KISSSOFT

Calculation programs for machine design

KISSSOFT RELEASE 03/2011 PRODUCT DESCRIPTION

Issue 1.3

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Chapter 1
Description of the calculation modules

Description of characters

* Programs from other manufacturers. We provide support and implement a compatible installation.

K02a Short designation of the calculation module. You will also find this abbreviation in the pricelist.

(M02a) Module designation as used in the software

1 Hardware and software requirements

1.1 Program versions

- **Demo program:** All the program modules can be tested in a demonstration program. The scope of the demo version is the same as the full version, apart from a few restrictions (listed below):
  - You cannot save calculation files and results
  - You can only select the first item in the lists
  - You cannot export graphics (DXF, CDL, IGES, etc.)
  - The text "KISSsoft demo version" also appears in the graphics
  - A demo window appears before each actual calculation
  - The reports have a demo extension

Programs from other suppliers which we also provide are not included in the demo version. The demo program gives you a good insight into how to work with the KISSsoft system.

- **Test installation:** Furthermore, starting on a date which you specify, you can also test a full version of our programs for a period of 30 days. You will then have unrestricted access to all our currently available calculation modules. The test installation gives you the opportunity to test our programs in a practical environment.
- **Single user version:** Copying protection: For security reasons, the programs can be copied at any time. To limit the illegal distribution of these programs, a software USB port protection device "dongle" is supplied along with the single user version. This is then inserted into the computer's USB port. Alternatively, on request, we can also supply an LPT protection device, however this is not supported by 64-bit operating systems.
- **Multi-user network installation with access directory:** We can supply a network installation, in which any number of users can work with the software, but at the same time only a limited number (depending on the number specified on the license) of users have authorization. This makes KISSsoft extremely flexible and easy to integrate into any network structure. To manage these licenses, you only need to install one directory with full rights on a server with general access rights for KISSsoft users. This does not start any server processes or similar processes. The license file contains the path of the access directory and the logical serial number of the network drive.

- **Multi-user network installation with USB protection:** Alternatively, you can also run the network installation with USB protection on the server. To achieve this, you need a server with a Windows operating system and a USB port as well as a directory to which both the server and clients have read and write access.

1.2 Computer configuration

To run the programs, you require the following computer configuration:

- Operating system: Windows XP (32bit/64bit), Windows VISTA (32bit/64bit) or Windows 7 (32bit/64bit)
- RAM: at least 500 MB RAM
- Screen resolution: at least 1024 x 768 pixels
- Printer: Windows printer
- Memory: hard disk approximately 500 MB (depending on requirements)

2 Base K modules

2.1 K1 base module

This module represents the administration module which is the basis for all calculation modules. The following items are covered:

- **KISSsoft in different languages:** KISSsoft is available in five languages. You can switch language separately for calculation reports and the user interface whilst the program is running (see also K02)
- **Data storage:** The KISSsoft system stores the data input by users and the results of calculations in a freely-definable storage medium (diskette, local hard disk, network server). You can create project-specific directories in the framework of project management.
- **Recording the results:** You can select where the results are output (printer or file) and how they are displayed to suit your own requirements. Additional properties:
  - The report file is in RTF format. Although an internal editor is available, you can also select an external editor. If you use an RTF editor (for example, KISSedit which is supplied with the system, Workpad or MS Word) relevant graphics are displayed in the report.
  - You can also select the scope of the printout (detailed variant and summary, to 9 levels of detail)
  - The content and appearance of the report templates can easily be modified using a text editor. Here you can pre-define formatting, such as font size, bold, italic or underlined.
  - You can select the language of the printout (see option K02)
  - Automatic page breaks and numbering.
  - User-specific print header (for example, to support quality assurance as specified in ISO 900x)
  - Display in a report editor. This allows you to add comments quickly and easily. In the report editor (KISSedit), you can select the header and footer format. You can include your company logo. The report you generate can be viewed directly. The report is displayed in a Word processing program, usually in the editor supplied with the system. You can use the KISSsoft settings to pre-define which word processing program you want to use.
- **Graphical representations and plotter:** To help you input and check data, at some points in the program, the inputs are shown in a scale graphic. Simply click a button to print out images, store them in graphics formats, or output

them via a CAD interface (DXF, IGES, see modules K05a and K05e). You can also define your own system of coordinates, line types and colors.

- **Help function:** KISSsoft has a powerful help system. Press function key F1 at any time to request information about the current situation in the program. In addition, you can call other topics in the help system by selecting them from the table of contents or by clicking a cross-reference. As you can also display graphics, consulting the manual is not necessary when working with KISSsoft.
- **Toggling units:** In KISSsoft, you can toggle units at any time. You can also store your own tailored configurations alongside the pre-prepared default settings.
- **Input parameter as formula:** In the interface you can perform simple calculations to help your work, directly when you input the data. This is useful if, for example, you must calculate a torque from the force and the lever arm, or work out a length from several masures.
- **Calculator:** You can activate a calculator program at any time, and use it to perform simple calculations.
- **Data exchange between different program sections:** At different places in the program you can refer back to the results of data that has already been calculated in other program modules. As a consequence, you can, for example, access data from the gear calculation when defining the external forces in the shaft.
- **Public data interface:** The freely-definable formatting of this data interface gives you a very effective communications tool for interacting with external programs. It has been specially designed to allow KISSsoft to be integrated into CAD programs. All input and output data can be exported in ASCII format. The scope and format of this data is freely definable. To allow this, each calculation module contains an editable report file. External programs can, in addition, transfer input data (also in ASCII format) to the calculation modules. These files are imported automatically during start-up and the data is displayed on the screen.
- **Calculation server, KISSsoft API:** You can use KISSsoft as a calculation server for your own program developments. You can do this either via the public data interface (see above) or via a COM interface.

2.2 K02 output text and interface

The program is currently available in the following languages:

- Authorization K02 German (always included)
- Authorization K02a English
- Authorization K02b French
- Authorization K02c Italian
- Authorization K02d Spanish

2.3 K05 CAD interfaces

KISSsoft's public interface is a powerful tool designed to create CAD integrations. The modular structure of KISSsoft programs enables them to be integrated smoothly into individual calculation functions in CAD. Detailed instructions about how to create interfaces on the CAD side are available in the manual.

Integration of KISSsoft:

In addition to this general solution, the system also has a wide range of standard formats for graphical displays. You can also request CAD integrations for numerous other CAD systems.

2.4 K05a DXF interfaces

All two-dimensional graphical data is described in AutoCAD DXF data format. As this interface is used in many CAD systems, this option can therefore also be used for other CAD systems. If necessary, you can also specify the layer in the inputs and outputs.

2.5 K05e IGES interface

Outputs all two dimensional graphical data in IGES format.

2.6 K05d SolidEdge interface

The interface between Solid Edge and KISSsoft is achieved by direct integration in the 3D CAD system. This enables you to start all KISSsoft calculation modules directly from Solid Edge. Cylindrical or bevel gears calculated in KISSsoft can be generated directly in Solid Edge as a 3D part with a real tooth form. From the KISSsoft system, in the tooth form calculation module, simply press a button to start Solid Edge. This opens a new part and generates the appropriate part. You can create cylindrical gears with straight or helical teeth, which are external or internal, or straight-toothed bevel gears, as defined in DIN 3971, Figure 1. Furthermore, you have the option of adding toothing to existing shafts. If you insert a reference layer to a side face of an existing shaft and then select it, the tooth form is cut out there on the shaft blank. In the 2D area, the interface also allows you to add gear manufacturer data automatically as a text field on the drawing. The gear manufacturing data is attached to the relevant cutout (tooth space).

2.7 K05g Neutral format interface

Output the three dimensional gear model in 3D view in IGES, STEP or SAT format. This covers cylindrical gears, straight or helical bevel gears in form 1 (tip, part and root cone peak at one point) spiral-toothed gears and worms.

2.8 K05k SolidWorks interface

The interface between Solid Works and KISSsoft is achieved by direct integration in the 3D CAD system. Use this to start all KISSsoft calculation modules directly from within Solid Works. Cylindrical or bevel gears calculated in KISSsoft can be generated directly in SolidWorks as a 3D part with real tooth form. From KISSsoft, in the tooth form calculation module, simply press a button to start Solid Works. This opens a new part and generates the appropriate part. You can create spur or helical cylindrical gears, which are external or internal, or straight-toothed bevel gears, as defined in DIN 3971, Figure 1. Furthermore, you have the option of adding toothing to existing shafts. If you insert a reference layer to a side face of an existing shaft and then select it, the tooth form is cut out there on the shaft blank. In the 2D area, the interface also gives you the option of adding gear manufacturing data automatically as a text field on the drawing. The gear manufacturing data is attached to the relevant cutout (tooth space).

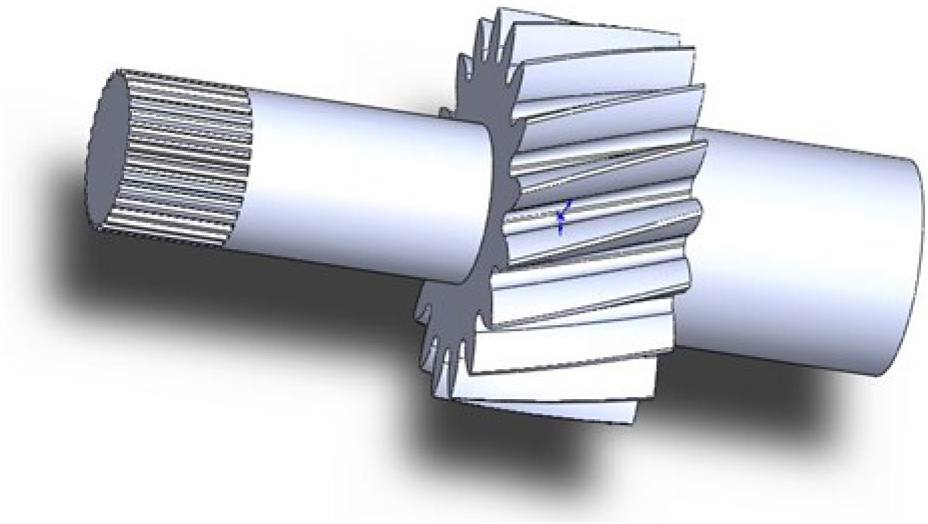

Figure 1.1: Pinion shaft generated in KISSsoft

2.9 K05m Inventor interface

The interface between Inventor and KISSsoft is achieved by direct integration in the 3D CAD system. Use this to start all KISSsoft calculation modules directly from within Inventor. Face or bevel gears calculated in KISSsoft can be generated directly in Inventor as a 3D part with a real tooth form. From KISSsoft, in the tooth form calculation module, you simply press a button to start Inventor. This opens a new part and generates the appropriate part. You can create spur or helical cylindrical gears, which are external or internal, or straight-toothed bevel gears, as defined in DIN 3971, Figure 1. Furthermore, you have the option of adding toothing to existing shafts. If you insert a reference layer to a side face of an existing shaft and then select it, the tooth form is cut out there on the shaft blank. In the 2D area, the interface also gives you the option of adding gear manufacturing data automatically as a text field on thedrawing. The gear manufacturing data is attached to the relevant cutout (tooth space).

2.10 K05n NX interface

The interface between NX and KISSsoft is achieved by direct integration in the 3D CAD system. Use this to start all KISSsoft calculation modules directly from within NX. Cylindrical or bevel gears calculated in KISSsoft can be generated directly in NX as a 3D part with a real tooth form. You can create spur or helical cylindrical gears with straight or sloping teeth, which are external or internal. Furthermore, you have the option of adding toothing to existing shafts. If you insert a reference layer to a side face of an existing shaft and then select it, the tooth form is cut out there on the shaft blank. In the 2D area, the interface also gives you the option of adding gear manufacturing data automatically as a text field on the drawing. The gear manufacturing data is attached to the relevant cutout (tooth space).

2.11 K05o* CATIA interface

Cylindrical or bevel gears calculated in KISSsoft can be generated directly in CATIA V5 as a 3D part with a real tooth form. You must open CATIA V5 before you start a 3D generation in KISSsoft. In CATIA V5, this then opens a new part and the appropriate part is generated. You can create spur or helical cylindrical gears, which are external or internal. In the 2D area, the interface also gives you the option of adding gear manufacturing data automatically as a text field on the drawing.

2.12 K05p* CoCreate interface

Cylindrical or bevel gears calculated in KISSsoft can be generated directly in CoCreate Modeling as a 3D part with a real tooth form. From KISSsoft, in the tooth form calculation module, simply press a button to start CoCreate. This opens a new part and generates the appropriate part. You can create spur or helical cylindrical gears, which are external or internal, or straight-toothed bevel gears, as defined in DIN 3971, Figure 1.

2.13 K05q* ProEngineer interface

Cylindrical or bevel gears calculated in KISSsoft can be generated directly in Pro-Engineer as a 3D part with a real tooth form. You must open ProEngineer before you start a 3D generation in KISSsoft. In ProEngineer this then opens a new part and the appropriate part is generated. You can create spur or helical cylindrical gears, which are external or internal, or straight-toothed bevel gears, as defined in DIN 3971, Figure 1. In the 2D area, the interface also gives you the option of adding gear manufacturing data automatically as a text field on the drawing.

2.14 K05r* Think3 interface

Cylindrical or bevel gears calculated in KISSsoft can be generated directly in Think3 as a 3D part with a real tooth form. You must open Think 3 before you start a 3D generation in KISSsoft. In Think3 this then opens a new part and the appropriate part is generated. You can create spur or helical cylindrical gears, which are external or internal. In the 2D area, the interface also gives you the option of adding gear manufacturing data automatically as a text field on the drawing.

2.15 K05s Parasolid display window

The cylindrical gears, racks, bevel gear, face gears, crossed helical gears and worm gears calculated in KISSsoft can be displayed directly in this parasolid 3D display window.

2.16 K05u Export STEP format (parasolid)

Export the displayed 3D models in the parasolid display window in STEP format.

2.17 P01 Parasolid base module

This is the base module for generating individual models in parasolid form.

2.18 P02 Generate a helical toothed cylindrical gear (parasolid)

Prerequisite: authorization P1

This module generates straight and helical toothed cylindrical gears in parasolid form. These can then be viewed in the 3D parasolid display window.

2.19 P03 Generate a bevel gear (parasolid)

Prerequisite: authorization P1

This module generates straight, angled and spiral toothed bevel gears in parasolid form. These can then be viewed in the 3D parasolid display window.

2.20 P03a Generate a straight-toothed bevel gear (parasolid)

Prerequisite: authorization P1

This module generates straight-toothed bevel gears in parasolid form. These can then be viewed in the 3D parasolid display window.

2.21 P04 Generate face gear (parasolid)

Prerequisite: authorization P1

This module generates face gears in parasolid form. These can then be viewed in the 3D parasolid display window.

2.22 P05 Generate a globoid worm gear (parasolid)

Prerequisite: authorization P1

This module generates globoid worm gears in parasolid form. These can then be viewed in the 3D parasolid display window.

2.23 K07 user database (materials etc.)

You can extend or change any data, such as materials, geometry data, toothing profile via the user database. One of KISSsoft's appealing features is that changes to material data also automatically become active in every calculation that has already been saved.

2.24 K7a material management (always present)

Module in which you input additional materials and where you change specific data of materials that are already present.

2.25 K7b Smith-Haigh diagram

Prerequisite: authorization W03, W06

This authorization allows you to display a Smith and Haigh diagram for a specific material. It can only be displayed as part of a shaft calculation. You can display a notched part. In the graphic you can select the cross-section as well as the stress components bending, tension/compression or torsion.

2.26 K09 Hardness Conversion (in the Extras menu)

Convert hardness data in accordance with Vickers, Brinell and Rockwell.

2.27 K10 Calculating tolerances

Calculate the total measurement of chain dimensions for the elements you input. You can define the tolerances either as a general tolerance (DIN ISO 2768, DIN 7168) with inputs specified in ISO in the tolerance field or use your own values. This calculation uses a constant distribution (arithmetical sum) and the root mean square of the tolerances (standard distribution) to define the whole tolerance field.

2.28 K12 Strength analysis with local stresses (FKM guideline)

The proof of static and fatigue strength (limited life time or endurance) with elastically calculated local stresses as specified in FKM guideline 183 (4th Edition) for non-welded parts.

Based on stresses in critical points that are calculated using an FE program, you can use this method to calculate a complete proof of strength with safety against fracture or against the yield point and a safety against fatigue fracture. You can also perform this calculation with load spectra.

2.29 K14 Hertzian pressure

Calculating the Hertzian pressure of two bodies. Hertzian equations are used to calculate the maximum pressure (Hertzian pressure) and also the proximity of the two bodies (ball, cylinder, ellipsoid, plane; convex or concave). In addition the distribution of the stress normal to the surface is calculated.

The calculation formulas have been taken from "Advanced Mechanics of Materials, 6th Edition".

2.30 K15 Linear Drive

Use this calculation module to calculate drive screws. Drive screws are used to convert rotational movement into longitudinal movement or to generate great forces. Trapezoidal screws (DIN 103 selectable) are almost exclusively used as drive screws.

The information provided in Roloff Matek [62] is used to calculate linear drives (drive screws).

3 Shafts, axes, bearing - W-module

3.1 General

The program is made up of individual modules, all of which are controlled via the base module, which contains input, correction and output options. Data that has been input once (geometry, material, forces, etc.) can therefore be used in all calculation modules and does not have to be entered again and again.

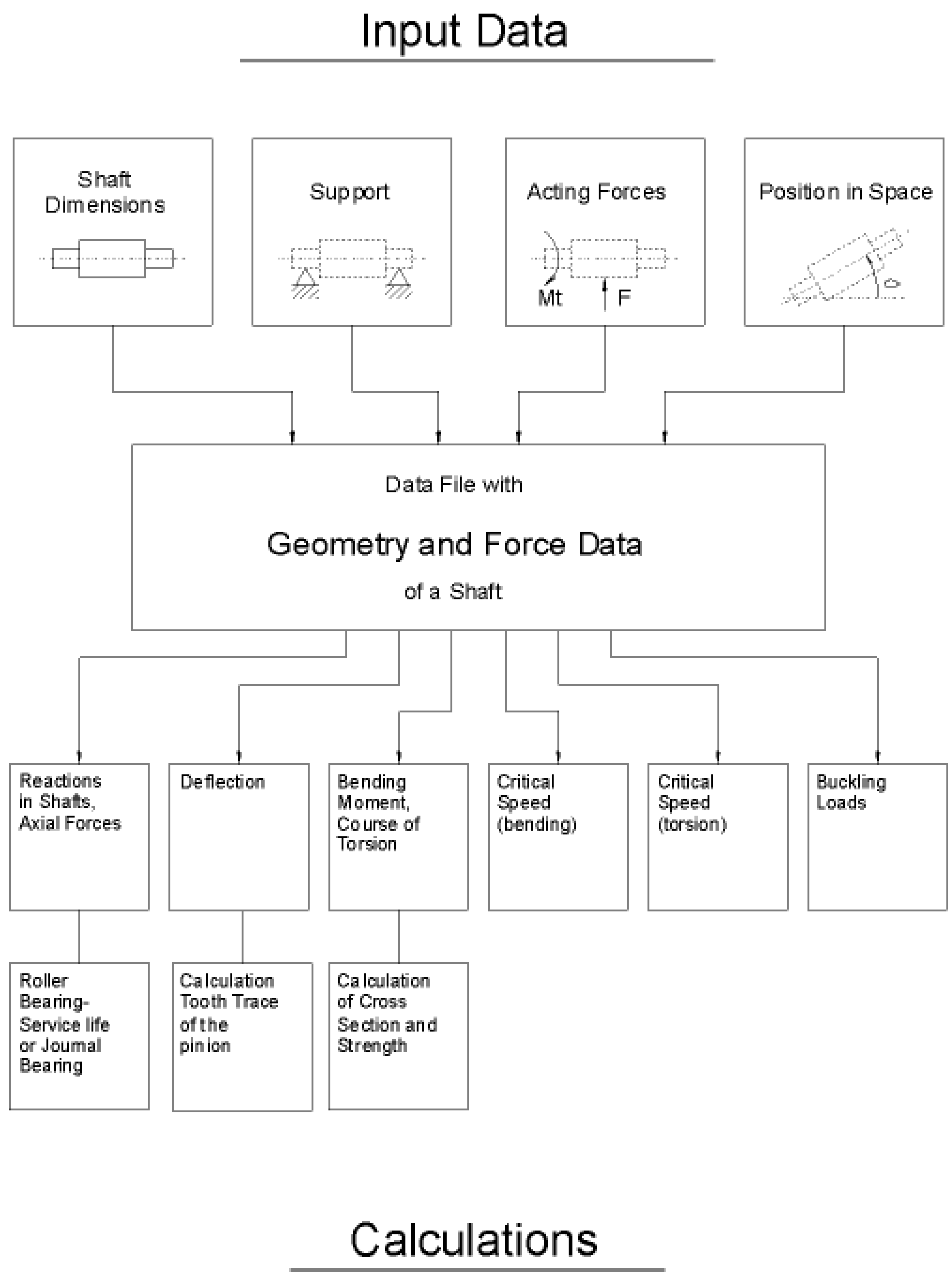

Figure 1.2: Flow-chart of the modules for shaft and bearing calculation in KISSsoft

3.2 W01 Shafts base module

Allows to start the calculation module:

- Shaft calculation [W010]

In this module, you can input and correct geometry and material data, shaft specifications, drawing numbers, bearing types, peripheral conditions, external forces and moments (simplified input for couplings, cylindrical and bevel gears, worms, worm gears, belt pulleys), interface to CAD. Graphical interface: The shaft contour and bearing are shown in a scale diagram.

Additional properties of the base module are:

- Any dimensions (cylindrical and conical), axial symmetric cross-section, solid and hollow shafts, beams (H-, I-,L-profiles etc.)
- Integrated drawing tool that allows simple corrections to be made to the shaft contour (diameter, lengths). You can change any of these elements by simply clicking on them with the mouse.
- List functions: The elements you input are output as a list and can be changed as required (change, insert, delete)
- You can enter these values for force and moment in any spatial positions, however, the following values are already predefined:
  - Cylindrical gear
  - Bevel gear
  - Worm/worm gear
  - Coupling/motor
  - Rope or belt pulley
  - Individual radial and axial forces, bending and torsional moments
  - External load
  - Eccentric force
  - Power loss
  - Interface used to import data from gear calculations
  - Forces can also apply outside the shaft
  - You can also specify your own power or torque
- Statically undefined bearings
- Calculation of:

- Shaft weight
- Moment of inertia
- Gyroscopic moment
- Resulting, axial force
- Static torsion of the shaft
- Torsional moment progression

- All force elements (external force, cylindrical gear, coupling etc.) can be assigned load spectra. This information is evaluated accordingly (bending, strength, roller bearing) in the calculations. Calculation with a load spectrum requires W01s
- The geometric data and the calculated bearing strengths are displayed in an easy to understand form.
- Interface to different CAD systems for transferring shaft geometry (import and export) in different formats (see options for K05).
- The results of the base calculation, the bending (W03), critical number of rotations (W04) and strength calculation (W06) including the specific relevant graphical representations are grouped together in an overall report.

3.3 W01a Input data for several shafts

Use this calculation module to input and calculate data for several coaxial shafts. You can connect the shafts with roller bearings or general links.

You may need to use several coaxial shafts, for example, for idler gears for speed change gear units where the deformation of the shaft and the idler gear can be taken into account when you arrange the tooth trace corrections.

At present, you can define a maximum of 15 coaxial shafts.

3.4 W01b Bearing offset, Bearing clearance

If you have this authorization you can take the bearing offset and the bearing clearance into account in the calculation. You can specify the bearing offset both for general bearings and for roller bearings.

In the case of roller bearings, you can define a radial clearance and a displacement in both X and Z directions. In the case of general bearings, you can define clearance or displacement for all six degrees of freedom.

3.5 W01c Take into account contact angle

Use this calculation module to take the bearing contact angle into account in the calculation. For this purpose, the bearing force from the center point of load application is moved along the effective line to the bearing centre. The resulting bending moment is then effective at the bearing.

3.6 W01s Load spectra

Use this calculation module to define load spectra that can then be taken into account in the calculation. You can either select a spectrum element, which allows you to perform all the calculations, or perform the calculation with the entire spectrum to calculate either the bearing service life (W05) or the strength of the shaft (W06s).

3.7 W03 Calculate bending and bearing forces

- Calculate the deflection line, course of transverse force and course of flexural moment in the XY and the ZY plane (shaft axes always along the Y axis) with or without considering the dead weight
- Calculate the axial force taking into account the weight (depending on the spatial position of the shaft)
- Calculate the axial strain of the shaft
- Graphical display of all critical dimensions on screen and as a printout: course of deflection, shearing force, bending moment in different planes, torsional moment, axial force and static comparative stress
- Calculate the forces and moments in bearings for an unlimited number and any type of bearing
- Output the bearing reaction forces for an unlimited number of bearings
- Calculate the inclination of the deflection line in bearings, e.g. when calculating cylindrical roller bearings. The progression of the angle of inclination can also be displayed on screen and printed out.
- If you input a shaft with load spectra, you can also calculate the deflection lines individually for the load on each load spectrum element (authorization W1s).
- Calculate all stress components (tension/compression, bending, shearing, torsion) and equivalent stress. Display the equivalent stress progression as well as stress components.
- Calculate the bending with or without taking into account deformation due to shearing (authorization W3a)

For the calculation of bending and the values in the cross sections a finite element calculation with one-dimensional bar elements is applied. This calculation is based on a CM2 FEM library of Computing Objects (http://www.computing-objects.com)

3.8 W03a take into account deformation due to shearing

Deformations due to shearing can be taken into account when you calculate deformations. You can specify the shear correction coefficient for that purpose. However, there is only one shear correction coefficient for the shaft system.

3.9 W03b Non-linear shaft

You can activate a calculation with a geometric non-linear bar model. A shaft calculation with two fixed bearings under shearing force then also supplies axial force due to elongation along the length. If you perform the calculation with a non-linear shaft model, you must take the deformations due to shearing into account. In standard shafts, the linear and non-linear calculations return the same results. The non-linear method supplies good results in cases that do not occur in mechanical engineering, such as, for two fixed bearings or for the calculation of the diagrams of bending for thin wires.

3.10 W03c Heat expansion

Input the temperature and heat expansion coefficient to define the axial expansion of temperature and housing. It is assumed that a shaft has a homogenous temperature.

3.11 W03d non-linear stiffness

The stiffness of roller bearings is calculated in accordance with ISO/TS 16281 (DIN ISO 281 supplement 4). The internal geometry data is taken from the roller bearing database or approximated from the load numbers, if not otherwise specified. This calculation option supplies a changed bending and load distribution on the bearing, but no additional results. For more information, see W05b and W05c.

You can take into account the non-linear bearing stiffness for spherical roller bearings, single-row cylindrical roller bearings, tapered roller bearings, grooved ball bearings, angular contact bearings, radial four-point bearings, deep grooved thrust ball bearings and angular contact thrust ball bearings.

3.12 W04 calculation of the critical speeds

Calculate the natural modes for the system of coaxial shafts, with or without additional mass.

- Calculate any number of natural modes
- Taking into account bending, torsion and axial movements
- Coupling of axial and bending movements by angular contact ball bearings and tapered roller bearings

- Display on screen and print out natural frequencies for deflections and displacement
- In the case of beam profiles, natural modes are defined in both main coordinate planes.
- Gears can be included automatically and handled like masses. In this situation, KISSsoft takes into account the mass and the moments of inertia of the gear sited on the shaft.

3.13 W04x gyro effect

Prerequisite: authorization W04

Addition used to calculate natural modes: This takes into account the gyro effect of large momentums of mass. The critical speed (bending mode) is calculated for forward and backward spin. In a synchronous forward spin, an unbalance increases the bending oscillations because the angular speeds of the rotating shaft and angle speed of the shaft's peripheral centre point are the same. The backward spin is, in most cases, not technically important.

The gyro effect of spinning is taken into account for the pre-defined speed.

3.14 W05 cylindrical roller bearing and roller bearing service life

Allows to start the calculation module:

- Roller bearing calculation [W050]

- Calculation of:
  - Grooved ball bearing (single and double row)
  - Angular contact bearing (single and double row)
  - Cylindrical roller bearing (single and double row)
  - Needle roller bearing
  - Spherical roller bearing, Self-aligning ball bearing
  - Tapered roller bearing
  - Paired tapered roller bearing
  - Four-point bearing (QJ)
  - Spherical roller axial bearing
  - Cylindrical roller axial bearing

  - Axial needle roller bearing
  - Axial grooved ball bearing
  - Axial angular contact bearing
- All data (approximately 18,000 different bearings) is stored; transferred directly from data from FAG, SKF, NSK, Koyo, Timken, IBC and KRW bearings.
- For integrating aditional bearings you can use the database tool
- Selecting a bearing by inside or outside diameter
- Taking into account radial and axial forces
- Calculate service life and static safety factor
- Check the bearing speed limit (oil and grease lubrication)
- Simultaneous calculation of up to 8 bearings (arbitrary number in shaft calculation)
- Bearing clearance: normal / C3 / C4 for grooved ball bearings
- Bearing arrangement: single, O or X arrangement.
- Calculate the axial forces for angular contact bearings and tapered roller bearings

3.15 W05a Bearing load spectra

Calculate the service life as specified in ISO 281 for arbitrary load spectra. Enhanced service life calculation (influence of operating conditions and lubricant): Roller bearing calculation is performed using the a_{ISO} factor (ISO 281-2007), in accordance with the extended service life criterion. KISSsoft uses data about lubricant viscosity, cleanliness, operating temperature, speed, the bearing geometry and the bearing type to define the a_{ISO} factor and then includes this in the calculation. Alternatively, you can also perform this calculation without the a_{ISO} factor.

You can also use this module to perform an enhanced bearing service life calculation in the shaft calculation.

Calculate the reference thermal limit of operating speed as specified in E-DIN 732-1 and E-DIN 732-2 from the heat level of the roller bearing.

3.16 W05b reference service life as specified in ISO/TS 16281

Prerequisite: W03d authorization

- In the shaft calculation, in the enhanced version of module W03d, you can also calculate and output the reference service life specified in ISO/TS 16281. This method performs a detailed calculation of the bearing service life and takes into account the internal bearing geometry (rolling body, clearance, etc.).

This calculates the reference service life Lnrh. With authorization W05a you can also calculate the modified reference service life.

As before, you can still analyze the following bearing types whilst taking their internal geometry into account:

- Deep groove ball bearing
- Angular contact ball bearing
- Cylindrical roller bearing
- Taper roller bearing
- Spherical roller bearings
- Needle roller bearing/Needle cage
- Axial cylindrical roller bearing
- Axial spherical roller bearings

3.17 W05c Load distribution in the bearing

Prerequisite: authorization W03d

In the shaft calculation in combination with modules W03d and W05b you can also calculate and output the pressure of the individual rolling element as specified in ISO/TS 16281. You can output this data either as a report or a graphic.

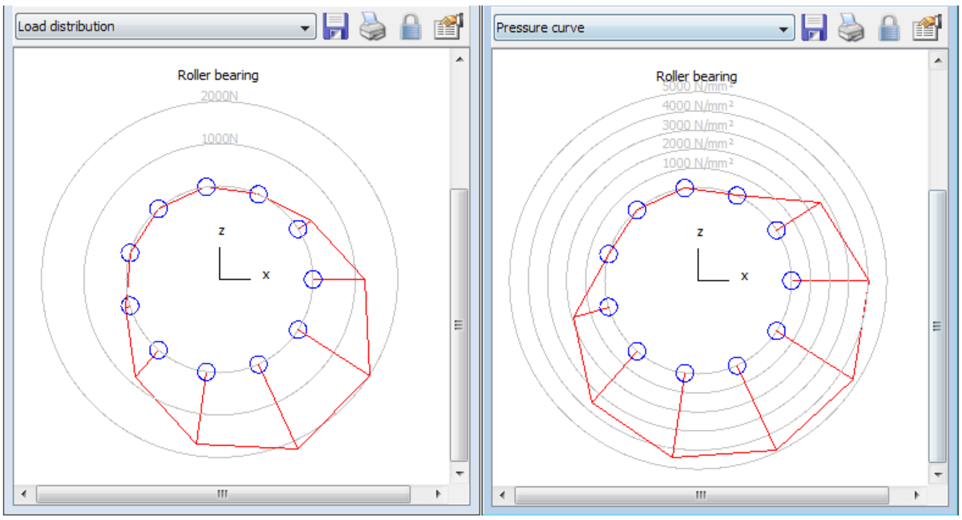

Figure 1.3: Load distribution in the bearing

3.18 W06 Calculate the service life and static calculation of cross-sections

- You can select the following cross-section types (automatic calculation of notch factors, effect of notch on the outside or inside diameter):
  - Smooth shaft
  - Shoulder
  - Shoulder with relief groove
  - Conical shoulder
  - Interference fit
  - Key
  - Splines
  - Straight-sided splines
  - Square groove
  - Circumferential groove
  - V-notch
  - Thread
  - Cross holen
  - Define your own definition notch factors
- Supplied materials: about 100 materials, such as CK 45, Ck 60, St 52, 16 MnCr 5, 18 CrNiMo7, GG 20, stainless steels, steel castings, malleable iron and many more
- Showing the course of the equivalent stress as a graphic makes it easier to locate the cross-sections that are critical.
- Input the values for surface roughness and quality as defined in ISO 1302 and output roughness Rz.
- Influence of surface treatments (shot-peening etc.) and heat treatments.
- Key tables for cross-sections with keyways are pre-installed. The data is imported from a data file that contains the ISO 773, DIN 6885.1, DIN 6885.2 and DIN 6885.3 standards. You can also specify other standards, or input them directly whilst the program is running.
- Calculate safety for fatigue; Static safety against yield point and fracture. With W06s, finite life calculation and load spectra.

3.19 W06a calculation method Hänchen + Decker

Calculate according to "Neue Festigkeitsberechnung für den Maschinenbau " by Hänchen + Decker. Well proven, calculation method although it no longer corresponds to the latest research results (accepted by TÜV).

3.20 W06b calculation method DIN 743

Calculate in accordance with DIN743 (2000 edition) "Tragfähigkeit von Wellen und Achsen" (similar to the calculation according to FKM guidelines): Strength calculation for shafts and axes with proof of fatigue safety/deformation. The stresses that occur (only mean stresses and amplitudes) are evaluated on the basis of a simplified Smith diagram.

Important features of this method:

- applies only to shafts and axes.
- Tension/compression, bending and torsion are included in the calculation. However, shearing is not taken into account.
- Take into account surface factor (nitriding, case-hardening, carbonitriding, rolling, shot-peening, induction and flame-hardening).
- As the service life is not calculated (finite life time domain) the load spectra are therefore also not calculated
- Temperature range: -40 to 150 degrees.
- Only applies to steel.

3.21 W06c Calculation methods according to the FKM Guideline

The FKM Guideline is the most comprehensive currently-available calculation method. It goes far beyond the application areas of DIN 743, but requires more time and effort to interpret its results. The calculation algorithm performs both a static and a finite life calculation. This calculation algorithm was developed by Professor Haibach.

3.22 W06s Strength calculation with load spectra

Prerequisite: authorization W06b or W06c

The calculations specified in the FKM guideline, or DIN743 with the FVA proposal or new draft allow you to calculate strength with load spectra. If you input a shaft with load spectra, you can use it to perform the calculation directly. However, the calculation method specified by Hänchen/Decker does not take load spectra into account because the standard does not allow this.

3.23 W07 Hydro-dynamic radial journal bearings

Calculation of hydro-dynamic radial journal bearings in stationary operation. Different oil types are pre-defined (ISO VG) and you can also input data for special lubricants. The calculation is performed for cylindrical bore journal bearings (however, using different construction types only gives a small variation in results)

3.24 W07a calculation in accordance with Niemann

This method calculates the power loss, oil flow, oil temperature, minimum lubricant gap thickness according to Niemann, Maschinenelemente I, Springer, and according to O. R. Lang, Gleitlager, Springer. This calculation can only be used for pressure lubricated bearings (circulatory lubrication) and also checks for operating reliability.

3.25 W07b calculation according to DIN 31652

Calculation according to DIN 31652: Complete calculation according to 31652, parts 1 to 3 (1983 edition) for pressure-less and pressure lubricated bearings. This takes into account the way in which lubricant is applied (lubrication holes, lubrication groove, lubrication glands). It calculates all the operating data in accordance with DIN 31652, including the operating temperature, minimum lubrication gap width, power loss, oil flow etc. It also checks operating reliability. In adition the spring stiffness (radial stiffness) of the bearing at the operating point is calculated. This value can then be included in the shaft calculation.

3.26 W08 Grease lubricated radial journal bearings

Calculates the bearing data in operation and during the transfer to mixed friction on the basis of the calculation method used for oil lubricated journal bearings when insufficient lubricant is present. A wide range of different greases are pre-defined here.

3.27 W07c Hydrodynamic axial journal bearing

Calculation of hydrodynamic axial journal bearings in stationary operation. Different oil types are pre-defined (ISO VG) and you can also input data for special lubricants.

- Calculation according to DIN 31653: Complete calculation of axial segment bearings according to 31653, parts 1 to 3 (1991 edition) for pressure-less and pressure lubricated bearings. It calculates all the operating data in accordance with DIN 31653, including the operating temperature, minimum lubrication gap width, power loss, oil flow etc.

- Calculation according to DIN 31654: Complete calculation of tilting-pad thrust bearings according to 31654, parts 1 to 3 (1991 edition) for pressure-less and pressure lubricated bearings. This takes into account the way in which lubricant is applied (lubrication holes, lubrication groove, lubrication glands). It calculates all the operating data in accordance with DIN 31654, including the operating temperature, minimum lubrication gap width, power loss, oil flow etc.

3.28 W10 Tooth trace correction

Calculates the shift of a cross-section point from its home position due to torsion and bending. For various purposes, for example, for grinding off crowning (also called length or flank line correction) on toothing, it is important that you know how much a specific point in the shaft cross-section moves in a particular direction due to elastic deformation. This program calculates the shift in a specific interval along the length of the axis and prints out the data. The tooth trace deviation due to deformation is also calculated for toothing. This value is needed for precise cylindrical gear calculations. Graphical display of deformation components on screen (and printer). You can transfer this data to any CAD program via the graphic interface.

3.29 W12 Shaft arrangement (integrated design tool)

Shaft sizing:

The system has two functions which you can use to size shafts (of any diameter):

- Sizing for strength: The KISSsoft system arranges the shaft contour so that the equivalent stress has the same (definable) value in all the cross-sections.
- Sizing for deflection: The KISSsoft system changes the diameters of the default shaft contour proportionally to achieve a pre-defined maximum deflection.

Procedure shaft optimization:

The "traditional" method of design leads from the idea to the design to rough-sizing and then to the draft design. This can be replicated very effectively by the KISSsoft system when it is implemented in a CAD environment. As soon as a design concept is available, the next step usually involves dimensioning the load bearing elements, such as couplings, gears, belts etc. The KISSsoft system provides a wide range of layout programs for this. The dimensions of the load bearing elements then result in the bearing distances and the shaft lengths. The KISSsoft system has a layout module that you use to dimension shafts with support. Start the shaft calculation program, enter the approximate shaft length, the bearing mid-points and elements with external forces. The system then returns a first suggestion for the diameter. You can then define the type of bearing and, depending on the required service life, you can modify the shaft diameter. You can easily exit from, or correct the appropriate diameter change in the graphical display on the screen.

In the next step, you calculate the exact strength (check for strength against overload failure and failure due to fatigue). As part of the strength calculation process, the outside shaft diameter is optimized automatically to achieve the required level of safety. You can, of course, also check the shaft-hub connections (press fit, key, couplings with toothing) at the same time.

You can now output this quickly calculated and optimally arranged shaft with support via the CAD interface and, without any additional effort, you now have the finished shaft contour, together with the bearings, in your CAD design drawing.

3.30 W13 Buckling

You use this function to calculate the buckling load of shafts and supports. All peripheral conditions, bearings and effective axial forces (point or line loads) are taken into account in the calculations. It outputs the safety for a number of buckling situations, however, only the first one is usually relevant. You must input the loads for this calculation.

4 Machine elements - M module

4.1 M01a Cylindrical interference fit

Cylindrical interference fits influenced by centrifugal force

- Loading in circumferential and axial directions
- Calculating the maximum torque for a non-slipping fit. If slip occurs in the fit, micro gliding will cause corrosion due to friction.
- The calculation includes the entirety of the DIN 7190 standard (elastics) with longitudinal, radial and oil interference fits

This module also calculates the safety of the interference fit against gliding and the safety of the shaft material and the hub are to fracture and yielding. The tolerance system in accordance with DIN 7151 (e.g. with diameter input 60 H7/f6), has been implemented to make it easier to input data.

4.2 M01b Conical interference fit

Conical interference fit connection: Calculation and design of a conical interference fit connection for transferring torque in an elastic operating state. Conical interference fits are normally joined axially with a screw or by pressing them together. Calculation method as specified by F. G. Kollman for connections with the same Young's modulus and with a solid inner part. The permitted area of the set angle is determined (for the upper installation). The displacement and pretension force for joints and in operation under maximum torque is also calculated.

Sizings:

- Permitted angle of taper (for self locking)
- Length of interference fit for transmitting the maximum torque
- Maximum transmissible torque

4.3 M01x Additional function for a press fit

Extension of the interference fit calculation:

- The calculation also takes into account the effect of the centrifugal force on the expansion of the interference fit and on the stress in the shaft and hub.
- You can either enter the tolerance manually, or use an automatic option to calculate the tolerance pairing based on the required safety against gliding and the

permissible material stress. Input the values for surface roughness with qualities defined in ISO 1302.

- You can define a hub with varying outside diameter in KISSsoft to calculate cylindrical and conical interference fits. In such cases, input the outside diameter section by section with the diameter and length. The system then derives an equivalent diameter from these values (as specified by V. Gross) and includes it in the calculation.

4.4 M01c clamped connections

There are two different configurations of clamped connections that can be calculated:

- Slotted hub
- Split hub

The surface pressure and safety against sticking are calculated in accordance with the classic literature (Roloff Matek, Machine elements, 15th Edition, 2001). Bending is calculated as specified by Decker, Machine elements, 15th Edition, 2000.

4.5 M02a Key / Key way

For keys as defined in:

- DIN 6885.1
- DIN 6885.2
- DIN 6885.3
- ANSI B17.1 Square
- ANSI B17.1 Rectangular
- Own definition

a calculation is performed to find the load on the shaft and hub (surface pressure) and the key (shearing) and also defines the safeties (calculation method: DIN 6892 (1998) method C). The calculation takes into account the tolerances of the key radii and the direction of force. You can also enter your own value for the number of keys and the operating factor. Scale graphic representation

Key calculation as specified by DIN 6892 (1998) method B:

This standard uses very clearly defined calculations for keys under constant and peak load. For example, it also includes the situation where an interference fit is present. You can input this data in a sub dialog: Chamfer on shaft and the hub; smaller and larger outside diameter of the hub; width to outside diameter; distance; torque curve; frequency of load direction change.

Sizings:

- Determine the load bearing length of the shaft or hub on the basis of target safety and
- determine the transmissible torque.

4.6 M02b Straight-sided spline/ Multi-groove profile

For multi-groove profiles specified in:

- DIN ISO 14 (light series)
- DIN ISO 14 (medium series)
- DIN 5464 (vehicles, heavy series)
- DIN 5471 (machine tools, with 4 keys)
- DIN 5472 (machine tools, with 6 keys)

a calculation is performed to find the load placed on the shaft and hub (surface pressure). You can also add additional standards. The calculation of the load placed on the shaft and hub (surface pressure) together with determining the safeties is performed in accordance with the "classic technical literature" (Niemann, Maschinenelemente I, 4th Edition, 2005). Scale graphic representation.

Sizings:

- Determine the load bearing length of the shaft or hub on the basis of target safety and
- determine the transmissible torque.

4.7 M02c Spline

For splines defined in:

- DIN 5480
- DIN 5481
- DIN 5482
- ISO 4156 (1991)
- ANSI B92.1 and ANSI B92.2 (1992)

a calculation is performed to find the load placed on the shaft and hub (surface pressure). You can also add additional standards. Toothing data is defined in the database and therefore you can make the use of in-house profiles mandatory. Use module Z09 of the gear calculation to calculate manufacturing data and tolerances. The calculation of the load placed on the shaft and hub (surface pressure) together with determining the safeties is performed in accordance with the "classic technical literature" (Niemann, Maschinenelemente I, 4th Edition, 2005).

Sizings:

- Determine the load bearing length of the shaft or hub on the basis of target safety and
- determine the transmissible torque.

4.8 M02d Polygon

For polygon shafts specified in:

- DIN 32711-1 (P3G profile)
- DIN 32712-1 (P4C profile)

a calculation is performed to find the load placed on the shaft and hub (surface pressure). You can also add additional standards. The calculation of the load placed on the shaft and hub (surface pressure) together with determining the safeties is performed either in accordance with DIN standards 32711-2 (for P3G profiles)/ DIN 32712-2 (for P4C profiles) or with the "classic technical literature" (Niemann, Maschinenelemente I, 4th Edition, 2005).

Scale graphic representation according to DIN standards

Sizings:

- Determine the load bearing length of the shaft or hub on the basis of target safety and determine the transmissible torque

4.9 M02e Woodruff key

For Woodruff keys specified in:

- DIN 6888, series A (high pinion groove)
- DIN 6888, series B (low pinion groove)

a calculation is performed to find the load placed on the shaft and hub (surface pressure). You can also add additional standards. The calculation of the load placed on the shaft and hub (surface pressure) together with determining the safeties is performed in accordance with the "classic technical literature" (Niemann, Maschinenelemente I, 4th Edition, 2005).

Sizings:

- Determine the load bearing length of the shaft or hub on the basis of target safety

4.10 M03a Pin calculation

Pin/spike connections are split into five calculations types, depending on the application case:

- Cross pin under torque
- Longitudinal pin under toque
- Guide pin under bending force
- Pin connection subjected to shearing action
- Pins in a circular layout

The calculation of the load placed on pin shaft and hub (or part) together with determining the safeties is performed in accordance with the "classic technical literature" (Niemann, Maschinenelemente I, 4th Edition, 2005), apart from pins in a circular layout.

You can select solid pins, notched pins, as well as spiral pins as specified in DIN EN ISO 8748, DIN EN ISO 8750, DIN EN ISO 8751 and spiral pins as specified in DIN EN ISO 8752, DIN EN ISO 13337 as required.

4.11 M04 Bolt calculation

The calculation permits the use of the entire scope of VDI 2230, 2003 Edition. If used together with the M04a option, you can, for example, calculate the complex examples of VDI 2230 quickly and effectively. Tables have been integrated for all the elements concerned, such as bolts specified in ISO 4762, 4017, 949 and ASME 18.2.1, standards for bores, washers, nuts etc. You can also define your own bolts with up to 8 sections, as well as hollow bolts. You can define plates, bushes, annulus segments or prismatic bodies as clamped parts. The program is able to make suggestions for the reference diameter and thread length. The default pretension force is 90% of the yield point, however, you can use the setting options to modify this. You can also perform calculations with a pre-defined starting torque or pretension force. Data is output for the state with the minimum pretension force (tightening factor 1.0), with the maximum pretension force and for the selected utilization of the yield point. The tension diagram and bolt geometry are shown as a graphic on screen and can then either be printed out or transferred to a CAD program.

4.12 M04a Eccentric clamping and load, configurations (for M04)

This in addition allows you to take into account an eccentric load and clamping. It checks for yawning in the joint. Configurations: This option also allows the input of bolt configurations with axial, transverse and bending moment loads. Minimum length of engagement and stripping strength: To determine the necessary minimum length of engagement, you can (as specified in section 5 of VDI 2330), calculate the stripping strength of bolts and nut threads whilst taking into account the nut expansion and plastic deformation.

4.13 M04b Bolt calculation at high and low temperatures (for M04)

Bolts are usually mounted at ambient temperature. However, the operating temperature has a significant influence on the pretension state of the bolt and therefore also on the safety of the connection. For example, if steel bolts are inserted into light metal materials the conditions change dramatically, even at 70 degrees! The extension to KISSsoft's bolt calculation function allows it to be used in the calculation standard specified in VDI 2230, which also calculates bolt connections for operating temperatures between -200 and +1000 degrees Celsius. You can specify different temperatures for the bolt and the clamped parts. You can also take into account the temperature-dependent changes in the Young's modulus, in the thermal expansion coefficients, in the yield point and in the pressures permitted for the materials. All the criteria for the bolt connection are checked for assembly status at ambient temperature as well as for stationary or non-stationary status at operating temperature (in accordance with VDI 2230: preload, bolt load, endurance limit and surface pressure).

4.14 M08 Welded joints

Calculation basis: DIN 18800, Part 1, November 1990 Edition, especially Section 8.4. Calculation and design of welded joints (joints with electric arc welds) with welded seam types:

- Butt seam through welded
- Double HV welded seam, counter welded
- HV welded seam, cap position counter welded/root through welded
- HY-seam with or without fillet weld, not through welded
- Double-HY-seam with or without fillet weld, not through welded
- Double-I-seam, not through welded
- Fillet weld, not through welded
- Double-fillet weld, not through welded

Input the load (normal force, shearing forces), the part safety coefficient and the weld seam boundary coefficient, integrated material database. Calculates the stresses, the weld seam boundary stress and safety.

4.15 M09a Glued and Soldered Joints

Glued joint:

Calculation basis: G. Niemann, Maschinenelemente, Volume I, 1981. The calculation of glued joints is performed for joints that are subject to shear load.

Two different load cases are described:

- Shearing force: Transmission of shearing force between two surfaces
- Torque: shaft hub joint with a torque load

The joint can be subject either to static or dynamic (usually pulsating) load. You can select adhesives (extendable database) that harden at room temperature or at higher temperatures.

Sizings:

- Sizing the adhesion width (for shaft hub), or the adhesion length (for brackets), on the basis on the strength of the underlying material. The tear resistance of the connection is set so that it corresponds to the tear resistance of the underlying material or the fatigue strength under pulsating stress of the shaft.
- Sizing the adhesion width on the basis of stress: The tear resistance of the joint is sized so that it can withstand the forces it is subjected to without compromising the specified safety.

Soldered joint

Calculation basis: G. Niemann, Maschinenelemente, Volume I, 1981. The calculation is performed for soldered joints that are subject to shear load.

Two different load cases are described:

- Shearing force: Transmission of shearing force between two surfaces
- Torque: shaft hub joint with a torque load

The joint can be subject either to static or dynamic (usually pulsating) load. You can select any material (extendable database):

- Soft solder LSn40, LSn60 for short-term loads
- Soft solder LSn40 for a permanent load
- Brass solder: Steel NE heavy metals
- New silver solder, copper: steel
- Silver solder: Steel NE heavy metals

Sizings:

- Sizing the solder width (for shaft hub), or the solder length (for brackets), on the basis on the strength of the underlying material. The tear resistance of the connection is set so that it corresponds to the tear resistance of the underlying material or the fatigue strength under pulsating stress of the shaft.
- Sizing the solder width on the basis of stress: The tear resistance of the joint is sized so that it can withstand the forces it is subjected to without compromising the specified safety.

5 Springs - F-module

5.1 F01 compression springs calculation

Calculation of cylindrical stressed compression springs, as specified in EN 13906-1. Includes the sizing (by inputting the compression forces and assembly masses) and the verification of compression springs. Database with the most important spring materials. Displays the spring characteristic line, the relaxation, the progression of relaxation over time, the progression of spring force over time and the Goodman diagram for dynamically loaded springs. Tolerances and main mass specified in DIN 2076, 2077, 2096, 2097, EN 10270-1. Integrated database with spring geometries specified in DIN 2098 sheet 1.

5.2 F02 tension spring calculation

Calculation of cylindrical tension springs in accordance with EN 13906-2. Contains the sizing (by inputting the compression forces and assembly dimensions) and the verification of tension springs. Database with the most important spring materials. Database with wire diameters as specified in DIN 2076, 2077, EN 10270-1. Display the spring characteristic line, Goodman diagram for dynamically loaded springs. Tolerances, main mass, eyes specified in DIN 2076, 2077, 2096, 2097, EN 10270-1.

5.3 F03 Leg spring calculation

Calculation of cylindrical rotating springs in accordance with EN 13906-3. Contains the sizing (by inputting the compression forces and assembly dimensions) and the verification of leg springs. Database with the most important spring materials. Database with wire diameters as specified in DIN 2076, 2077, EN 10270-1. Display the spring characteristic line. The leg can either be clamped in a fixed position, supported, tangential or bent. Tolerances specified in DIN 2076, 2077, EN 10270-1.

5.4 F04 disk spring calculation

Calculation of disk springs and spring packages as specified in DIN 2092. Contains the sizing (by inputting the compression forces and assembly dimensions) and the verification of disk springs. Database with material characteristic values and dimensions specified in DIN 2093. Display the spring characteristic line, Goodman diagram.

5.5 F05 torsion bar spring calculation

Calculation of torsion bar springs with round cross-section in accordance with DIN 2091. Contains the sizing (by inputting the torsional moments and assembly dimensions) and the verification of torsion bar springs. Material characteristic values according to DIN 17221. Main mass specified by DIN 2091. Display the spring characteristic line.

6 Gears - Z-modules

6.1 Z01 Gear - Base module

Allows to start the calculation module:

- Single gear [Z011]
- Gear pair [Z012]

Gear geometry calculation for cylindrical gears as specified in ISO 21771 (and DIN 3960)

Valid for: internal and external toothings

- Spur and helical gears, herringbone gears
- Reference profiles specified in ISO 53, DIN 867, DIN 3972 profiles I, II, III and IV, DIN 58400 and free choice (for precision mechanics: topping tools); protuberance, buckling root flank.
  - Input of hobbing cutters (specified in DIN 3972 and your own tool lists) and pinion-type cutters (specified in DIN 1825, 1826, 1828 and your own tool lists).
  - Alternatively, you can also determine the tooth form as a theoretical involute without inputting tool data
- Taking into account tip circle changes, length corrections, chamfers, tip chamfer, profile modifications, etc.
- Check for undercut, a pointed tooth, meshing interference, tip clearance, ease of assembly, tip and root form diameter, active tip and root diameter (active involutes), contact outside the meshing area, etc.
- Calculate the control measures, tooth width, tooth thickness, effective radial measurement over one and two balls, single roller and double roller dimension. The control measures are calculated separately for each lower and upper deviation.
- Optional you can also determine the tooth thickness deviation:
  - in accordance with DIN 3967 (for example, e25) (database tables installed)
  - in accordance with ISO 1328 (for example, GJ)(1980 edition, these details are not included in the current edition)
  - in accordance with ISO 23509 (for bevel gears)
  - in accordance with DIN 58405 (e.g. 8g) for precision mechanics (database tables installed)

- from the target circumferential backlash or from the normal backlash

- You can also create your own tooth thickness allowance tables. These tables are then processed automatically by the program.
- For precision mechanics: tip circle (with tolerances) for a topping tool
- Calculate the circumferential backlash (and normal backlash) of the gear pair whilst taking into account tooth thickness deviations and centre distance tolerance.
- Calculate all relevant values, such as contact ratio, specific sliding etc.
- Calculate and check the effective contact ratios and root diameters (taking into account the tooth thickness deviation); calculate all the important data for the smallest centre distance and greatest tooth thickness, as well as for the greatest centre distance and smallest tooth thickness
- Angles can be input either as decimal numbers with decimal points or with minutes and seconds.
- Modules can be input either in mm or as diametral pitch or transverse diametral pitch, transverse or normal pitch.
- Different toothing qualities for individual gears.
- Increase the interval for permitted profile shifts: you can use this authorization to significantly increase the bandwidth of the usual permitted profile shifts. This is very useful for special cases.
- You can also calculate power loss, moment of inertia and weight for all types of strength calculations (for cylindrical gears, bevel gears, worm gears).

Materials and reference profiles are taken from the database

You can define any number of different materials and reference profiles in special data base entries. At present, the system is shipped with approximately 220 different materials and a wide and varied range of reference profile, hobbing cutter and pinion-type cutter lists. All the hardening techniques specified in DIN 3990 are taken into account. KISSsoft also supports the use of stainless steels, aluminum, bronzes etc. Plastics with module Z14.

6.2 Z01x extension of cylindrical gear geometry

Extension for calculation modules: Z011, Z012, Z013, Z014, Z015, Z016

Profile shift layout (optimum area, balanced sliding etc.). Deer and stub toothing, topping tool. Special report with all manufacturing tolerances ISO 1328, DIN 3961, AGMA 2015, AGMA 2001, DIN 58405, BS 436; Calculate tolerances/deviations from measured values

Preliminary treatment tool and input for preliminary treatment: Input the preliminary treatment tool with grinding allowance, along with the grinding wheel (tip rounding and grinding depth: up to the form diameter or active tip and root diameters, or own input). All the control measures for preliminary and final treatments, the tooth form for preliminary and final treatment, the grinding notch (if one is produced and if this reduces the strength for the strength calculation as specified in ISO6336 or DIN3990) are calculated and documented. Manufacturing processes involving more than two processing steps (for example, two cutting processes plus a grinding process) are performed with authorization Z051.

Define form diameters from the tooth form: The tip and root form diameters are usually calculated according to the theoretical equations in ISO21771. However, this does not take into account the effective undercut. If you activate the "Calculate tip and/or root form diameter from tooth form" option, the form diameter is determined on the basis of the effective tooth form. In the case of toothing with an undercut, this option determines the starting point of the undercut and includes it in the calculation used to determine the transverse contact ratio etc.

NOTE:

In the case of toothing with profile modifications, the starting point of the correction is displayed, to allow the transverse contact ratio to be displayed as being too small.

Determine the tooth thickness in any diameter: Report of tooth thickness (chord and arc with deviation) at any diameter.

6.3 Z19h Sizing of deep toothing

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Special reference profiles with larger addendums and dedendums are used for deep toothing. This sizing function calculates the required standard basic rack tooth profile on the basis of the required transverse contact ratio. If this function is active in gear fine sizing, the reference profile for every solution is calculated so that precisely the target transverse contact ratio is achieved.

6.4 Z15 Calculate the details used to modify the profile of cylindrical gears

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Calculation of points A to E along the path of contact with the corresponding involute lengths. Output the diameter, radii, involutes and pitch lengths for the involute test diagram (for the gear and its paired opposing gear). Input all reference values in accordance with the different methods used to calculate tip relief. KISSsoft proposes a tool that can be used to generate the profile modification. You can get the data in the tooth form calculation. Short or long correction length, tip and/or root relief, specify the load for which the sizing is to be calculated.

6.5 Z19a Calculation with operating center distance and profile shift according to manufacture

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

The cylindrical gear specified in ISO 21771 or DIN 3960 is based on the calculation of a (theoretical) backlash-free meshing. This enables the total addendum modifications for the individual gears over the centre distance to be specified. With this authorization, you can input the profile shifts independently of the center distance. This is very useful as it provides a way to check the limits of a toothing (backlash, contact ratio etc.) if there are major variations in the center distance (e.g. in the case of large center distance tolerance zones).

6.6 Z19d Optimize axis centre distance with respect to balanced sliding

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Optimize axis center distance with respect to balanced sliding: For a specified addendum modification of a (selectable) gear, this authorization calculates the axis center distance in such a way as to balance gear pair specific sliding (for cylindrical gears).

6.7 Z19e Representation of specific sliding

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016, Z070

The progression of specific sliding (sliding speed and tangential speed) during the meshing can be shown as a graphic. The calculation is performed for involute cylindrical gear toothing. This shows specific sliding for the smallest centre distance and greatest tooth thickness, as well as for the largest centre distance and smallest tooth thickness.

(See authorization Z27 for details on how to calculate specific sliding and the sliding movements for any tooth form and involute gears with profile modifications.)

6.8 Z19f suggestion of sensible lead corrections

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

For calculations specified in ISO (Z02a) or DIN (Z02).

The ISO 6336 or DIN 3990 standards assume that flank line corrections are performed in a reasonable manner. This additional program generates reasonable sizings for lead corrections as specified in ISO 6336.

6.9 Z19l Conversion of profile shift coefficient and tooth thickness deviation

Extension for calculation modules: Z011, Z012, Z013, Z014, Z015, Z016, Z080, Z170, Z09A

With this authorization, KISSsoft can convert the profile shift coefficient from the base tangent length, measurement over balls etc. The tooth thickness deviation can also be converted in the tolerance screen.

6.10 Z19n Profile and tooth trace diagrams }

Extension for calculation modules: Z011, Z012, Z013, Z014, Z015, Z016, Z080, Z170, Z09A

Use this authorization to display profile and tooth trace diagrams.

6.11 Z02 Strength calculation as specified in DIN 3990

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

According to DIN 3990, December 1987 edition (most recent, valid edition)

Comprehensive, very detailed calculation using the most precise methods (method B) with the option of influencing all the most critical values.

You can also use method DIN 3990, Part 41, for vehicle gears.

Calculate general influencing values (DIN 3990, Part 1) with dynamic and face load factors and transverse coefficients:

- Face load factor for cylindrical gear pairs according to method C2 with: Load configurations shown as graphics when selected
  - Optionally taking into account the support effect and contact pattern check.
  - Load coefficients for planetary stages in accordance with method C1.
  - Load coefficients according to method B by the exact verification of production errors as the result of deformation with shaft calculation (authorization W10)
- Calculate tooth flank-load capacity (micro pitting; DIN 3990, Part 2) according to method B.
- Calculate root-load capacity (DIN 3990, Part 3) according to method B, tooth form- and stress correction factor, optionally also using method C.
- Calculate scuffing safety (DIN 3990, Part 4) with both calculation procedures (flash temperature and integral temperature criterion) according to method B.
- Materials specified in DIN 3990, Part 5
- Taking into account the influence of grinding notches. Here, you input the relationship tg/ρg (tg: depth of grinding notch, ρg: radius of grinding notch) in accordance with the Figure in DIN3990, Part 3, Chapter.4.4 or ISO6336, Part 3, Fig.33. This calculates Yg' (factor, which is multiplied with YS). If you input the preliminary and finishing tools, tg/ρg is calculated automatically.

6.12 Z02a Strength calculation as specified in ISO 6336

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

The ISO 6336 standard for calculating the strength of cylindrical gears first appeared in 1996. The current edition, ISO 6336:2006, includes useful innovations. The calculation includes all the general factors (Part 1), flank safety (Part 2), root safety (Part 3), materials (Part 5) and scuffing safety (as specified in DIN 3990-4) Grinding notches are taken into account as specified in DIN 3990, (Z02). ISO 6336 corresponds to a great extent to DIN 3990. However, it does have a few significant differences (primarily in the endurance limit range).

Calculate the internal temperature and the flash temperature as specified in ISO TR 13989-1 and ISO TR 13989-2

Corrigendum ISO6336-2 (2008): A different helix angle factor Zβ can be selected if required.

6.13 Z02x Static strength of the tooth root

Prerequisite: authorization Z2 or Z2a or Z13 or Z14

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Calculate the tooth root static strength of cylindrical gears

Define the tooth root stress (with and without stress correction factor YS) as specified in ISO6336, calculate safety against overload failure and against persistent deformation (yield point). For metallic materials and for plastics (tensile strength and yield point depending on temperature)

6.14 Z13 Calculation using the AGMA standard (USA standard)

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Calculation using a wide range of AGMA standards:

You can use either the USA standards 2001-B88, 2001-C95, 2001-D04 (all in imperial units of measurement) and 2101-D04 (metric units of measurement) to calculate the strength of cylindrical gears. The standard implemented in its complete form and the dynamic factor and the face load coefficient are calculated in accordance with AGMA recommendations. You can also input your own coefficients. The geometry factors (for tooth root and flank) are calculated entirely in accordance with ANSI/AGMA 908-B89. In addition to all the relevant intermediate results, the following values are also supplied: Pitting Resistance Power Rating, Contact Load Factor, Bending Strength Power Rating, Unit Load for Bending Strength, Service Factor. This calculation can also be used for every other cylindrical gear configuration (including planetary stages). However, it is worth noting that AGMA Directives do not permit the calculation of tooth root strength in internal gear pairs.

However, authorization Z19i (graphical method) does allow this to be calculated.

The strength calculation specified in AGMA6004-F88 can be used for open gear rims (for example, cement mills).

Tooth form factor Y must be calculated in accordance with AGMA 908 for each type and degree of accuracy of toothing for tip load (application of force at tip) or for HPSTC (application of force at HPSTC). HPSTC is used in calculations for spur gears of high quality, otherwise, the tip load is used. However, if required, this can be overridden and you can use either tip load or HPSTC for the calculations.

6.15 Z13b Calculation in accordance with AGMA 6011/AGMA 6014 (US norm)

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

- Strength calculation as defined in AGMA 6011-I (for turbo drives).
- Strength calculation as defined in AGMA6014-A06 (for large, open gear rings). AGMA6014 replaces AGMA6004-F88.

6.16 Z02b Strength calculation as specified in BV RINA

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Strength calculation of cylindrical gears. Special calculation method for marine applications (primarily for France and Italy), similar to ISO 6336 with a few additions. Special documentation is available on request.

6.17 Z10 Cylindrical gear calculation using the FVA method

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Gear strength is calculated using the gear calculation programs developed by the Forschungsvereinigung Antriebstechnik (Germany). The calculations are performed on the basis of DIN 3990, and take into account all the variations. Therefore this option achieves exactly the same results as those given by the FVA program. FVA is used as a reference program. If problems arise when comparing calculations performed using different programs, you can use the calculation with the FVA program as a reference.

6.18 Z14 Plastic gears

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Calculate tooth root and tooth flank safeties for cylindrical gears made of plastic modified in accordance with VDI 2545, VDI 2545 modified or as specified by G. Niemann, Machine elements III, 1985. Differences between the calculation methods are detailed in the KISSsoft Help.

The calculation methods used for plastics pay particular attention to the fact that these materials are very sensitive to extremes of temperature. The types of lubrication used here include oil, grease or none at all (dry run).

The calculation method defines the local temperature at the tooth flank and at the tooth root, and uses these values to determine the permitted loads depending on the number of load cycles. The calculation is performed for combinations of plastic/plastic and also steel/plastic. The acceptable deformation (tooth deformation) is also checked.

The KISSsoft database includes all the materials documented in VDI 2545:

- Molded laminated wood
- Laminated fabric
- Polyamide (PA12, PA66)
- Polyoxymethylene (POM)
- Materials with data from different manufacturers, such as PEEK (made by Victrex) or LUBRICOMP UCL-4036A HS (from SABIC Innovative Plastic) are added on an on-going basis. The corresponding material data is based on manufacturer measurements. As a result, data may not be present for specific calculation methods and therefore not all calculations can be performed.

All specific properties of a particular material are stored in text tables (material-strength depending on temperature and number of load cycles). You can easily add your own material data to these tables.

If you know the wear values of a particular plastic, you can also calculate the service life with regard to wear. This can be added to the tooth flank safety specified in VDI 2545 or used as a replacement value if the Wöhler lines for permitted Hertzian pressure are not known.

6.19 Z19i Tooth form factor calculation using the graphical method

Prerequisite: authorization Z2 or Z2a or Z13 or Z14

Extension for calculation modules: Z012, Z013, Z014, Z015, Z01

As defined in ISO 6336 or DIN 3990, the tooth form and the stress correction coefficient are calculate at the tangent point of the root at which the tangent and the tooth centre line form an angle of 30°. However, it is generally acknowledged that this method is rather imprecise, for special forms (for example, deep toothings or gears with pressure angles that vary greatly from 20°). According to Obsieger (Konstruktion 32 (1980) pages 443-447), there is a more precise approach in which the product of the tooth form factor and the stress correction factor is calculated for all points in the whole root area, based on the specific tooth form generated by the defined manufacturing process. This maximum value is then used in calculating the strength.

AGMA provides a method for calculating tooth form factor Y in external gears. No calculation methods are available for internal gears. As specified in AGMA, internal gears can only be calculated using the graphical method. Here, the exact tooth form must be described and the fundamental values measured (root radius etc.) KISSsoft can now calculate these values. To do this, the program first calculates the tooth form and from this, then automatically defines the required parameters (tooth radius, lever arm, root width). A better method than that used in the AGMA proposal is then used to determine tooth form factor Y and stress correction factor Kf. As in the Obsieger procedure, the point on the tooth root where the factor I(=Y/Kf*..) is at a minimum is defined. It is at this point that the greatest stress occurs.

This is the recommended method, particularly for unusual tooth forms and internal toothings (for verifications specified by AGMA and DIN). If required, this calculation procedure can also be applied in strength calculations as defined in ISO 6336, DIN 3990, AGMA 2001 or AGMA 2101 and VDI 2545 (plastics) DIN 3990, as well as in fine sizing (Z4a).

6.20 Z19m Flash temperature progression

Prerequisite: authorization Z2 or Z2a or Z13 or Z14

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Display the flash temperature progression during meshing as specified in DIN 3990-4.

6.21 Z01a Planets, 3 and 4 gear

Use this to start the calculation module:

- Planetary gear (sun, planet, rim) [Z014]
- 3 gears [Z015]: power distribution level or position of contact (pinion, idler gear/idler gears, gear)

- 4 gears [Z016]: dual position of contact (pinion, idler gear/idler gears I, idler gear/ gears II, gear)

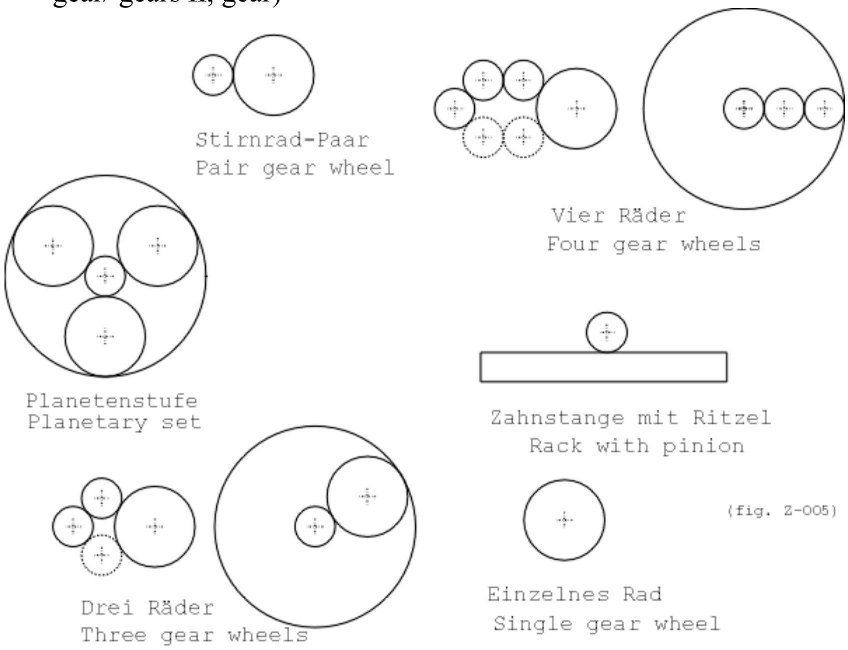

Figure 1.3: Gear configurations

The input interface has been modified to suit the appropriate configuration, as is the output. In the program, the calculation is performed for each individual pair of gears. This process also checks configuration-specific problems. For example, if you input the number of planets, the program checks whether the planets will interfere. The overall backlash of the sun to the planet carrier is also calculated for planetary stages. In strength calculations, the method takes into account notes about the selected calculation method (for example, when calculating the dynamic factor and the face load factor, the special information provided in ISO 6336 or DIN 3990 for planetary stages or for idler gears is used)

The 2D display (authorization Z05) shows the individual meshing. The 3D display (authorization Z05x) shows the configuration with all the gears (only one strand is shown for 3 gear and 4 gear configurations).

You can also switch the check for possibility of mounting of the planets on and off (if the planet center points have distributed evenly). If you deactivate this check, authorization Z19g can be used to calculate the centre points. You can define any combination of speeds for a planetary configuration (you can pre-define 2 of the 3 speeds: speeds of sun planet carrier, and rim)

6.22 Z19g Calculate the center points of planets or idler gears

Prerequisite: authorization Z1a

For planetary gears: calculate the centre points of planetary gears to see how the planets can be assembled (this is very important, if the planets cannot be arranged in an even distribution because of the restrictions imposed by the number of gear teeth).

For gear wheel chains (3 gear): input the required distance between the first and the last gear in the chain to define either its position or the position of the idler gears (taking into account the practical aspects of assembly).

6.23 Z01b Rack

Allows to start the calculation module: Pinion-Rack [Z013]

The input interface is modified to suit the rack-pinion configuration. Input the rack height. Input the distance from the pinion centre to the rack as the "centre distance". You can then input the over-rolled rack length to determine the number of load cycles on one tooth of the rack when calculating the strength. The strength calculation for a rack is performed as specified in ISO, AGMA or DIN for an internal gear with an extremely large number of teeth. The correct dimension center to ball is calculated for the rack.

6.24 Z03 Cylindrical gear-Rough sizing

Prerequisite: authorization Z2 or Z2a or Z13 or Z14

Extension for calculation modules: Z012, Z014

Rough sizing automatically defines the most important tooth parameters (center distance, module, number of teeth, width) from the power that is to be transmitted and the subsecuent required transmission ratio with optimization based on the strength calculation program.You can specify the target safety factors. Input intervals for b/mn, b/a, or b/d ratios to limit the data to focus on the solution you require.

You can use either the ISO, AGMA or DIN calculation methods here, or VDI 2545 for plastics. The result of this is a list of solutions that display the possible centre distances, tooth widths and module range. You can then either extend or reduce this list, if you want to display more, or fewer individual results for each solution. The total weight of a solution is also displayed. Where the strength values are the same, this data is useful for seeing which solutions are more cost-effective or more expensive.

The aim of rough sizing is to show possible solutions to a drive problem. You can select a solution and transfer it to the basis window where you can check and refine it. As long as the rough sizing window remains open, you can access alternative solutions at any time.

6.25 Z04 Cylindrical gear-Fine sizing

Extension for calculation modules: Z012, Z014, Z015

This is a very powerful tool that can be used to find the best variants for cylindrical gear stages under pre-defined constraints.

If you input a nominal ratio, a centre distance and an interval for the KISSsoft module, the system calculates and displays all the possible suggestions for the number of teeth, module, helix angle and profile shift. It also shows the deviation from the nominal ratio, the specific sliding and the contact ratio.

It also provides variant options for the helix angle, the pressure angle and the centre distance.

For planetary gears or cylindrical gears that have an idler gear, you can:

- perform the calculation either with the pre-defined centre distance or with the pre-defined internal gear reference diameter.

For cylindrical gear stages, you can:

- either specify a fixed centre distance or an interval.

All the variants KISSsoft finds are then output in a list, classified by a large range of criteria (generation of vibrations, precision of conversion, weight, strength, variation in tooth contact stiffness etc.). If necessary, you can also limit the critical parameters (tip circle, root diameter, minimum number of teeth, reject variants with specific sliding 3.0 etc.)

The overall evaluation criterion ("evaluation") that can be set using parameters, allows you to find the "optimum" variant. All variants (results) are shown in a list. You can either expand or reduce the scope of the list, if you want to display more or fewer individual results for each specific solution.

You can select a solution and transfer it to the basis window where you can check and refine it. As long as the fine sizing window remains open, you can access alternative solutions at any time.

Graphical display of results as in Figure Graphics for fine sizing on page I-66.

6.26 Z04a Additional strength calculation of all variants

Prerequisite: authorization Z4

Prerequisite: authorization Z2 or Z2a or Z13 or Z14

KISSsoft also calculates the strength (tooth root, flank and scuffing) for every proposed variant at the same time as it calculates the geometry variants and outputs this as a printed list. If you have the appropriate authorizations you can also define the angle of rotation error (transmission error), the wear, the transverse contact under load and the variation in bearing forces by verifying the path of contact under load for each geometry variant. It is very useful to display this data as a graphic where you can vary the data in order to find the optimum solution. In the example, the color scale used in the figure clearly shows the tooth root safety as the X axis, flank safety as the Y axis and the module. This highlights how the root safety increases for larger modules (all the solutions displayed here have the same face width and center distance).

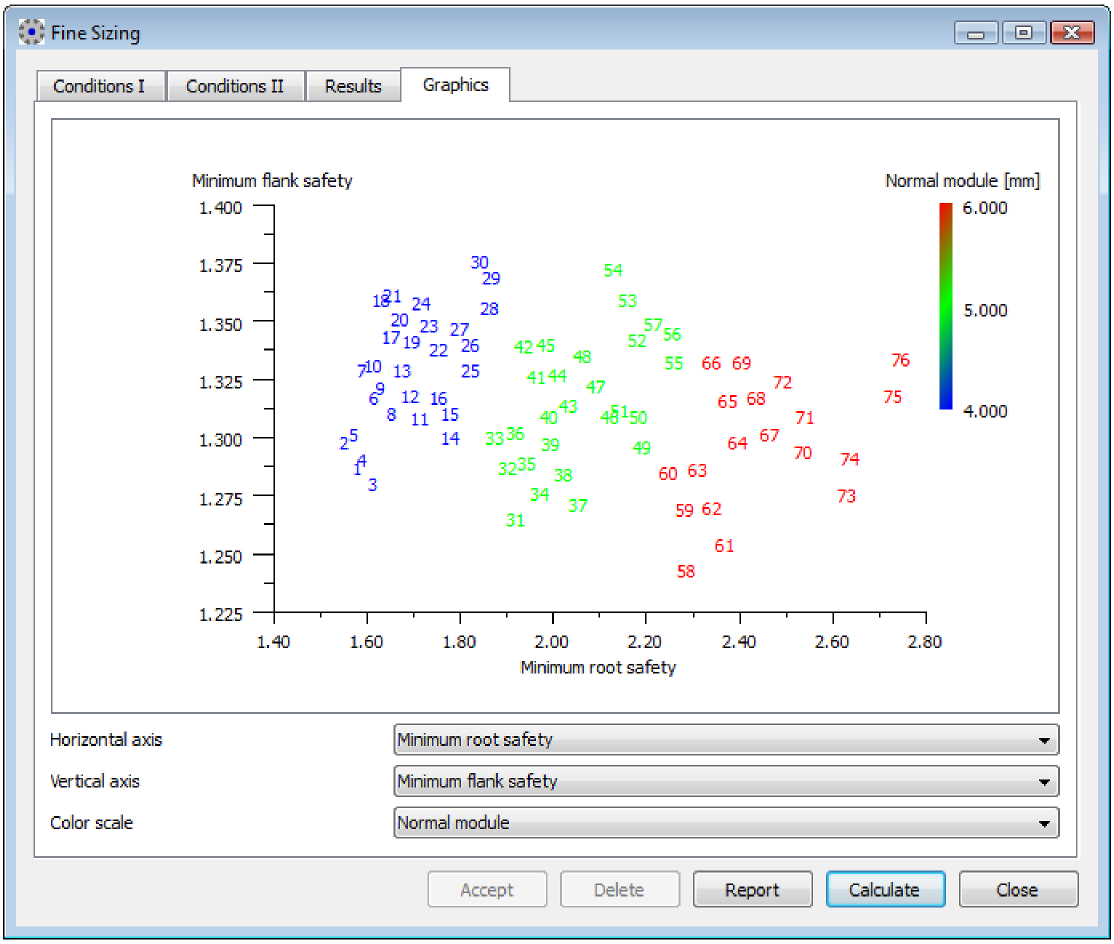

Figure 1.4: Graphics in fine sizing

6.27 Z05 Tooth form calculation and display

For all gear types except:

- Bevel gears: tooth form is calculated on the basis of equivalent spur gear.
- Hypoid gears: no tooth form calculation.
- Spiral-toothed gear wheels: gear pair not shown in a 2D display (geometry) for shaft angles <> 90°.

- Exact calculation of the tooth form, taking into account the manufacturing process: hob, rack-shaped cutter or pinion type cutter.
- With pre-defined tolerances for tooth thickness and tip/root diameter.

- Gear view: Graphic representation of the gears in transverse and axis section.
- Checking the practicality of manufacture (usable involute etc.): Precise checks to see whether the intermeshing can be manufactured using the selected tool.
- Display the tooth form in 2D on screen. You can display the gears either individually or in a pair here. Transfer the tooth form (of one or more teeth) and the gear view in face and axial section to CAD systems, if the corresponding options (K05a etc.) are present.

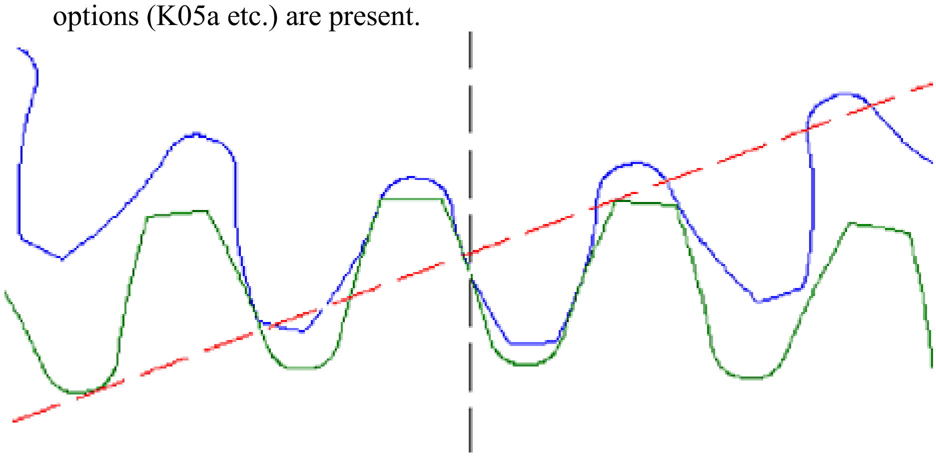

Figure 1.5: Tooth form of a cylindrical gear pair in 2D

- Graphical display of the manufacturing process.

This module is especially useful in the manufacture of internal gears because it calculates the entire manufacturing process along with all the checks on impacts, reduction of the contact ratio, start and end of the involute on the tooth, etc.

Display gears in 3D on screen. Use the corresponding options (K05G etc.) to transfer 3D solids to CAD systems or via 3D interfaces.

6.28 Z05x Animate the 2D display

Extension for option: Z05

By turning the gear step-by-step on screen, you can monitor how the gear pair is meshing and also simulate the production process. The measuring functions integrated in the graphics allow you to determine distances and angles. You can also rotate the gears relative to each other. An additional memory function allows you to compare different variants or modifications. If necessary, you can also display the measuring ball for spur gears, worm gears and worms in normal section in the graphic.

6.29 Z05a Input any tool or tooth form

Extension for calculation modules: Z011, Z012, Z013, Z014, Z015, Z016, Z070, Z080, Z170, Z09A

If you cannot input special tools (hobbing cutters or pinion-type cutters) in the input screen provided for them, you can import them from a DXF file and then use this data to calculate the tooth form. Alternatively, you can also import the tooth form directly from a DXF file.

The tooth form that is generated or imported in this manner can then be used in all the calculation options that reference data directly from the tooth form (for example, Z24, Z25, Z26 und Z27) and used to analyze the behavior of the geometry and strengths.

6.30 Z05c Reference profile calculation for gears with involutes or special profiles

Extension for calculation modules: Z011, Z012, Z013, Z014, Z015, Z016, Z070, Z080, Z170, Z09A

You can calculate the appropriate gear-reference profile (in transverse section) of any tooth form (involute and non-involute). The profile can then also be displayed in a normal section. This is usually used to calculate the tool profile for an arbitrary tooth form. This tooth profile can then be used to manufacture the gear in the generating process.

The calculation process first defines the reference profile (= tool) and then generates the tooth form again for the tool that was defined in this manner. In the graphic, you can then see the original tooth form and, once again, the tooth form generated with this tool. If there are differences between these two tooth forms, this means either that the required tooth form cannot be manufactured in this generating process or that an incorrect manufacturing operating pitch diameter has been predefined.

6.31 Z05d Calculate the tooth form from the paired gear (generate with other gear in the pair)

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

When calculating the tooth form from the other gear in the pair, the gear pair is defined with the number of teeth etc. in the cylindrical gear input. Here, gear 1 is the generating gear ("paired gear") and gear 2 is the gear whose tooth form is generated from gear 1 by the generating process. The tooth form from the opposing gear is calculated automatically in two steps:

1. Step: calculate the tooth form of the gear to be generated. To do this, KISSsoft calculates generating gear 1 by increasing the tooth contour by the allowance of gear 2. Gear 1 is then used as the pinion type cutter to generate gear 2. A useable intermeshing always requires a certain amount of tip clearance. To achieve this, the tip circle of the pinion type cutter (gear 1) is increased. You can input the required tip clearance c. The tip circle of gear 1 is then increased by 2*c. A usual amount is c = 0.2 * mn. The tip is also rounded off with the optimum value for the radius. The calculation of gear 2 achieves the corresponding root clearance and an optimum root rounding.
2. Step: Calculate gear 2 without allowance (the allowance was already taken into account in step 1) with the tool defined in step 1. This gives the effective tooth form for gear 1 and gear 2.

6.32 Z05e Addition for mold making

Extension for option: Z05

Calculate the tooth form, taking into account the:

- Target total deviation of tooth thickness
- Radial elongation (tooth tip and root)
- Tangential elongation (tooth thickness)
- Inlay body made of steel

The contour calculated using this method gives the contour of the injection molding mold. Calculate the electrodes used to manufacture the mold.

- Calculation as before, but this time taking into account the spark gap
- With option Z05c you can also calculate the hob used to manufacture the electrode if necessary.

6.33 Z05f Arc shaped tip relief

Extension for option: Z05

A tip relief that passes into the involute tangentially is applied to the tooth tip starting from the specific diameter. This tip relief consists of three arcs. The bend in the curve increases from arc to arc so that the final curve is tangential to the tip circle. This modified tooth form (also called a hybrid tooth) has significant benefits, because it permits extremely quiet running despite relatively imprecise production methods. For this reason the modification is applied for plastic products, for preference. An tip relief is usually only applied to deep toothing with transverse contact ratios of greater than 2.1. Tip modification of the calculated gear with: no tip modification, tip chamfer, tip relief from arc (as stated by H. Hirn), tip relief with progressive profile modification and tip rounding, linear profile correction, progressive profile correction. Use factors to set the tip modification progression. In addition, KISSsoft can use its sizing function to suggest a suitable starting point (diameter) for the tip relief and the tip relief value. To do this, it uses the profile modification calculation (Z01x).

6.34 Z05g Optimum tooth root rounding

Extension for option: Z05

The tooth root created on the basis of the selected tool may not necessarily have the best possible rounding. If the radius of the root is too small, this may lead to the notch effect being too high and therefore reduce the strength of the tooth root. For this reason, option Z05g calculates an ellipse in the root area, starting from a defined diameter (usually the active root diameter). This ellipse has the largest possible tooth root radius. The system then modifies the tooth form accordingly. You can also add a definable length on the tooth root diameter. This is useful for specific purposes, for example, to install measuring pins correctly. You can use this option for the following purposes:

1. If you want to erode the tooth form, the root form should be manufactured to be as strong as possible.
2. if you want to hob the gear and size the best possible tool for this. In this case, you must activate this option and also calculate the intermeshing reference profile from the tooth form (Z05c) to manufacture the required tool.

Checking with strength calculation: Optimized root rounding can be included in the strength calculation if you select the "Tooth form calculation using graphical method" variant when selecting the calculation settings. The sizing function in the input window prompts the root diameters as suggestions for the start of the modification. 0.02 * module is suggested as the arc length.

6.35 Z05h Cycloid and circular arc toothings

Extension for calculation modules: Z011 to Z016, Z070, Z09A, Z170

Input cycloid and circular arc toothings (cylindrical gears) as involute cylindrical gears in the KISSsoft base screen. In the tooth form calculation, they can then be defined as the flank forms "Cycloid" or "Circular arc" with the corresponding data. The following applies to all non-involute (or modified involute) tooth forms: the effective path of contact is defined (by simulating the generating process) on the basis of the tooth form (with option Z24).

You can use the data defined in this manner to calculate:

- Transmission errors, temporary transmission changes, temporary power loss etc. (with option Z24)
- Lubrication gap EHD and flash temperature (with option Z30)
- Wear (with option Z31)
- Sliding velocity, specific sliding (with option Z27)
- Hertzian pressure and tooth root stress (with option Z25)

6.36 Z05i Circular arcs approximation

Extension for option: Z05

Convert tooth flank into circular arcs. You can specify the degree of accuracy. Several eroding machines find it difficult to process polylines. You can help them by outputting the data as circular arcs.

6.37 Z05j Display collisions in the meshing (cylindrical gears)

Extension for option: Z05; for calculation modules: Z012 to Z016

When rolling off two gears (in the graphical display) you can activate the collision check option. In the graphic, this shows (with squares) the points where the gears touch or where collisions may occur.

shown in brown: touch (between 0.005 * module distance and 0.001 * module penetration)

shown in red: collision (greater than 0.001 * module penetration)

The system identifies and marks collisions in all the meshing teeth. This option is particularly useful for analyzing the generation of non-involute tooth forms or measured tooth forms (using a 3D measuring machine) with a theoretical single flank check.

6.38 Z05k Display collisions in the meshing (worms/spiral-toothed gears)

Extension for option: Z05; for calculation module: Z170

Same function as Z05j.

6.39 Z05l Using the same tool multiple times

Extension for all calculation modules:

Use this option to use the same tool type more than once.

Example application: In large-scale production runs, a roughing hob (usually with another pressure angle and module) is often used, followed by a fine hob and then the grinding or honing process.

6.40 Z05m Non-symmetrical gears

Extension for calculation module: Z012

Use this to import and process non-symmetrical gears.

(Still in development)

6.41 Z05n Straight line flank

Extension for calculation modules: Z011 to Z016, Z070, Z09A, Z170

Input straight line flank (cylindrical gears) as involute cylindrical gears in the KISSsoft base screen. As part of the tooth form calculation you can then define the flank shape as "straight line" using the appropriate data.

The "straight line flank" form is primarily used for spline profiles as defined in DIN 5481.

6.42 Z19k Lubrication gap EHD/ Scoring

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Prerequisite: authorization Z2 or Z2a or Z13

As specified in AGMA925, you can use this calculation module to define the probability of scuffing and wear as well as susceptibility to micropitting. AGMA925-A03 the "Effect of Lubricant on Gear Surface Distress" describes the situation in the lubrication gap during the meshing. AGMA925 defines how to calculate the lubrication gap height whilst taking into account the flank curvature, lubricant properties, sliding speed and the local Hertzian stress

Graphical display of results and comprehensive report.

6.43 Z23 Calculate the tooth root load capacity of internal gears with the influence of the ring gear in accordance with VDI 2737 and calculate the deformation of gear rings

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

VDI 2737 fulfils the following task:

The usual proof of tooth root load capacity for cylindrical gears requires a fundamental addition when internal gears are involved. In most cases, a significant gear rim stress value is usually present. This can have a critical effect on load capacity. Fractures can run both through the tooth root ("thick" gear rims) and also through the gear rim ("thin" gear rims).

This guideline also takes into account the stress on the gear rim and the influences associated with this. Here, the crucial aspects are the determination and evaluation of local strain in the tooth root. This starts from the basic structure and basic equations detailed in DIN 3990 or ISO 6336 and defines the calculation of the strain that runs outwards from the area of the tooth root transition curve for the tooth root or the gear rim transverse section.

Calculate deformation:

If, for design reasons, the gear rims of hollow gears must be made relatively thin, they may be deformed significantly by the meshing forces. This program calculates the bending and tangential stress along with the radial deformation for the conditions at the tooth contact point and in the middle between these points of contact (of two neighboring planetary stages).

6.44 Z24 Meshing stiffness of the gear pair and transmission error

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Prerequisite: authorization Z32

Calculation of the meshing under load whilst taking into account tooth deformation and determination of the transmission error.

The different positions of the teeth to each other and the shape of the teeth have a constant and changing effect on tooth contact stiffness during rolling. The progression of the meshing stiffness of a pair of gears is calculated on the basis of the effective tooth form and displayed as a graphic. Taking into account tooth deformation, gear body deformation and Hertzian flattening(calculation as stated by D. Petersen, Diss, Braunschweig (Prof. Roth), 1989). The average change in stiffness (variance) is also calculated. This value is important for evaluating the generation of vibration. The more the stiffness changes, the greater the transmission error and the more vibrations are generated. These are then transferred along the shaft and generate noise in the shaft and housing. This calculation is also integrated as part of fine sizing. Here the variance of stiffness is output for each variant.

6.45 Z25 Graphical representation of Hertzian flattening and tooth root strain along the actual tooth form

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Prerequisite: authorization Z32

Representation of Hertzian pressure and tooth root strain using the effective tooth form:

The effective path of contact of two gears with any tooth form (calculated or imported; involute, cycloid or circular pitch) is calculated and displayed. To do this, the system calculates the progression of Hertzian flattening pressure as well as the tooth root strain, and displays this as a graphic.

In addition, the system displays the progression of normal force and torque on both gears, as well as, assuming a two-sided, symmetrical bearing layout, the progression of the size and the direction of the force to which the bearing is subjected.

Both the amount and changes in direction to the bearing force can generate vibrations in the bearing, which are then transmitted to the housing.

Furthermore, the Hertzian pressure, the normal force curve and the tooth root stress can be represented on the tooth as stress distribution.

6.46 Z26 Displacement volumes for gear pumps

Automatic calculation of the displacement volume (however without taking into account loss due to reflows in pinched volumes) (select under Settings) due to the effective tooth form and printed out in the report. This also includes the calculation function used in fine sizing (Z04).

6.47 Z26a Additional option for gear pumps Z26

Prerequisite: authorization Z24

For cylindrical gears: gear pairs (authorization Z01)

Restriction: only for cylindrical gears

You can use this option to perform an extremely detailed analysis of gear pumps. Calculation for external gear pumps and for internal gear pumps (with or without round ended sunk key). This calculation allows you to analyze any type of cylindrical gear with involute and non-involute teeth forms. As a result, you can also verify the internal gear pumps of the "Gerotor" construction type. The system calculates and displays the changes to the critical parameters of a pump that occur during meshing. These include geometric parameters such as the pinched volume (between two meshed tooth pairs, reflow volume), the volume with a critical inflow area (if possible, the flow of oil should be kept constant), the smallest gap (minimum distance between the first tooth pair without contact), inflow speed, oil inflow at the entry point (with Fourier analysis to evaluate the noise levels), volume under pressure at input. Other important information is the progression of torque on the two gears, the progression of the Hertzian pressure sigH, the sliding velocity vg and the wear value sigH*vg. The Hertzian flattening can be included when calculating forces because this effect has a significant influence. The pinched volume depends on how the pump construction functions under input or output pressure. This is defined by the appropriate input value and has a considerable effect on the torque curve.

The pinched volume depends on how the pump construction functions. Either if it is insulated (enclosed) or has pressure relief grooves under input or output pressure. This is defined by the appropriate input value and has a considerable effect on the torque curve. When the pinched volume is reduced, you see a significant momentary increase in pressure in this volume. This produces strong pulsing forces on the bearings and therefore generates noise. A pressure relief groove must be installed to avoid this increase in pressure. For this reason, it is very useful to calculate and display the pressure flow in the pinched volume.

6.48 Z27 Kinematics based on the actual tooth form

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Prerequisite: authorization Z32

Calculate and display the progression of sliding velocity, of specific sliding and the sliding factors of two arbitrary gears or whilst simulating the gear manufacturing process. In contrast to option Z19e, this calculation is generally applicable because it includes all the profile modifications and is also well suited to defining the sliding conditions of cycloid gears.

6.49 Z29 Layout and checking of master gears

Extension for calculation modules: Z011 to Z016, Z170

To perform a double flank test, you require one master gear which is then rotated on a test device together with the gear you want to test. After you have calculated a gear, you can start this master gear sizing option. When you start this option, the system prompts you with a suitable standard master gear as defined in DIN 3970. With this option you can check whether an existing master gear can be used. You can also size a master gear so that it can be used as the optimum gear to check a test gear. This module is available for cylindrical and worm gears that have more than 6 teeth.

6.50 Z30 Micropitting (frosting) and flash temperature

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Prerequisite: authorization Z2 or Z2a or Z13, Z24, Z25, Z26

Calculate the local lubrication gap (thickness h) during meshing and the local flash temperature using one of two methods:

- Draft ISO TR 15144
- AGMA 925

Both methods are based on Blok's theory and deliver similar results. The calculation is based on calculating meshing under load and uses the local parameters for sliding and rolling speed, Hertzian pressure, line load and bending radii that result from this calculation. The gap height and minimum gap height are shown as a graphic.

Calculate specific lubrication film thickness λGF as specified in ISO TR 15144 with the graphical display and output of the specific lubrication film thickness λGFmin. The specific lubrication film thickness λ is required to determine the risk of micropitting.

This is calculated if the lubricant's load stage for micropitting as specified in FVA info sheet 54/7 (C-/8.3/90 test) is known. Safety against micropitting is then shown as a 2D diagram (middle of the facewidth) and in a 3D diagram (by the path of contact and the facewidth).

6.51 Z31 Wear

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Prerequisite: authorization Z14, Z32

Restriction: only for plastics

Tooth flank wear is the main damage criterion that affects plastic gears that run without lubrication. The wear, and how it is distributed across the tooth flank, can vary greatly depending on the geometry and load.

Calculate local wear, if you know the wear factor Jw for the corresponding material. You can input the wear factor Jw, in the plastic data file, for plastics, depending on the temperature (for example, Z014-100.DAT for POM). Input this data in 10^-10 mm2/N.

The

- local wear (in a relative measurement scale with normal beams on the tooth flank) and
- the worn flank are displayed in real-coordinates

6.52 Z32 Calculation of contact analysis under load

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016

Use this option to calculate the path of contact for any tooth form. In theory, the path of contact between two involute toothings is straight. For any (non-involute) gear, the path of contact in each case can be any curve. However, the load placed on the teeth of involute gears will also cause these gears to deform. As a result, in practice, the path of contact is never an exactly straight line. In particular, this may cause meshing to start earlier and to continue beyond the usual point. The progression of the path of contact and therefore the characteristic parameters of gears defined by it, such as, the transmission error, is a critical aspect for estimating the risk of vibration, losses, local warming and the wear characteristics of a pair of gears.

You can predefine the accuracy (computing time). Depending on the level of accuracy you select, the number of sections (into which the tooth width is divided) and the precision of the iteration are set for the calculation. You can also take the influence of manufacturing errors (pitch) and the angular deviation of the axes (axis deviation and axis inclination) into account.

Use option Z24 (see Meshing stiffness (see section "Z24 Meshing stiffness of the gear pair and transmission error " on page I-75)) to calculate the stiffness of the gears. The results achieved with this method are very similar to those achieved with much more complicated verifications using FEM. Without option Z24, the average tooth stiffness stated in ISO 6336 is used.

Defining meshing under load is an important tool in helping you check the effect of profile and width corrections. The transmission error will increase or decrease, depending on the sizing of the correction. In addition, the meshing graphic shows whether an impact of contact is present.

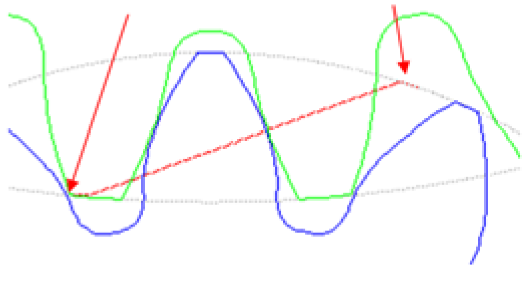	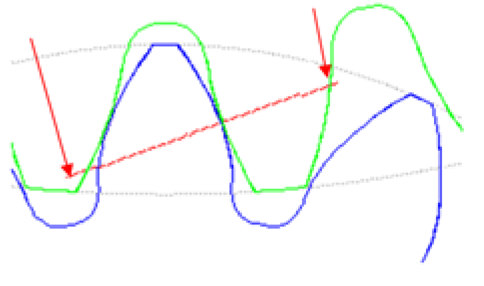
a is too small. Path of contact runs on to the tip circle. This shows contact impact is present. Extended contact	Ca is too big. Path of contact does not reach the tip circle. Transverse contact ratio is reduced.

Figure 53<Kap.3>.3: Display path of contact under load in meshing graphic. On the left: impact of contact if tip relief Ca is too small. On the right: shortened contact if tip relief Ca is too great

Calculate the path of contact during manufacturing:

You also have the option of calculating the path of contact during manufacturing (tool-gear). This can be useful if you want to analyze specific sliding or wear (options Z27, Z31).

6.53 Z33 Profile correction optimization with contact analysis under load

Calculate contact analysis for an area of profile correction variants and partial loads. The contact analysis details are the same as in the description for (Contact analysis calculation (see section "Z32 Calculation of contact analysis under load " on page I-79)).

6.54 Z06 Face gear calculation (Z060)

Allows to start the calculation module:

- Face gear [Z060]

Geometry of face gears paired with cylindrical gear pinions. The 2D display displays the inside, middle and outside of the face gear tooth form all at the same time. You can check for undercut and pointed teeth in the 2D graphic. You can predefine the tip circle changes to prevent the creation of pointed teeth. 3D display with export option (option K05g*). Simulate the manufacturing process using a pinion type cutter to calculate the tooth form.

This applies to straight and helical gears without offset and with a 90° shaft angle.

6.55 Z06a Strength calculation based on ISO 6336/ Literature

Extension for calculation module: Z060

Strength calculation based on ISO 6336/ Literature

We recommend you use this calculation method. It is based on the technical literature produced by the company Crown Gear. Crown Gear was a Dutch company, which specialized in the production of face gears between 1990 and 2000. The method is similar to option Z06b, but implements the smallest line of contact length as the effective face width for calculating Hertzian stress. The formulas used here are listed in the report.

6.56 Z06b Strength calculation based on CrownGear/ DIN 3990

Extension for calculation module: Z060

Strength calculation based on CrownGear/ DIN 3990.

This calculation method delivers the same results as the SoftwareCrown Gear that was developed by Crown Gear. This was a Dutch company which specialized in manufacturing face gears from 1990 to 2000. The method is similar to option Z06a, but always uses the shared face width of the pinion and the gear as the effective face width for calculating Hertzian flattening even if the contact line length is smaller. The formulae used here are listed in the report.

6.57 Z06c Strength calculation based on ISO 10300, method B

Extension for calculation module: Z060

Strength calculation based on ISO 10300, method B

Face gears belong to the class of bevel gears, where the pinion has a bevel angle of 0° and the face gear has a bevel angle of 90°. For this reason, you can also use a bevel gear strength calculation such as ISO 10300 or DIN 3991.

6.58 Z06d Strength calculation based on DIN 3991, method B

Extension for calculation module: Z060

Strength calculation based on DIN 3991, method B

Face gears belong to the class of bevel gears, where the pinion has a bevel angle of 0° and the face gear has a bevel angle of 90°. For this reason, you can also use a bevel gear strength calculation such as ISO 10300 or DIN 3991.

6.59 Z6e Static strength

Extension for calculation module: Z060

Calculate the static strength of face gears.

6.60 Z6f 3-D display

Extension for calculation module: Z060

Display face gear geometry with any shaft angle and offset in 3D in the parasolid viewer with the option of exporting data in STEP format (K05u option).

6.61 Z07 Bevel gear calculation (Z070)

Use this to start the calculation module:

- Bevel gear [Z070]

Calculate the geometry and strength of straight, angled and spiral toothed bevel gears. Geometry and control measures as stated in ISO 23509. The calculation includes the geometry of bevel gears for all currently used manufacturing techniques. Compare this with the calculation example in the documentation. Calculate all necessary data required to create a bevel gear drawing (tip and active root diameter on the outer and inner cone) and tooth thickness mass. Applies to all types of bevel gears and manufacturing process, such as Gleason, Klingelnberg, Oerlikon. The bevel gears are also shown as graphics.

Input geometry by predefining the reference diameter (d_{e2}) or the mean normal module (m_{nm}). Dimensioning suggestion for the profile shift and the cutter radius.

Bevel gear-Rough sizing

Simple presizing of bevel gears. After you input the gear reduction, the helix angle and the design parameter b/mn and Re/b the system produces a proposal calculated for the module, the face width, number of teeth and outside diameter.

6.62 Z07d Gleason bevel gear toothing

Extension for calculation module: Z070

The input data required to calculate geometry according to ISO 23509 is often missing from data sheets for Gleason calculations. For this reason, a special input window has been provided in which you can enter data that is present on all the Gleason data sheets. The software then checks these entries and converts them into ISO 23509 geometry.

In a second input window you can define the bevel gear geometry and achieve a good approximation of the base data defined in the Gleason datasheets for the following types of bevel gears:

- Constant helix angle (straight or helical)
- Duplex (constant root gap)
- Spiral toothing, default (non-constant root gap)
- Zerol "Duplex taper"
- Zerol "Standard"

6.63 Z07e Strength calculation based on ISO 10300, methods B and C

Extension for calculation module: Z070

ISO 10300 for verifying the strength of bevel gears first appeared in 2001. This standard is currently the most up-to-date for bevel gears, which is why it is recommended.

ISO 10300 allows you to prove safety against tooth fracture and pitting, and calculate scuffing safety (integral temperature criterion) as specified in DIN 3991.

An extension of the method to include hypoid bevel gears is currently being discussed. A suggestion in accordance with FVA is already implemented in KISSsoft.

6.64 Z07g Strength calculation based on DIN 3991

Extension for calculation module: Z070

Calculation according to DIN 3991 (method based on equivalent spur gear)

DIN 3991 allows you to prove safety against tooth fracture, pitting and scuffing (integral temperature criterion)

6.65 Z07h Strength calculation for plastics

Extension for calculation module: Z070

Strength calculation for plastics against tooth fracture and flank strength as specified by Niemann and VDI 2545. The calculation is performed in accordance with the procedure described in option Z14 for the equivalent spur gear.

6.66 Z07i Calculation of bevel gear differentials

Extension for calculation module: Z070

Calculate the static strength of bevel gears and calculate bevel gear differentials.

Calculate the static strength of the tooth root. The calculation is performed in accordance with the procedure described in option Z2x for the equivalent spur gear.

Bevel gears in differentials are usually only subject to a static load and are therefore only checked for static fracture safety at the tooth root. To calculate a differential, input the torque at the differential and the number of strands.

6.67 Z07j Strength calculation based on AGMA 2003

Extension for calculation module: Z070

Calculate the strength of bevel gears based on AGMA 2003.

6.68 Z07a bevel gears with cyclo-palloid and palloid-intermeshing

Extension for calculation module: Z070

Geometry, manufacturability and strength calculation of bevel gears as defined in the Klingelnberg process. As stated in the Klingelnberg in-house standard KN 3028 (geometry and manufacturing of cyclo-palloid gears) or KN 3025 (geometry and manufacturing of palloid gears) and KN3030 (strength calculation) a complete calculation is performed for cyclo-palloid toothing:

- Machine types FK41B, AMK400, AMK635, AMK855, AMK1602, KNC25, KNC40, KNC60 with all corresponding cutters, cutter radiuses and numbers of starts
- You can specify any shaft angle, or angle modification here
- Overall geometry with machine distance, modules (inside, middle, outside), pitch of helix, checks on the cut back, undercut space, calculation of the addendum modification for balanced sliding, checks on the backwards cut, control and calculation of the necessary tip reduction on the inside diameter, profile and overlap ratio, tooth form factor and stress correction coefficient
- Calculation of all toothing dimensions
- Calculation of pitting, tooth root and resistance to scoring (as defined by the integral temperature criterion) with all modifications in the in-house standard KN3030

Sizings:

- Sizing of profile shift for:
  - Minimum necessary value to avoid undercut
  - Balanced sliding

6.69 Z07b Hypoid gears with cyclo-palloid gear teeth

Extension for calculation module: Z070

Geometry, manufacturability and strength calculation of hypoid gears (bevel gears with offset) as defined in the Klingelnberg process. As stated in the Klingelnberg in-house standard KN3029 (geometry and manufacturing of cyclo-palloid gears) or KN3026 (palloid-hypoid gears) and KN3030 (strength calculation) a complete calculation is performed for cyclo-palloid toothing.

- Machine types FK41B, KNC40, KNC60, AMK855, AMK1602, KNC25, KNC40, KNC60 with all corresponding cutters, cutter radiuses and number of starts.
- You can use any value as the shaft angle, angle modification, pressure angle for the driving and driven flank.

- Overall geometry with calculation of the pitch of helix, face widths, machine distance, modules (inside, middle, outside), checks on the cut back, undercut space, calculation of gap widths, checks on backwards cut, checking and calculating the necessary tip reduction on the inside diameter, profile and jump overlaps, tooth form factor stress and correction factor either for the driving or driven flank
- Calculation of all toothing dimensions
- Calculation of pitting, tooth root and resistance to scoring (as defined by the integral temperature criterion for the replacement spiral-toothed gear wheel) with all modifications in the in-house standard KN3030

Sizings:

- Suggestion for suitable pressure angles on the driving and driven flank
- Sizing of the profile shift for the minimum value required to prevent undercut

6.70 Z07p 3-D display

Extension for calculation module: Z070

Display bevel gear geometry in 3D in the parasolid viewer with the option of exporting data in STEP format (K05u option). The straight, helical, and spiral tooth types except hypoid gears are available. The basic geometry and the tooth form are calculated according to ISO 23509 and the face hobbing process. The final tooth form along the face width is extended with epicycloids.

6.71 Z08 Worm gear calculation (Z080)

Use this to start the calculation module:

- Worms with enveloping worm gears [Z080]

Use this calculation module to size and verify worm gears (cylindrical worms or globoid worms) with enveloping worm gears. Use calculation module [Z170] to verify worm gears with cylindrical worm gears.

- Calculate worm geometry in accordance with ISO 14521 and DIN 3975. Tooth thickness and control measures (base tangent length, rollers and measurement over balls of the worm gear as specified in DIN 3960. Manufacturing tolerances as stated in DIN 3974-1 and 3974-2 (1995)).
- Various different worm gear materials with special data for calculating wear and efficiency. Flank forms: ZA, ZE, ZH, ZI, ZK, ZN, ZC.
- Control measures are calculated for worms with flank forms ZA, ZI (or ZE). This calculation takes into account the tooth thickness deviation: the three wire measurement and tooth thickness for the worm, measurement over balls for the worm gear and centre distance for the worm gear pair.

6.72 Z08a Strength calculation based on DIN 3996

Extension for calculation module: Z080

- Sizing the face width, centre distance, lead angle etc.

- Strength calculation in accordance with DIN 3996 (1998 edition) or according to the draft EDI 3996:2005 with efficiency, temperature safety, pitting safety, wear safety, tooth fracture and bending safety.
- You can also calculate the starting torque under load, which is a critical value when sizing gear drives.

6.73 Z08b Strength calculation based on ISO 14521

Extension for calculation module: Z080

Strength calculation according to ISO TR 14521, 2008 edition, with calculation of efficiency, wear safety, pitting safety, tooth fracture, temperature and bending safety.

6.74 Z08c Strength calculation based on AGMA 6034 and AGMA 6135

Extension for calculation module: Z080

The method stated in AGMA 6034 applies to steel worms with bronze globoid worm gears. It calculates the transmissible power of the gear pair. This is a simple method which is suitable for overall layouts.

The method stated in AGMA6135 applies to steel globoid worms with bronze globoid worm gears. It calculates the transmissible power of the gear pair. This is also a simple method which is suitable for overall layouts.

It also determines bending safety as stated in AGMA 6135, Appendix B.

6.75 Z08p 3-D display

Extension for calculation module: Z080

Display globoid worm gear geometry in 3D in the parasolid viewer with the option of exporting data in STEP format (K05u option). The worm wheel model is generated from the cutting simulation by using the ideal hob that is duplicating the worm.

6.76 Z19b Worm calculation with sizing using the normal module (tool module)

Extension for calculation module: Z080

The geometry of worm pairings is usually calculated with the axial module. With this option, you can also perform sizing using the normal module (tool module). This has a particular influence on the tip and root diameter as well as the profile shift.

6.77 Z17 Calculate spiral-toothed gear pairs

Allows to start the calculation module:

- Crossed helical gears and precision mechanics worms with a cylindrical worm gear [Z170]

Use this calculation module to size and verify crossed axis helical gear pairs and worm gears with a cylindrical worm gear.

Calculate the geometry of crossed helical gears (cylindrical gears with crossed axes) as specified by G. Niemann, Machine elements II, The current version of this text book describes methods used to calculate and check the geometry of crossed helical gears for any shaft angle. This module calculates the control and manufacturing measures.

The calculation permits both the usual combination of helix that points in the same direction (left-left or right-right) and also left-right combinations. The service life of worm gears with plastic-gears and steel-worms can be significantly increased by increasing the tooth thickness in the gear and reducing it in the worm. Special functions are available for sizing this type of gear.

6.78 Z17a Strength calculation in accordance with ISO 6336/Hirn

Extension for calculation module: Z170

Strength calculation for metallic materials:

The method developed by G. Niemann (Machinenelemente, Vol III, combined with the ISO 6336 method) enables an up-to-date and comprehensive strength calculation for worm gears (root strength, flank strength, or wear strength and scuffing safety). Niemann's calculation of pressure ellipses takes the special geometry of worm gears into account. The effective load-bearing face width is then derived from this. The tooth root calculation is performed in the same way as in ISO 6336. Flank strength calculation as specified by Niemann also includes the service life factors stated in ISO 6336. Scuffing safety, integral temperature process, as stated in Niemann (corresponds to DIN 3990).

Strength calculation for plastics (VDI 2545):

The method defined by G.Niemann is the same as for steel, but includes the verification specified in VDI 2545 and the other procedure for plastics (such as the one given in option Z14 for cylindrical gears).

Strength calculation for plastics (VDI 2736):

This is a new standard that will become available, as soon as it is ready in draft form.

Static strength calculation:

-static proof against fracture and yield point against tooth deformation (as for cylindrical gears)

-static proof of the worm wheel against shearing as specified in the draft version of VDI 2736.

Strength calculation in accordance with Hoechst for steel worms where the worm gear is made of Hostaform:

Calculate using the procedure developed by Hoechst, load values procedure and blocking safety (shearing strength)

Strength calculation as specified by Hirn: 2 Calculation method developed by Hirn for special pairings: steel/bronze; steel/aluminum; as well as various different steel/steel combinations. This is an uncomplicated method developed in 1965, which is no longer recommended.

6.79 Z17b Strength calculation in accordance with Niemann/VDI 2545

Extension for calculation module: Z170

Method developed by G. Niemann, same as for steel, however with verification in accordance with VDI 2545 and other procedures for plastic (as in option Z14 for cylindrical gears).

6.80 Z17c Strength calculation in accordance with Hoechst

Extension for calculation module: Z170

The strength calculation defined by Hoechst is to be used for steel worms where the worm wheel is made of Hostaform.

Calculate using the procedure developed by Hoechst, load values procedure and blocking safety (shearing strength)

6.81 Z09 Splines

Use this to start the calculation module:

- Splines [Z09A]

Calculate the geometry with a tolerance system as well as proof of strength according to two different methods.

The geometry and control measures of splines and pinion centers is calculated according to:

- DIN 5480 (edition 2006)
- DIN 5481 (edition 2005)*[1] *[2]
- DIN 5482 (edition 1973)*[2]
- ISO 4156 (1991)
- ANSI B92.1 and ANSI B92.2 (1992)

. Selection lists with recommended dimensions, as well as all possible dimensions, make it easier for you to select the one you want. In the "Own input" option, you can also define any other dimensions you require. The system includes all the tolerance systems (deviations and manufacturing tolerances) listed in the standards. Control measures for "Actual dimensions" and for "Effective dimensions". The "Actual" data contains the dimensions for individual measurements (for example, base tangent length). The "Effective" data has the dimensions that include manufacturing errors when checked against templates.

For splines that conform to ISO 4156 this method calculates all the data required to design templates as specified in ISO 4156, Amendment 1, with details for GO and Not-GO templates.

Their strength is calculated by two different methods: Niemann/Winter and Draft DIN 5466.

*[1] : to output straight line tooth flanks, DIN5481 also requires authorization Z5h

*[2] : all the standard geometries for DIN 5481 and DIN 5482 are supplied as files that can be uploaded.

6.82 Z12 Operating backlash

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016, Z080, Z170

In addition to calculating the theoretical backlash (integrated in Z01) for cylindrical gears as defined in DIN 3967, the backlash after mounting can also be calculated (this includes toothing deviations, deviation error of axis in accordance with ISO 10064 or DIN 3964 form and mounting deviations) and of the operating backlash (including the temperature differences between the gears and the gear case). The influence of the thickness increase due to water absorption is also taken into account for plastic gears. The increase in pitch error and the reduction in tip clearance due to heat expansion is also documented.

6.83 Z22 Hardening depth

Extension for calculation modules: Z012, Z013, Z014, Z015, Z016, Z070

TThis calculates the optimum hardening depth (for case hardened or nitrite hardened gears). By calculating the stress progression in the depth using Hertzsches law. Displays the stress curve in the depth (normal to the flank surface) and the hardening progression and issues a message if the situation is insufficient. The recommended hardening depth specified in ISO 6336-5, AGMA 2001 and Niemann is also documented.

6.84 Z16 Torque sizing

Extension for calculation modules: Z011, Z012, Z013, Z014, Z015, Z016, Z070, Z080, Z170

For cylindrical gears, bevel gears, crossed helical gears and worm gears, the maximum transmissible torque with respect to the pre-defined safety levels is calculated based on the required service life and required safeties (for tooth fracture, pitting, scuffing, and, for worm gears, also for wear and temperature safety).

6.85 Z16a Torque sizing for load spectra

Extension for option: Z16

This is an addition to Z16 to calculate load spectra. You can define any load spectra by inputting frequency, power/torque and speed. The system includes all load spectra as defined in DIN 15020 (crane construction). The calculation is based on ISO 6336, part 6 (2006) using the Palmgren-Miner Rule. In the endurance limit range you can select a modified form of the Wöhler line as an alternative to ISO:

- according to Miner (corresponds to ISO 6336 or DIN 3990)
- according to Corten/Dolan
- according to Haibach

6.86 Z18 Service life calculation

Extension for option: Z16

After you input or confirm the minimum safeties for tooth root and flank safety, the service life (in hours) for the specified load is calculated for all gears, apart from splines (Z09). Service life is calculated in accordance with ISO 6336, Part 6 (2006) using the Palmgren-Miner Rule. In the endurance limit range, you can select a modified form of the Wöhler line as an alternative to ISO:

- according to Miner (corresponds to ISO 6336 or DIN 3990)
- according to Corten/Dolan
- according to Haibach

The service life of the system (every gear in the configuration) is also output.

6.87 Z18a Calculate service life for load spectra

Extension for option: Z18

This offers a calculation of load spectra as an addition to Z18. You can define any load spectra by inputting the frequency, power/torque and speed. The system includes all load spectra as defined in DIN 15020 (crane construction). The calculation is based on ISO 6336, part 6 (2006) using the Palmgren-Miner Rule. Calculate safeties with load spectra: If you input the target service life, the load, the application factor (usually 1.0 for classic load spectra) and a load spectrum, KISSsoft calculates the resulting safeties for tooth root and tooth flank, as well as the scuffing safety for the critical element of the load. It then outputs the results in a report.

6.88 Z40 non-circular gears

Allows to start the calculation module:

- Non-circular gears [z040]

Calculate the entire tooth contour of non-circular gears. The optional sets for the input are:

- Center distance and ratio progression (instantaneous transmission ratio at the rotating position of Gear1)
- Center distance and rolling curve of Gear1 (in polar coordinates)
- Rolling curve of Gear 1 and Gear 2 (each in polar coordinates)

The center distance can be fixed or variable. The software first defines the roiling curve and then adds teeth to the rolling curves in the pinion type cutter simulation. This produces very precise and elegant toothing both on outer contours and "bosses" of the gear that go to the inside. After this, both gears can be meshed with each other to check that they function correctly. The instantaneous transmission ratio is displayed as it happens.

There are instructions about how to estimate strength. These are used to convert the critical areas of an non-circular gear pair into the equivalent, circular gear pair and then verify this with the cylindrical gear module [Z012].

Both non-circular segments (for example, a pinion with an angle of rotation of 330° to a gear with an angle of rotation of 60°) and non-circular gears with an overall reduction of 1:2 to 1:10 (for example, a pinion with an angle of rotation of 720° to a gear with an angle of rotation of 360°) can be created here.

Restriction: Center distance > 0 (no internal toothed pairs)

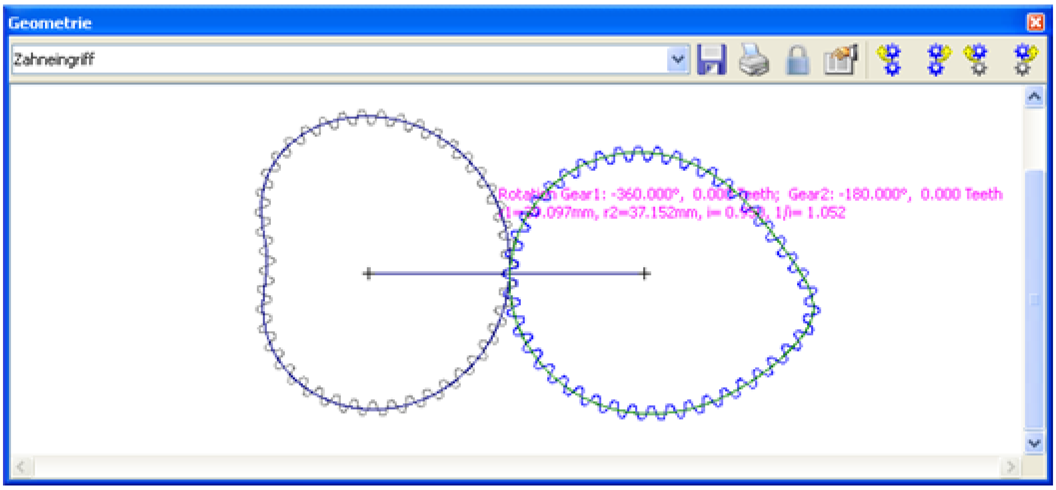

Figure 1.5: Display of non-circular gears

7 Belt/chain drives Z module

7.1 Z90 V-belts (Z090)

Complete calculation including standard v-belt lengths and standard effective diameters. Determining transmittable power per belt taking into account the speed, effective diameter, transmission ratio and belt length. All the data for each type of belt is stored in self-describing text files. These contain the data from technical catalogues produced by the relevant manufacturer (e.g. Fenner). This also includes a belt stress calculation module that uses data from belt-bending tests. This calculates the strand force and axis load at standstill and in operation for optimum setting as well as for setting in accordance with data in the catalogs.

V-belt profiles

- SPZ, SPA, SPB, SPC
- XPZ, XPA, XPB, XPC
- XPZ, XPA, XPB, XPC narrow V-belts DIN 7753/ISO 4184 (Conti-FO-Z brand)
- 3V/9N, 5V/15N, 8V/25N
- 3V/9J, 5V/15J, 8V/25J
- Dayco RPP (Panther)
- Further profiles on request

Rough dimensioning (suggests a v-belt that would be suitable for solving your drive problem), sizing of the number of belts, calculate belt length from the center distance and vice versa. As a variant, the calculation can also be performed with a third roller (tensioning pulley). You specify its position interactively on the graphical screen. This roller can be positioned outside or inside as required. The changed length of loop is then taken into account in the subsequent calculation.

7.2 Z91 Toothed belts (Z091)

Use this module to calculate and size all aspects of toothed belt drives, including the tooth number and belt length whilst taking into account considering standard numbers of teeth. When you enter the required nominal ratio and/or the nominal distance of axes, the program calculates the best possible positions. You can also calculate the required belt width, taking into account the correction factors, the minimum tooth numbers and the number of meshing teeth. You can also print out assembly details (belt tension test). The data for each type of belt is stored in self-describing text files which can be edited as required.

Toothed belt profiles:

- XL, L, H, 8m, 14mm ISORAN (FENNER)
- 8mm, 14mm ISORAN-RPP-GOLD, ISORAN-RPP-SILVER (Megadyne)
- 8mm, 14mm RPP-HRP (Pirelli)
- 3mm, 5mm, 8mm, 14mm PowerGrip HTD (Gates)
- 8mm RPP (Marke DAYCO, Panther)
- 8mm, 14mm MGT Poly Chain GT2 (Gates)
- 8mm, 14mm MGT Poly Chain GT Carbon (Gates)
- AT5mm, AT10mm, AT20mm BRECOflex (BRECO)
- AT3mm, AT3mm GEN III, AT5mm GEN III, AT10mm GEN III SYNCHROFLEX (CONTITECH)
- others types of toothed belts are available on request

Rough dimensioning (suggests a toothed belt that would be suitable for solving your drive problem), sizing of the belt width, calculate the number of teeth on the belt from the center distance and vice versa. You can also perform calculations for stress-resistant toothed belts with integrated steel ropes (e.g. AT5) You can also include a tensioning pulley in the same way as in v-belt module Z90. Additional profiles: AT 5mm, AT10mm, AT20mm (Breco).

7.3 Z92 Chain gears (Z092)

Calculate of chain gears with roller chains as specified in ISO 606 (DIN 8187 and DIN 8188) with standard roller chains taken from a database. The chain geometry (centre distance, number of chain elements) for simple and multiple chains and the transmissible power, axial forces, variation in speed due to polygon effect, etc. Basis: DIN ISO 10823 (2006), Dubbel, Taschenbuch für den Maschinenbau, and G. Niemann, Maschinenelemente. Checking permitted highest speed, suggestion for the required lubrication. In the same way as in v-belt module Z90, you can add a third gear (tensioning pulley) to the on screen graphic and include it in the calculation.

Sizing: Using the drive data as a starting point, the program displays a list of suggested values for suitable chain drives. Calculating the chain length from the center distance and vice versa; internal/external tensioning pulley graphical positioning.

8 Automotive - A Module

8.1 A10 Synchronization (A010)

Calculation of synchronization time for engaging/disengaging two gears, based on geometry, operating conditions and materials input.

9 KISSsys - K11-Module

9.1 Overview

In KISSsys, you can create a system of machine elements. For this system, you can calculate the power flow and manage the links between the various different elements. KISSsys uses KISSsoft routines to calculate the strength of the machine elements. The results of the calculations are then made available in KISSsys both as tables and as graphics. KISSsys allows you to get a clear overview of the strength and service life of all the elements in your design at any time.

9.2 Modules

- **K11a:** KISSsys Administrator License
- **K11c:** 3D core, Export functions

9.3 Different views of the data

In KISSsys, a model of the system you are monitoring is stored as base data. Users can then access different views of this data:

- In the table view, the machine element data is presented in an easy-to-understand format. You can input your own data quickly and easily in this view.
- A freely-configurable user interface, in table format, groups together the most important input and output values and allows you to call other functions.
- Use the flexible dialogs to configure the templates. You can also easily change these dialogs to suit your own templates.
- A tree view gives a clear overview of the assembly structure.
- The 2D schematic diagram illustrates the power flow.
- The 3D view allows you to check your input visually. Here you can, of course, also rotate, move and zoom in on the graphic.

9.4 Modeling

The systems modeled in KISSsys are extremely flexible and can be modified to suit your own requirements. You can manage the KISSsys templates to help complete your daily tasks more efficiently. To do this, simply combine already defined elements, from single parts up to entire assemblies. The integrated programming language allows you to write very powerful case-specific applications. For example, it is possible to implement an automated rough sizing, for a drive train within KISSsys. A range of effective plotting functions are available to represent the results of variations.

9.5 Variants

Most designs in mechanical engineering occur in variants. KISSsys uses special data formats to support these variants, so that you can, at any time, easily toggle between different device types in a series, shift gears or similar.

9.6 Example applications

The system's high degree of flexibility offers a wide range of application fields. However, three main applications stand out from the others:

- Designing machines: When designing machines, the sizing of each individual machine element depends on the others. KISSsys can manage and display these interrelationships. Typical applications are, for example, the sizing of multi-stage drives for assembly in confined spaces, or for the well-balanced sizing of drive trains. By using the programming options, you can also define company-specific applications which can then be sent to drawing offices and used to automate specific sizing functions.
- Handling variants: By managing variants, KISSsys can, for example, extract transmissible power data that can then be used to create catalogues of gear sets or gear series. Alternatively, it can analyse an entire series of variants for one design.
- Sales support: If required, the sales team can be given a special variant of KISSsys which does not include any options for changing the basic models but which does allow them to input specific data in the appropriate dialogs. This not only speeds up the quotation process but also makes it more precise, because the sales team members can explain certain technical aspects without having to refer back to the design team.

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