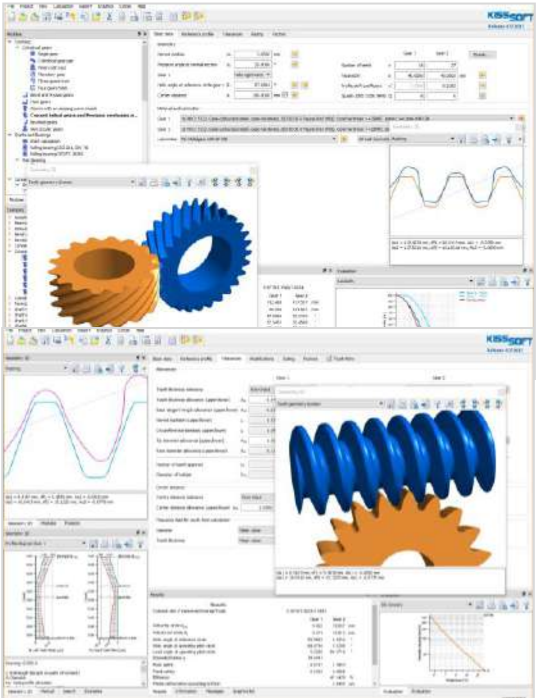
Crossed axis helical gear

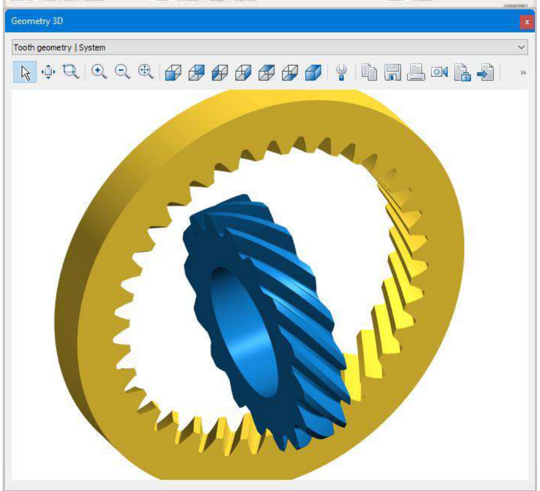
General

- Strength rating along ISO 6336 (modified along Niemann), along Hoechst for worm gears and along Hirn for worm gears
- Calculation of theoretical backlash, acceptance, and operating backlash
- Calculation of flank, root and scuffing safety factor with single load or load spectrum
- Output of control measures like dimension over pins and balls
- With rough and fine sizing function

Configurations

- For plastic and metallic materials
- Calculation with lead or helix angle
- Calculation of meshing efficiency
- For worm type or helical gear type mesh (any helix angle)
- Tooth form calculation with modifications like tip and root relief, chamfer, tip rounding, elliptic root rounding for improved noise and strength properties





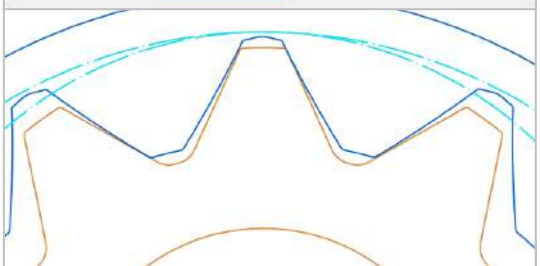
Gear pumps

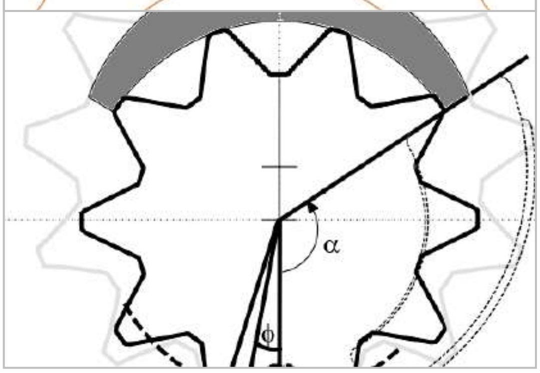
General

- For involute and non-involute tooth shape
- For external or internal gear pumps
- Calculation of tooth form, tooth load and volume flow
- Nominal flow calculation or considering elastic deformation of teeth
- Flow calculation can be combined with sizing functions

Expert options

- Changes in important parameters of pump during contact are calculated
- Includes enclosed volume, the volume with critical in-flow, narrowest point between flanks of first tooth pair not engaging marking the boundary of critical in-flow area, in flow velocity, oil flow, Fourier analysis for evaluation of noise potential, and total volume under entry chamber pressure





Face gears

General

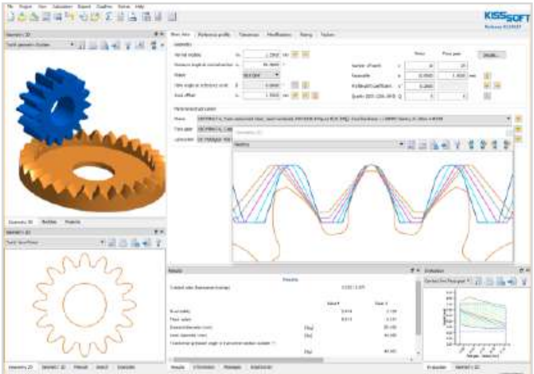
- Strength rating along ISO 6336 (modified along Niemann, Roth and Basstein), ASS / Crown Gear / DIN 3990, based on ISO 10300, based on DIN 3991
- For 90° or greater shaft angle, with axis offset, for spur and helical gears
- Axis offset may be positive or negative
- 3D models include solid model, skin model, cutting model (based on shaping cutter geometry) and solid model of single toot and single gap of face gear
- Calculation of subsystem reliability based on pinion and face gear life, using three parametric Weibull distribution

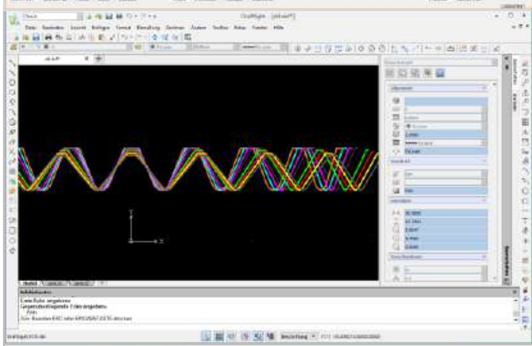
Configurations

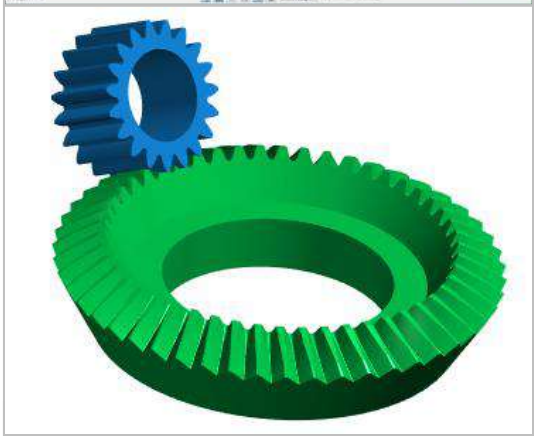
- Face gear with cylindrical pinion as spur or helical gear
- Calculation of face gear geometry at different diameters by simulating manufacturing with a pinion type cutter
- Check against undercut and pointed tooth by varying tooth height
- Export of 2D or 3D geometry considering tolerances such as tooth thickness tolerances, tip and root diameter tolerances
- Crowning of face gear through modifications on pinion type cutter
- Output of contact lines on face gear
- Corner modification on inner and outer diameter

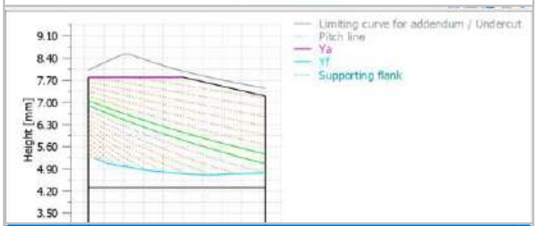
Export

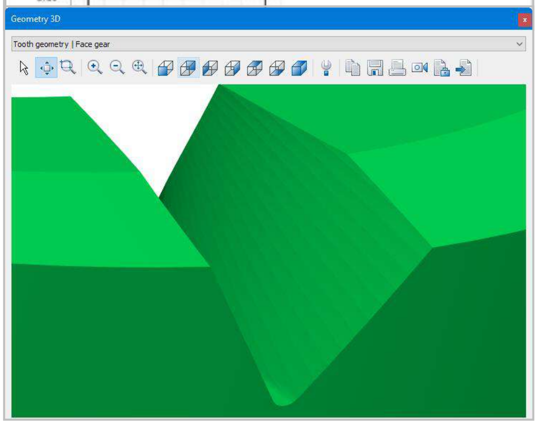
- Export of 3D geometry of pinion, face gear and system as *.stp file
- Export of 2D geometry of pinion, shaping cutter and face gear sections as *.dxf file
- Export of surface topology / measurement grid using Klingelnberg and Gleason data format, for pinion and face gear, for a user defined number of grid points
- Export of pinion and face gear data table for CAD drawings











Asymmetrical teeth, cylindrical gears

General

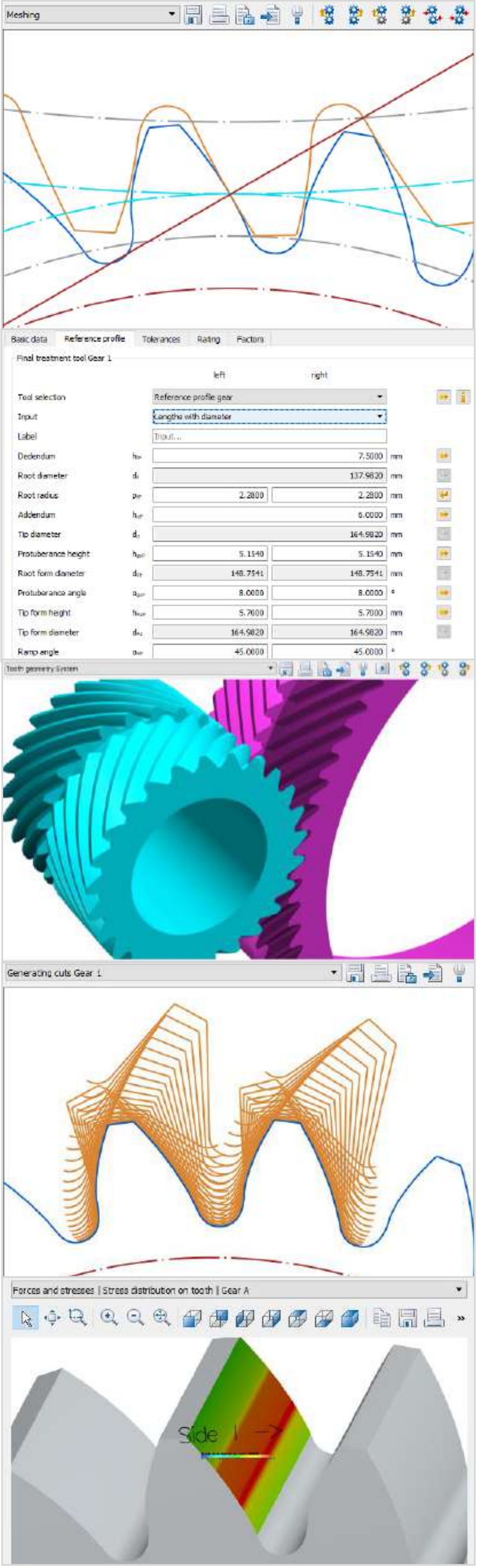
- Strength rating along ISO 6336 for left and right flank / root
- Different pressure angle and root rounding for left and right side
- Face width offset may be positive or negative
- 3D models include solid model, skin model, cutting model
- Calculation of subsystem reliability based on pinion and face gear life, using three parametric Weibull distribution

Configurations

- Spur, helical, double helical
- Gear pair calculation where pinion is driving or driven
- Rack and pinion, chain of three gears, chain of four gears
- Planetary gears consisting of sun, planet and ring gear, with any number of planets
- Export of 2D or 3D geometry considering tolerances such as tooth thickness tolerances, tip and root diameter tolerances
- Gear modifications in lead and profile direction

Features

- Export of 3D geometry or of 2D geometry
- Allows for LTCA in loaded tooth contact analysis module with own input of tooth stiffness (tooth stiffness is not calculated)
- No load contact analysis (intersection of skin models)
- Loaded tooth contact analysis for both flanks considering shaft misalignment and modifications
- Lead and profile modifications may be applied differently for left and right flank.



Non-circular gears

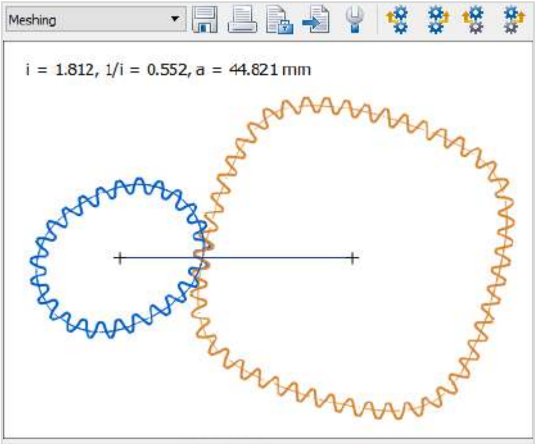
Non-circular gears can be calculated in KISSsoft based on an operating pitch curve. Gears may be closed or open.

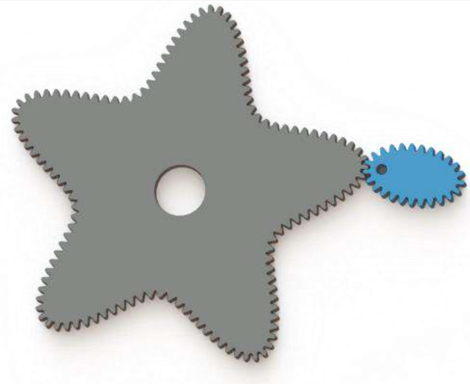
Design of geometry

- required momentary ratio may be defined
- required meshing curve may be defined

From there, the following is calculated

- calculation of meshing curve from momentary ratio
- calculation of shaping cutter from gear / tooth data
- calculation of backlash such that no jamming occurs
- calculation of non-circular gear contour
- export to CAD with different levels of accuracy (up to 800 points per flank)
- add tip rounding
- modify root geometry to increase strength
- check of meshing / collisions in 2D
- calculation of position of rolls for dimension over rolls measuring



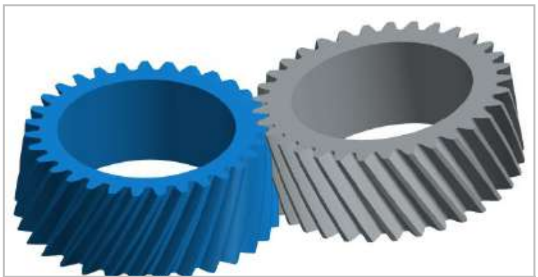


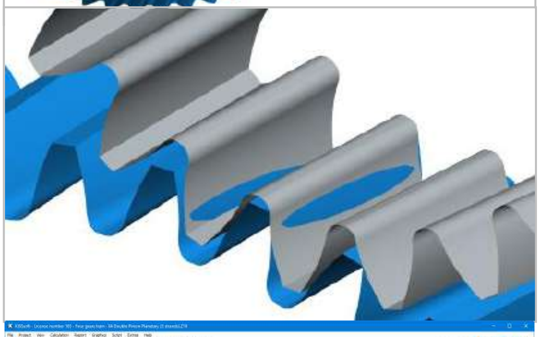
Beveloid gears

Beveloid gears (conical gears) can be modelled and rated in KISSsoft for small shaft and cone angles

Calculations, geometry and strength

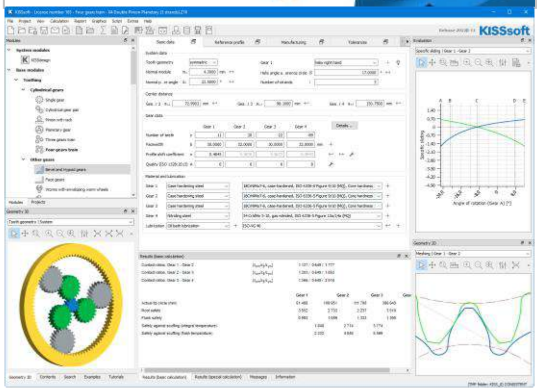
- Cone angle on both gears may be different
- Considers shaft and cone angles
- Spur and helical gears
- Includes micro geometry model
- Strength rating as per DIN, ISO, AGMA based on equivalent cylindrical gear
- No load tooth contact analysis





Double planet

- Assembly condition and collision check
- Strength rating as for cylindrical gear modules
- 2D and 3D geometry



Shafts, coaxial shaft systems

General

- Graphical shaft editor for fast modelling
- Calculates stress concentrations from feature geometry
- Add force elements like gears, pulleys or couplings for simple load definition
- Materials, bearings, lubricants databases
- Automatic identification of critical sections

Configurations

- Single shaft or coaxial shaft systems
- Static deformation, modal analysis
- General supports or rolling element bearings, pilot bearings, internal bearings
- Linear or non-linear calculation with Euler or Timoshenko beam model considering temperature effects

Strength rating

- Strength rating along DIN 743, FKM guideline, Hänchen & Decker or AGMA 6101
- For static and fatigue strength, for single load case or load spectrum
- Using material database or own definition for S-N curve, different Miner rules
- Independent load factors and stress ratios for static and fatigue rating

Modal and forced response analysis

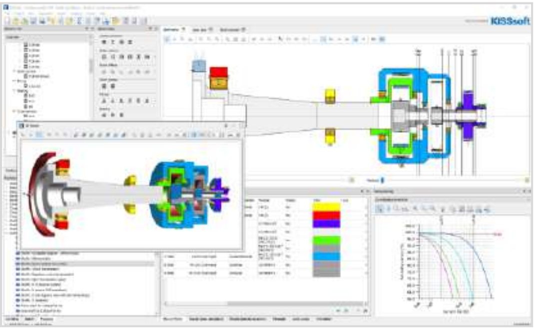
- Modal analysis
- Forced response analysis, with damping
- Considers bearing stiffness

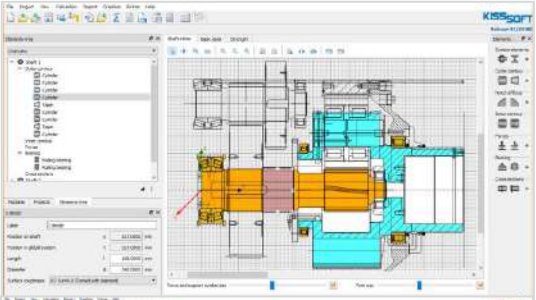
Deformation and stiffness calculation

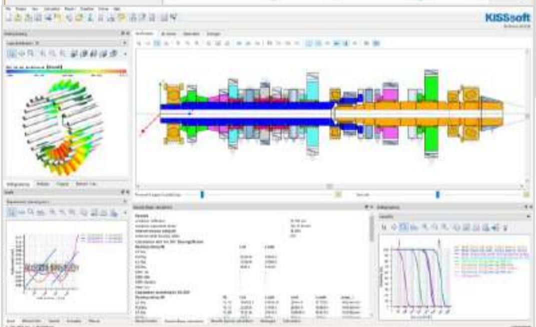
- Non-linear bearing stiffness is calculated based on inner bearing geometry
- Housing deformation, machining errors and similar may be defined as initial bearing offset
- Any number of loads may be added

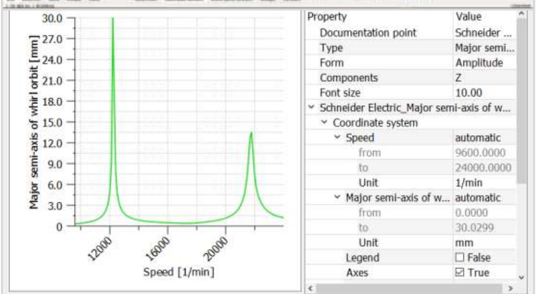
Tooth trace calculation

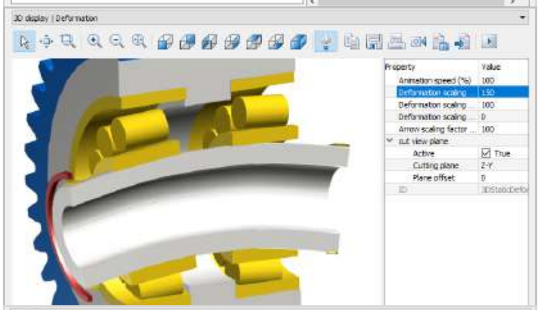
- Calculation of shaft deformation of pinion shaft, calculation of necessary lead correction
- Housing stiffness, bearing stiffness and shaft stiffness may be considered

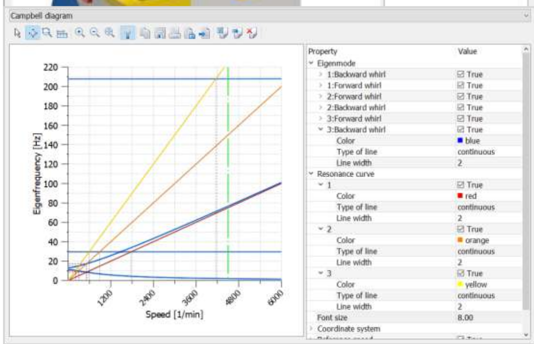












Bearings

Configuration

- Calculation of single bearing or bearing-shaft system, any number of bearings in system
- With single load or load spectrum
- Sizing function for bearing selection

Bearing life rating

- Basic rating using load capacity numbers
- Modified rating considering lubricant properties
- Reference rating considering load distribution
- Modified reference rating
- Along ISO 281, ISO/TS 16281, ISO 76

Bearing stiffness and clearance

- Based on bearing inner geometry
- Shaft-bearing interaction for shaft and bearing systems
- Considers operating clearance / pre-tension
- Considers bearing, shaft, hub tolerances

Load distribution calculation

- Load distribution among rolling elements
- Contact stresses for balls
- Contact stresses for rollers, considering roller geometry modification (logarithmic)
- Contact stress distribution on raceway

Thermal rating

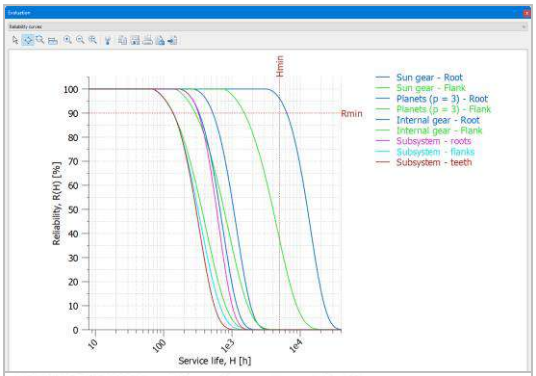
- Along DIN 732

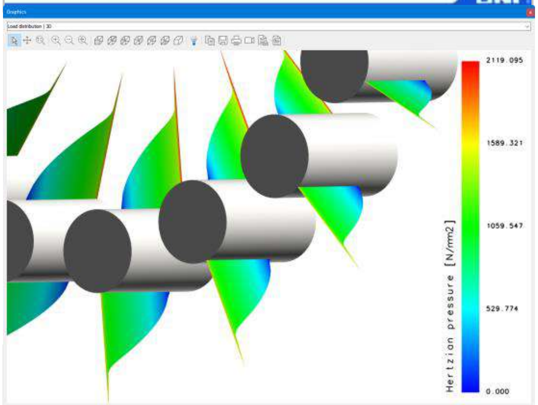
Bearing database

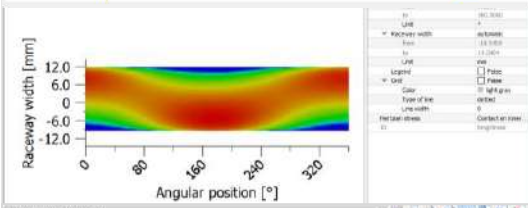
- Bearing data from different bearing suppliers
- For different bearing types
- Basic bearing properties
- Bearing inner geometry, user editable
- Separate database for lubricants, lubricant purity definitions along ISO 4406

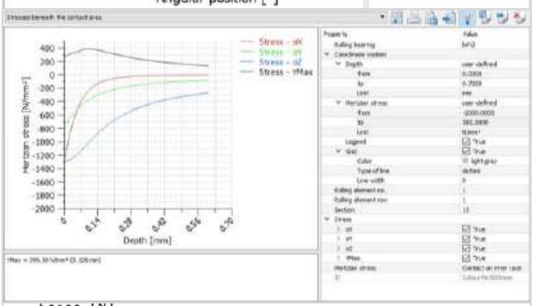
Hydrodynamic bearings

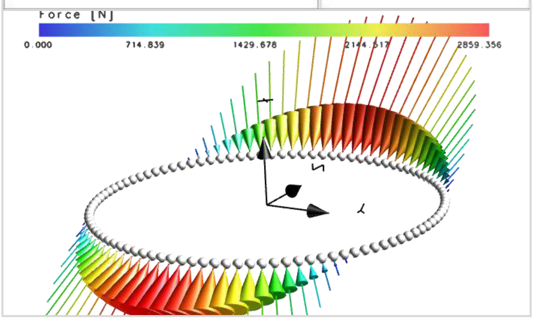
- Axial bearings DIN 31653, ISO 12130, DIN 31654
- Radial bearings ISO 7902, DIN 31652, DIN 31657, Niemann and Spiegel for grease lubricated bearings











Bearing designer

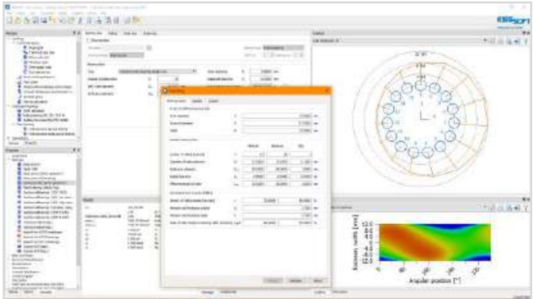
- Sizing function for bearing inner geometry
- Define ranges e.g., for rolling element diameter, pitch diameter, no. of rolling elements and others
- Software calculates possible bearing designs
- For each design, load capacity and properties of inner geometry are calculated
- Allows for specific, optimized design of bearings, in particular slewing bearings

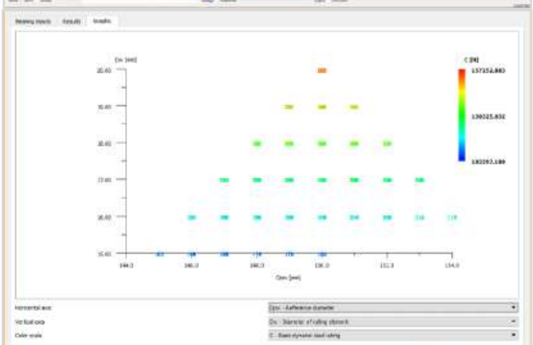
Load distribution with elastic rings

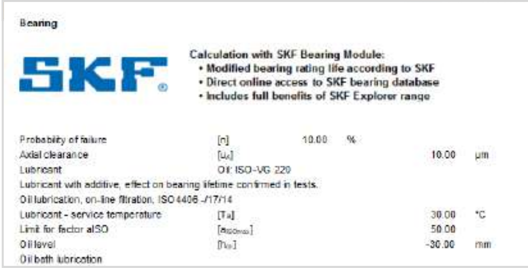
- Elastic or stiff rings
- Ring deformation influencing load distribution

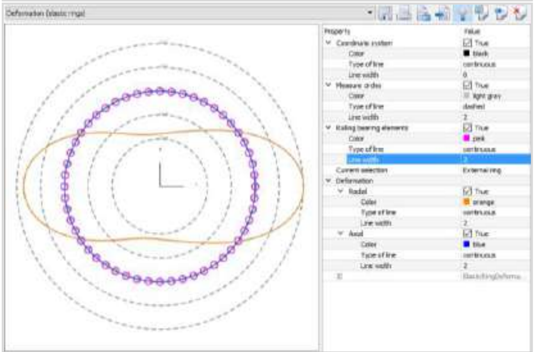
Calculation by SKF

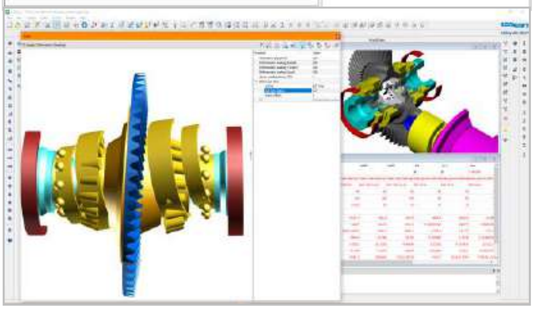
- Cloud based calculation
- Bearing forces are transmitted from KISSsoft to SKF cloud-based tool
- Bearings are rated by SKF, and results are sent back to KISSsoft











Available Calculation Services	External Tools	
	KISSsoft 2019	KISSsoft 2020
Minimum load	YES	YES
Minimum radial load	✗	✓
Equivalent dynamic load	YES	YES
Load ratio	✓	✓
Grease life and relubrication interval	NO	YES
Grease life	✗	✓
Relubrication interval	✗	✓
Grease quantity	✗	✓
Bearing rating life	YES	YES
Basic rating life	✓	✓
SKF rating life	✓	✓
Contamination factor	✓	✓
Life modification factor	✓	✓
Static safety factor	NO	YES
Static safety factor	✗	✓
Viscosity	YES	YES
Operating viscosity	✓	✓
Reference viscosity	✓	✓
Viscosity ratio	✓	✓
Bearing frequencies	NO	YES
Rotational frequency inner ring	✗	✓
Rotational frequency outer ring	✗	✓
Rotational frequency cage	✗	✓
Rotational frequency rolling element	✗	✓
Over-rolling frequency inner ring	✗	✓
Over-rolling frequency outer ring	✗	✓
Over-rolling frequency rolling element	✗	✓
Friction and power loss	NO	YES
Total frictional moment	✗	✓
Rolling frictional moment	✗	✓
Sliding frictional moment	✗	✓
Frictional moment drag losses	✗	✓
Frictional moment seals	✗	✓
Starting frictional moment	✗	✓
Bearing frictional power loss	✗	✓
Adjusted reference speed	NO	YES
Adjusted reference speed	✗	✓
Adjustment factors for bearing load P	✗	✓
Adjustment factors for Oil viscosity	✗	✓

Shaft-hub connections

Cylindrical interference fit

- Strength rating along DIN 7190
- Sizing function for tolerances
- Stress calculation for stepped hub and hollow shaft
- Considers torsional, radial, and bending load, including centrifugal loads
- Calculation of mounting temperatures

Conical interference fit

- For different mounting procedures
- Calculation along Kollmann
- Considers cone angle and cone angle tolerances

Key

- Geometry along DIN 6885, ANSIB17.1
- Strength rating along DIN 6892
- Woodruff key

Involute spline

- Geometry along DIN 5480, ISO 4156, ANSIB92, own definition
- Tolerances along DIN 5480, ISO 4156, ANSIB92, own definition
- Reference profiles along DIN 5480, ISO 4156, ANSIB92, own definition
- Strength rating along Niemann or DIN 5466
- Graphical output

Straight sided spline

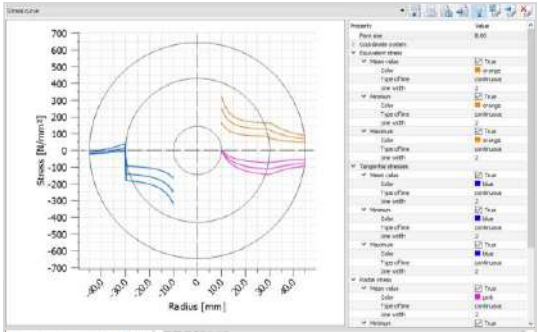
- Geometry along DIN 5464, DIN 5471, DIN 5472, ISO 14, own definition
- Strength rating along Niemann
- Graphical output

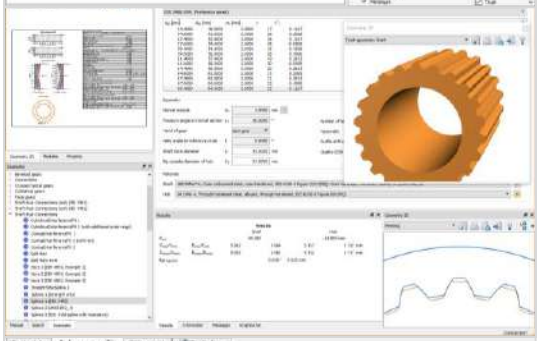
Serrated spline, polygons

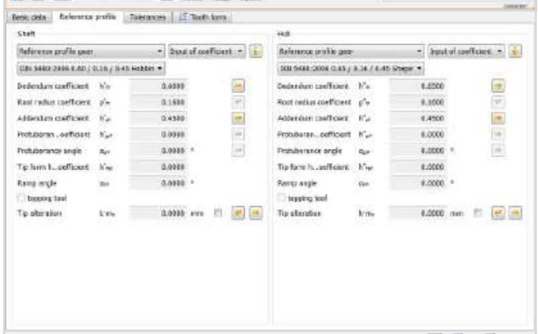
- Geometry along DIN 5481
- Strength rating along Niemann
- 3-sided and 4-sided polygon along DIN 32711, DIN 32711
- Strength rating along Niemann

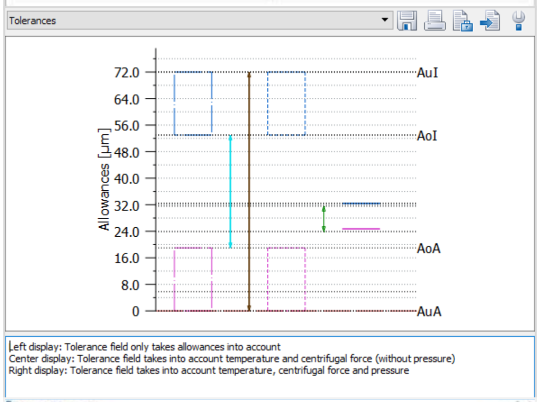
Hirth coupling

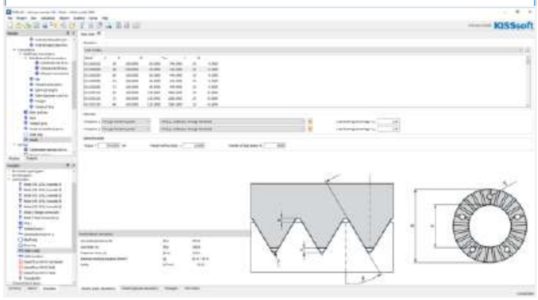
- Includes Voith ® profiles
- Strength and geometry calculation



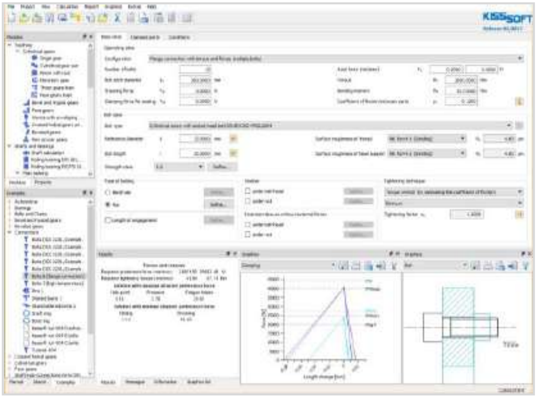






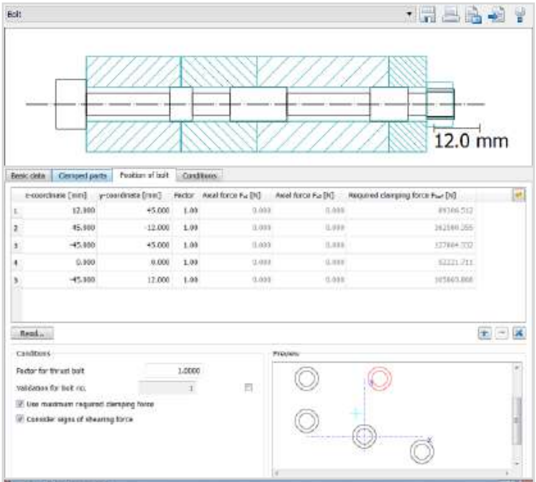


High strength bolting modules



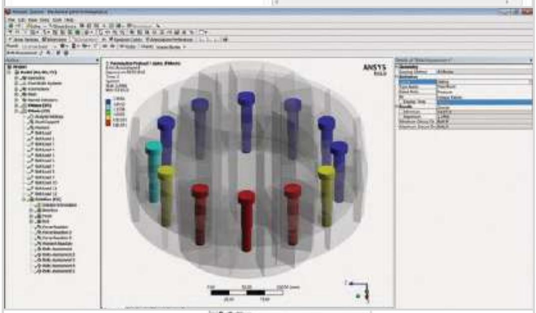
Bolt rating along VDI2230, configurations

- Connection under axial load only
- Connection under axial and shear load
- Flange type bolted connection
- Arbitrary bolting pattern
- Import of FEM results for loading condition
- Sizing function for bolt length and bolt diameter



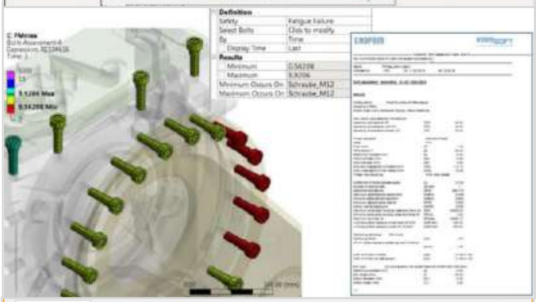
Bolt, nut and washer types

- Own bolt geometry definitions
- Own nut and washer definition
- Washers: ISO 7089, ISO 7090, ISO 7093-1, ISO 7093-2, ANSI / ASME 18.22.1, own definition
- Nut: ISO 274, DIN EN 2432, DIN EN 24035, DIN EN 28673, DIN EN 28675, ANSI / ASME B.18.2.2, own definition
- Bolt: ISO 4762, ISO 4014, ISO 4017, ISO 1207, ISO 8765, ISO 8676 and others
- Strength classes, 8.8, 10.9, 12.9, A1…A5, SAE J492, own definition
- Extension sleeves under bolt and nut



Tightening

- Considers different tightening procedures
- Considers pre-tension loss
- Considers friction in thread and under head / nut

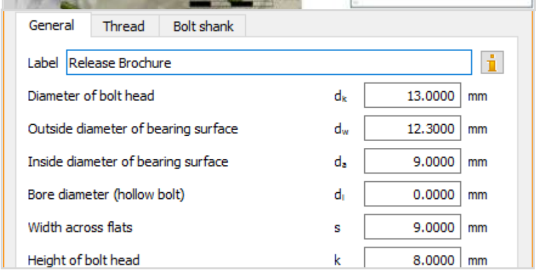


Temperatures

- For low and high temperatures
- Considers assembly temperature, temperature of bolt and temperature of clamped parts

ANSYS Integration

- KISSsoft integrated in ANSYS by CADFEM
- Calculate bolt loads in ANSYS and perform strength rating along VDI 2230 based on KISSsoft
- For arbitrary bolting patterns, considering clamped parts elasticity



Spindle drives

Calculations

- Safety factor against buckling, contact pressure and torsion
- Geometry along DIN 103 and own definition
- For static, alternating and pulsating loads

Shear pins, circlips

Calculation along Niemann / Seeger

- Bolt under shearing
- Cross pin under torque
- Longitudinal pin under torque
- Pin under bending
- Shear pin system
- Hub and shaft circlip

Calculations

- Static or fatigue loads
- For full or notched type pins
- Material database
- Sizing function for pin diameter

General purpose modules

Hertzian contact

- Contact between balls, cylinders, ellipsoid and plane, arbitrary body
- Calculation of contact ellipse dimension
- Calculation of contact and sub-surface stress

Local stress analysis

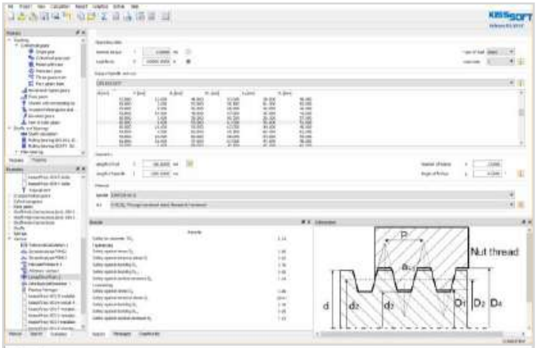
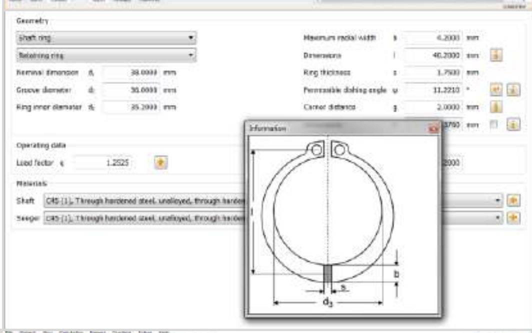
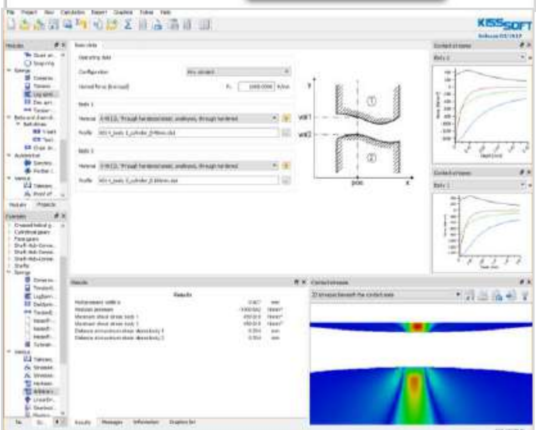
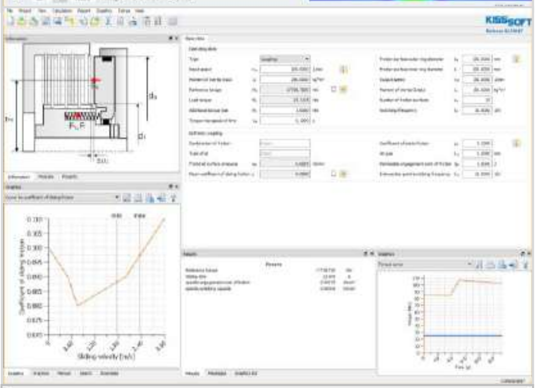
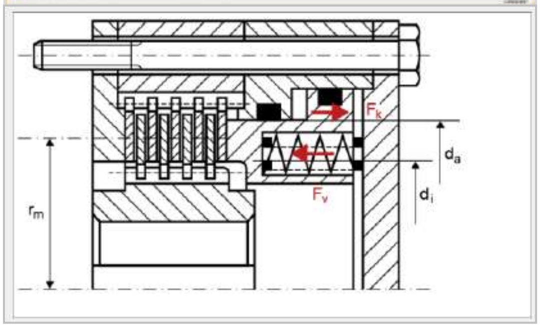
- Strength verification along FKM guideline
- For steel and aluminum
- For 1, 2 and 3-dimensional stress state

Tolerance analysis

- Min / Max values, statistical calculation
- Standardized or user defined tolerances

Belt drives, chain drives, clutches

- Chain sprocket geometry
- Belt and chain length
- Belt and chain strength
- Wet clutches along VDI 2241-1

Springs modules

Compression springs

- Geometry along DIN 2098 or own definition
- Tolerances along DIN 2095 or DIN 2096
- Calculation along EN 13906-1
- Goodman diagram for spring / wire strength
- Spring relaxation
- Sizing for wire diameter and active coils / windings

Tensile springs

- Different end geometries
- Tolerances along DIN 2097 or DIN 2096
- Calculation along EN 13906-2
- Goodman diagram for spring / wire strength
- Spring relaxation
- Sizing for wire diameter and active coils / windings

Garter springs

- Tolerances along DIN 2194
- Calculation along EN 13906-3
- Sizing function for wire diameter and active coils / windings
- For static or dynamic stress loading

Spring disks

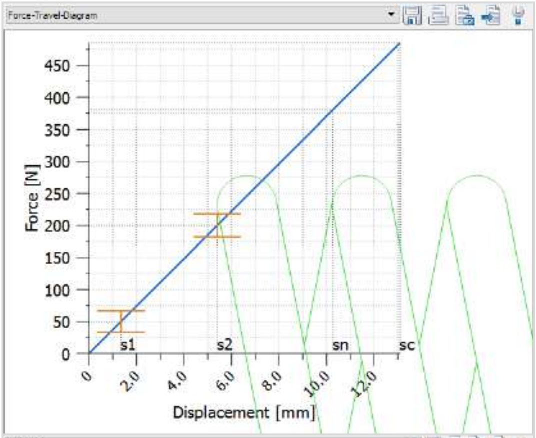
- Geometry along DIN 2093, Series A / B / C or own definition
- Calculation along DIN 2092
- Sizing function for number of disks in stack
- For static or dynamic stress loading
- Non-linear spring stack stiffness

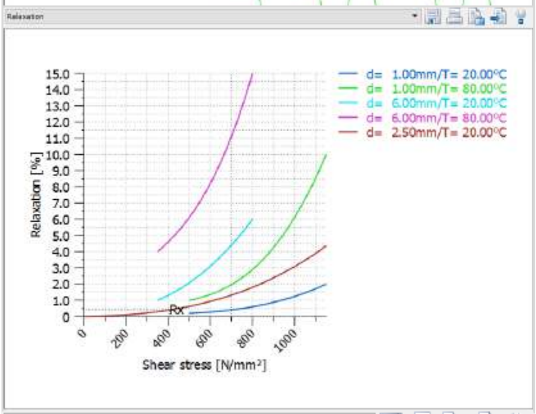
Torsional spring

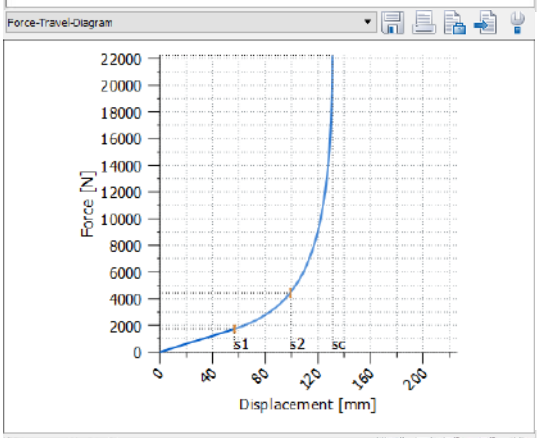
- Different head forms
- Single or multiple springs
- Calculation along DIN 2091
- Sizing function for selection of torsion bar diameter and shank length

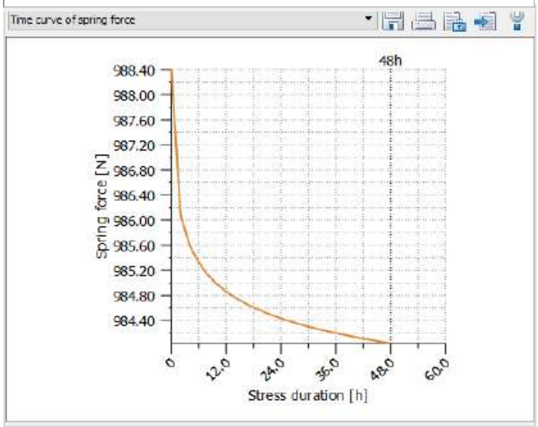
Conical spring

- Tolerances along DIN EN 15800
- Spring standard DIN 2076, DIN EN 10270, DIN EN 10218





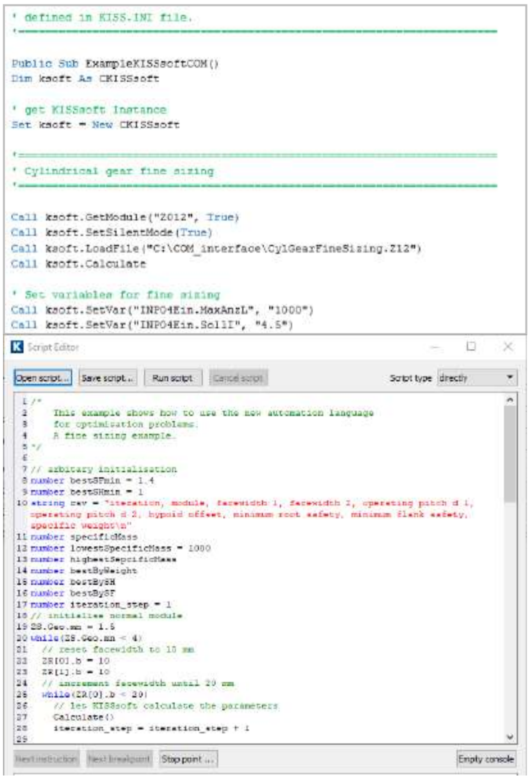




Scripting

Several scripting options

- Scripting language integrated with KISSsoft
- Control of KISSsoft through COM interface
- Address COM interface e.g., through MATLAB®, VBA® or PYTHON®



Data exchange

Gear data exchange GDE

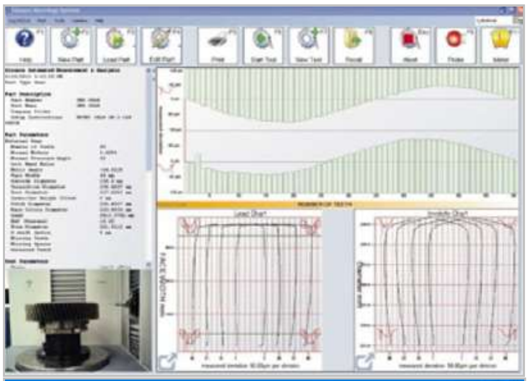
- Defined by VDI, VDI/VDE 2610
- Format for the exchange of gear and tooth data
- Based on XML language
- Seamless and error free exchange of gear data between design, manufacturing and quality control

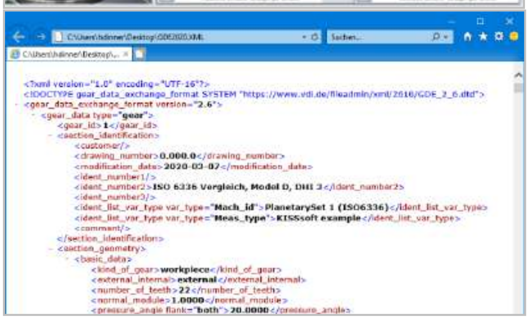
REXS

- Reusable Engineering Exchange Standard
- REXS definition by FVA
- Neutral format for gearbox data exchange
- Exchange gearbox data between non-compatible software

Data exchange to Gleason GAMA™

- Export of macro geometry of cylindrical gear
- Import to GAMA™ measuring software



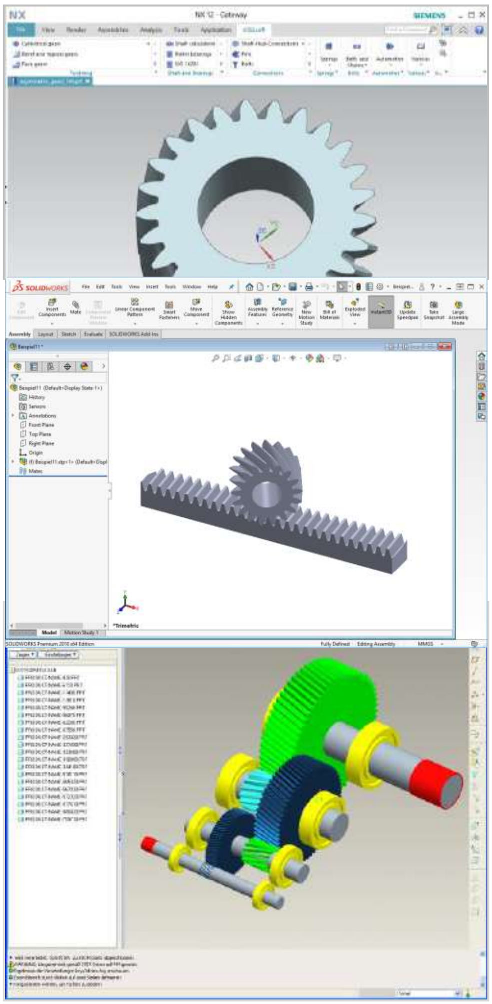


CAD interfaces

KISSsoft may include the above CAD interfaces to various systems. Thus, at the pressing of a button, the gears defined in KISSsoft can be exported to any of the above-mentioned CAD platforms. Gear Geometries supported are indicated above.

A gear can be generated for an existing construction or, simply, as a new part. Gears are generated by polylines, circular arc approximation or splines. The exact tooth profile is generated by manufacturing simulation considering tools like shaping cutter or protuberance hob. In addition, it is possible to place several gears on shafts already modelled in the CAD environment.

Neutral interfaces in 2D and 3D formats complete the CAD-specific export functions.



Feature/CAD	SOLIDWORKS	Autodesk Inventor	Solid Edge	Siemens NX	Creo Parametric	CATIA	HiCAD	Parasolid/ Neutralformat Interface (STEP)
Version	2017 - 2020	2017 - 2020	ST10, 2019, 2020	NX12, NX1847, NX1872, NX1899	Creo Parametric 3, 4 und 5	V5 R14 - R23	2016 - 2019	
Cylindrical gears, spur-toothed/spiral	✓	✓	✓	✓	✓	✓	✓	✓
Cylindrical gears, internal/external teeth	✓	✓	✓	✓	✓	✓	✓	✓
Worm/ helical gears	✓	✓	✓	✓	✓	✓	✓	✓
Rack spur-toothed/spiral	✓	✓	✓	✓	–	–	✓	✓
Asymmetric cylindrical gears	✓	✓	✓	✓	✓	✓	✓	✓
Bevel gears, spur-toothed	✓	✓	✓	✓	✓	✓	✓	✓
Bevel gears, helical	–	–	–	–	–	–	–	✓
Bevel gears, spiral	–	–	–	–	–	–	–	✓
Face gears	–	–	–	–	–	–	–	✓
Splines (shaft-hub)	✓	✓	✓	✓	✓	✓	✓	✓
Toothing on a existing shaft	✓	✓	✓	✓	✓	✓	–	–
Shafts	✓	✓	✓	✓	–	–	–	✓
Model generation with	KISSsoft menu, CAD add-in menu	KISSsoft menu, CAD add-in menu	KISSsoft menu, CAD add-in menu	CAD add-in menu	–	Special window in KISSsoft menu	–	–
Manufacturing data	✓	✓	✓	✓	✓	✓	–	–
64 bit version	✓	✓	✓	✓	✓	✓	✓	–

Export to CAM

KISSsoft includes a highly accurate detailed modeler for 3D gear geometries. Based on the geometry generated in KISSsoft, mold cavities, electrodes or final parts may be machined using 5-axis CNC machines.

For most gears, the 3D models can be generated including a protuberance to facilitate a roughing and a final machining operating. 3D models include gear modifications like lead, profile or topological modifications including chamfers or tip rounding.

Applications
Gears or cavities successfully machined by our customers include:

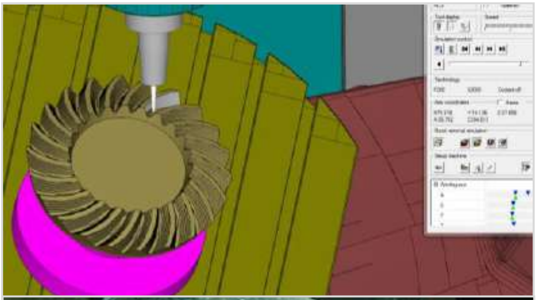
- Spur, helical and herringbone gears
- Spur, helical and spiral bevel gears
- Bevel gears with constant or varying tooth height
- Spur and helical face gears
- Worm gears (different shapes)

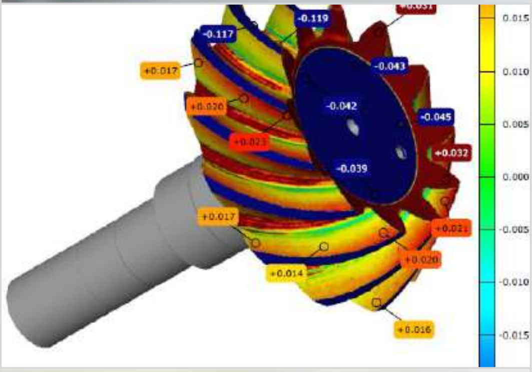
Geometries may be imported into any CAM software. Imported geometry includes profile and lead modifications, root geometry simulated from manufacturing, inner diameter, tip chamfer or rounding. Geometry resolution is finer than 0.1um.

Verification
Tests have confirmed that contact patterns of e.g., spiral bevel gears are matching with predictions calculated in KISSsoft.

Request specific information and technical papers on the subject from your local authorized reseller.

Gear geometry measurement may be controlled using KISSsoft measuring data (flank and root coordinates on measurement grid) and point normal vectors exported in different formats (e.g., to suit Gleason, Klingelnberg or Wenzel gear testers).





Training

Types of training

- Public trainings and technology seminars
- Company specific training, worldwide
- At KISSsoft AG training center, Switzerland
- On site or virtual classes by web meeting

Topics

- KISSsoft & KISSsys software usage
- KISSsys programming, scripting
- Gear theory, gear design technology
- Fine pitch and plastic gearing technology

Trainers

- Mechanical engineers with application-level experience
- Long-time software users or programmers
- Public training in German or English, company specific training in Korean, French, Italian




Updates and support

Services

- Software updates on annual basis
- Service Packs as required
- Installation and configuration support
- Software support (software usage)
- Technical support (software application)

USF modalities

- Perpetual by service contract
- Annual renewal

Software licenses

Licensing

- Perpetual, subscription or rental licenses
- Node locked, dongle and floating licenses

Combination of modules

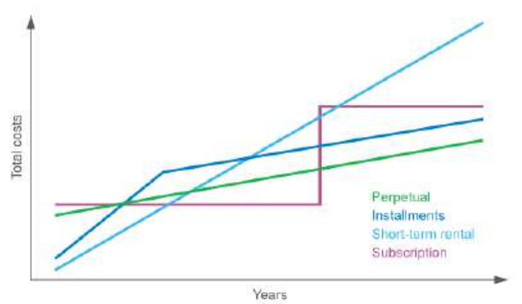
- Basic modules for gears, shafts, bearings, connections, shaft-hub connections
- Expert modules as add-on modules
- Total of about 130 software modules

Adding modules

- Modules may be added to an existing license
- Request list from authorized reseller

	Perpetual	Installments	Short-term rental	Flat rate	Subscription 3 years	Subscription 5 years
Freelance engineers, design offices	●	●	●	○ ○	●	●
SME	● ●	○	●	○	●	○
Large, multinational OEM	● ●	○	●	●	●	○
Global players	● ●	○	● ●	● ●	●	○

● ● recommended, ● suitable, ○ possible, ○ ○ not recommended



Stay in touch

If you want to stay in touch with us and be up to date on KISSsoft, register for our KISSsoft News which will be sent to you approximately every three weeks and/or you follow us on our Social Media channels: Facebook, LinkedIn and YouTube.

www.KISSsoft.com
www.facebook.com/KISSsoft
www.linkedin.com/company/KISSsoft-ag
www.youtube.com/KISSsoftAG

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звертайтесь до компанії «Інформаційні технології САПР»:**

044 503 95 34   **info@itsapr.com**   **http://itsapr.com**