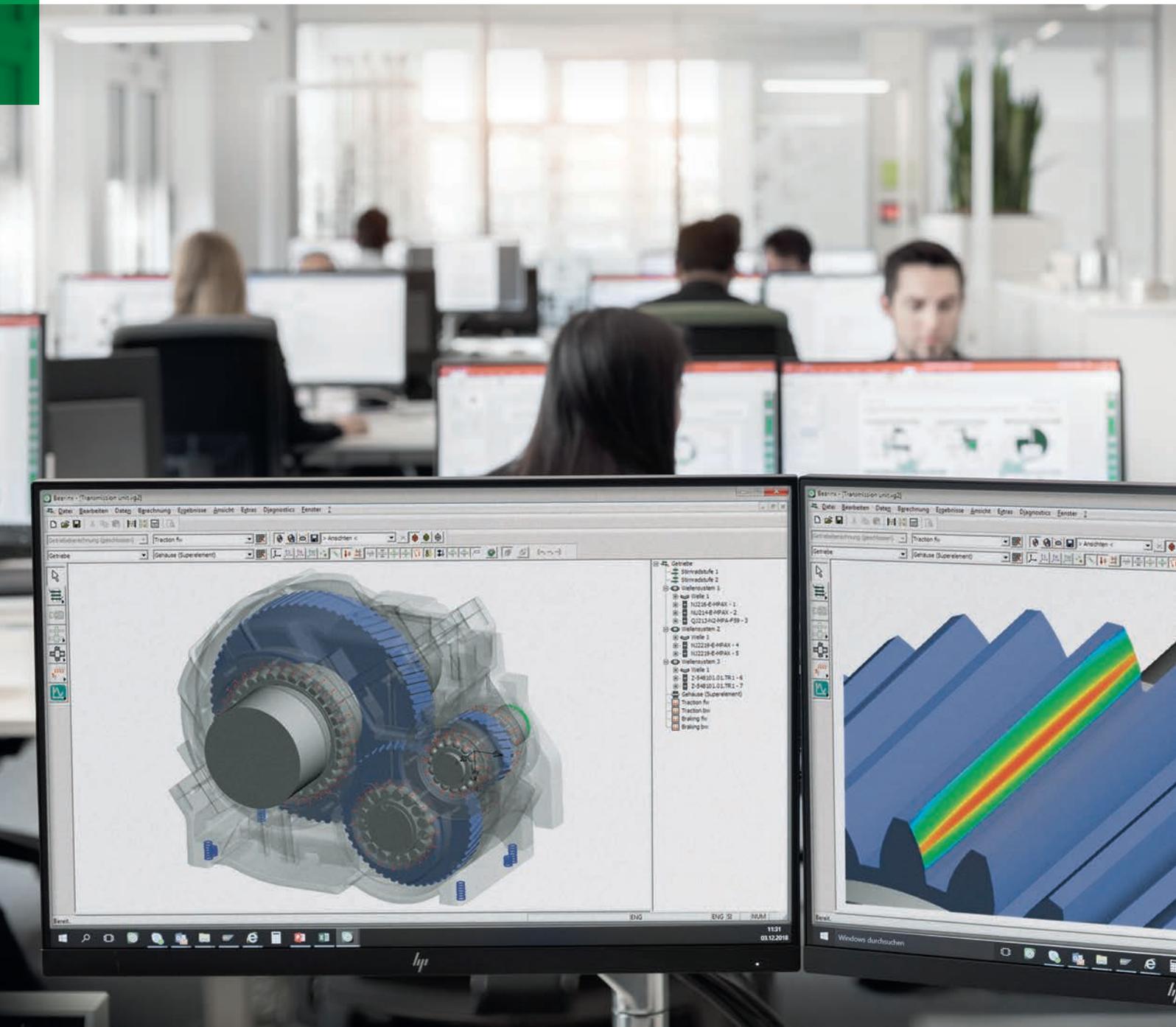


We pioneer motion

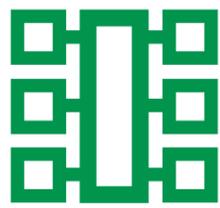
# Bearinx

High-Level Bearing Design



# Bearinx Simulation Suite – The perfect tools for systems with rolling bearings

Thanks to its state-of-the-art simulation programs, Schaeffler offers the best possible support in the product development process – from the dynamic simulation of an entire drive train, through to the detailed simulation of contact conditions inside rolling bearings. The Bearinx Simulation Suite includes CAE tools that are perfectly suited to the specific requirements of the design.



Simpla

### Simpla – system simulation with rolling bearing expertise

As part of the Bearinx Simulation Suite, Simpla provides support in the creation, control, and analysis of complex mechanical system simulations, e.g. wind turbines, in order to help analyze and optimize their dynamic behavior. The focus here is on the interactions between our products and the customer's design. Simpla uses numerous interfaces to combine expertise from software developed inhouse such as Bearinx and commercial programs such as Abaqus, Simpack, and Samcef. This enables a wide range of simulation methods to be combined with each other.



Bearinx

### Bearinx – bearing design with an understanding of systems

Bearinx allows complete gearboxes and linear guidance systems to be modeled and calculated with all the relevant data regarding elasticity, contact rigidity, and environmental influences. The results provided also include loads and the displacement and deformation of all the components. Additional parameters such as rating life, safety factors, pressure curves, and friction values are calculated for bearings. Gear teeth are also analyzed with a high level of detail. Data records and calculation models can be easily exchanged with other programs via different interfaces.



Caba3D

### Caba3D – a dynamic view inside the bearing

As part of the Bearinx Simulation Suite, the Caba3D MBS software allows a view inside rolling bearings. It enables a precise analysis of the dynamic processes that take place inside a rolling bearing. This means that the movement patterns of the bearing components, the forces acting between them, and the frictional power that is generated can be determined. These results allow statements to be made regarding the minimum load, the risk of smearing, and surface-induced damage. Stresses and damage can be predicted by analyzing the elasticity of cages.



Telos

### Telos – where the focus is on contact

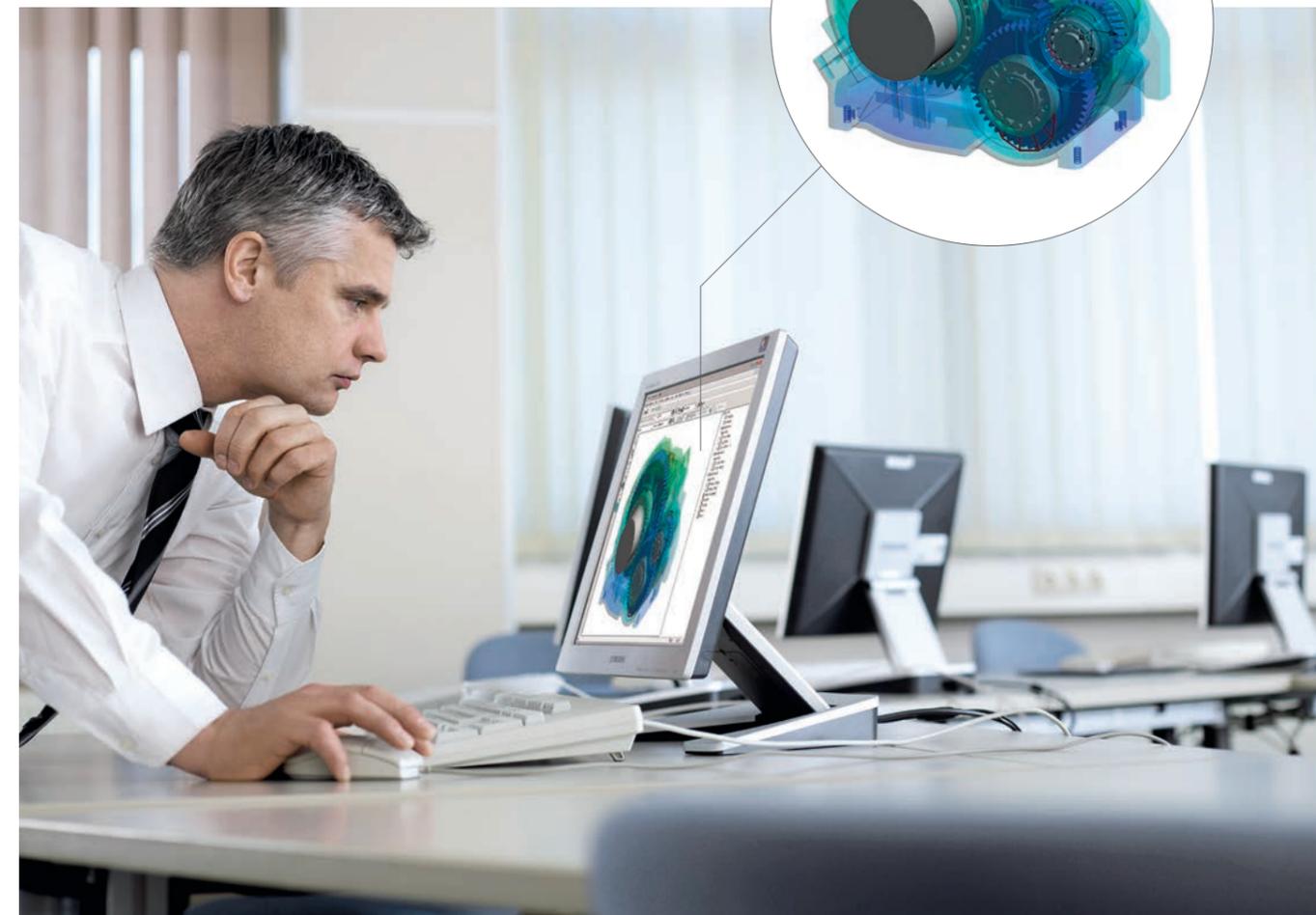
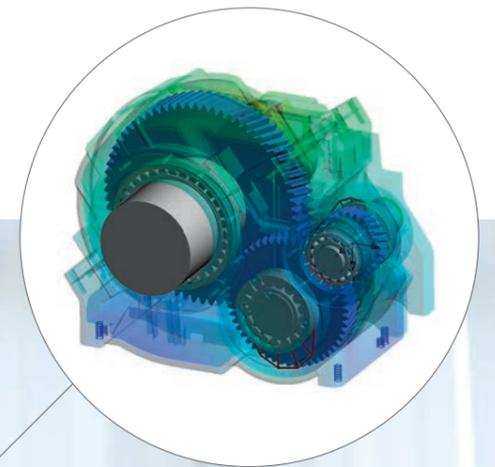
The Telos program is the detailed contact simulation within the Bearinx Simulation Suite. Telos considers the lubrication conditions in individual contacts, for example between the rolling elements and the raceway in detail. The effects of surface damage and coatings can thus be analyzed as well. Furthermore, it is possible to specify different input values with a time curve. The input data from a Bearinx simulation model can also be automatically transferred using a special interface.

Even when the best rolling bearing is installed in the best machine, it will only run faultlessly if the two are properly matched to each other. To achieve the optimum design, the bearing must therefore be analyzed in the context of the overall system. The Bearinx design program developed by Schaeffler makes this possible. In addition to a detailed analysis of the individual bearing, elastic shaft systems, gearboxes, and complex linear guidance systems can also be calculated. Bearinx also has customized calculation models for designing tool spindles, steering units, wheel bearing units, and crank drives.

### It's a question of balance

The basis for determining a bearing's rating life is its internal load distribution. For this to be ascertained, it is necessary to balance all the relevant external loads and elasticity data of the overall system. Among others, Bearinx considers the following factors:

- The non-linear elastic behavior of the individual raceway and rib contacts in the bearing
- Elastic shafts according to Timoschenko
- Elastic housings using FE influencing values for elasticity, inertia forces, thermal expansion, and predeformation
- Gear stages with rigid or elastic tooth contact that can be used in any combination
- Distributed loads in the tooth contact of the gear stages
- Expansion of the bearing seats



## We are always precise when it come to bearings

The small and inconspicuous things are often what makes the difference between success and failure – the following parameters have a decisive influence on the load distribution and rating life of rolling bearings, for example:

- Profiling of rolling elements and raceways
- The influence of the fits in the bearing seat and the temperature on the operating clearance
- The influence of oval deformation of the raceway in track rollers or elastic housings
- The influence of surface quality, lubrication gaps, and the degree of contamination on the rating life

All of these parameters are taken into consideration in Bearinx and optimized by our engineering service to suit the requirements of your application.

## Verified reliability

It goes without saying that even the most detailed calculation model only delivers reliable results when it has been comprehensively validated. The calculation models used in Bearinx are either standardized and published methods (such as modified reference rating life, calculation of interference fits) or methods developed by Schaeffler that have been verified using in-depth testing on our numerous test rigs and finite element calculations.

The consistent use of Bearinx when designing our products and the continuous comparison with approval tests and FE analyses ensures the constant validity of the calculation models used in Bearinx.

## Which bearing would you like?

Bearinx includes a comprehensive bearing database in which all bearings from the INA/FAG catalog range and numerous special bearings are available at the click of a mouse. Does your application require the use of a customized special bearing? No problem! Our engineering service will also configure a new bearing for you, which you can then integrate into your Bearinx model.

## The most important thing: Detailed results in Bearinx

Once the calculation has been successfully completed, results for all components and all levels of detail are available in Bearinx, from the gearbox down to the individual raceway contacts:

### Gearbox

- Power flow for all operating conditions
- Tooth, belt, and chain forces
- Centrifugal forces due to planet gears
- Frictional torque and fuel consumption

### Shafts

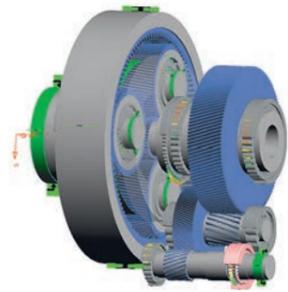
- Bend lines, section values
- Comparative stress curve, taking notches into consideration
- Critical speeds and natural frequencies
- Resulting inertia forces (crankshafts and balancer shafts)

### Bearings

- Loads and displacements
- Operating clearance
- Modified reference rating life
- Static and dynamic load safety factors
- Exact internal load distribution in the bearing
- Frictional torque and frictional power
- Cage loads and cages stresses

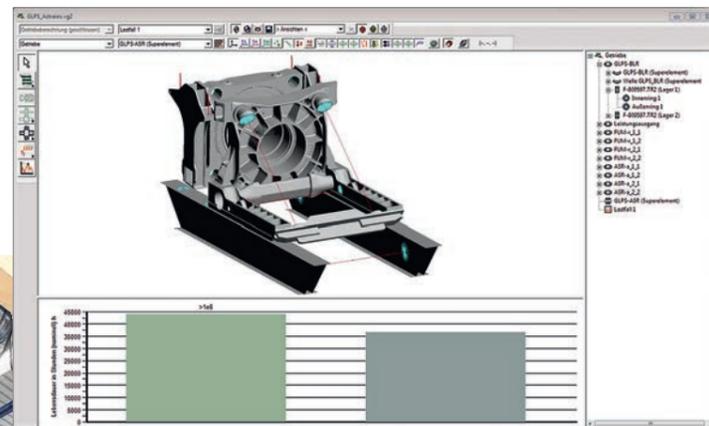
### Contacts

- Pressure and stress curves, taking edge effects into consideration
- Required raceway hardness



Planetary gearbox for wind power applications

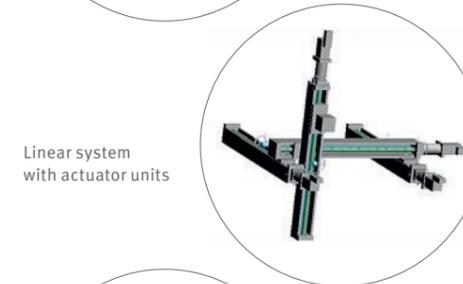
ASTRAIOS large-size bearing test rig: Comparison between calculation and testing



## Views of various products in Bearinx:



Crank drive



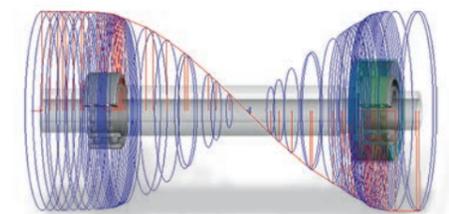
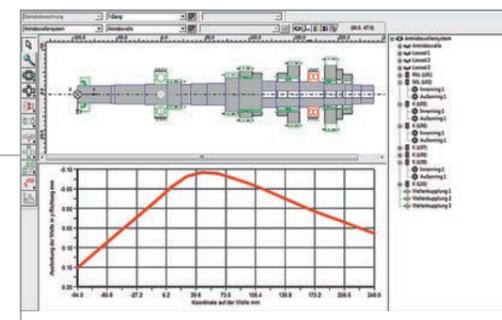
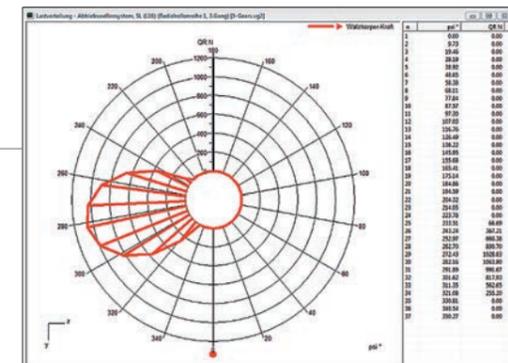
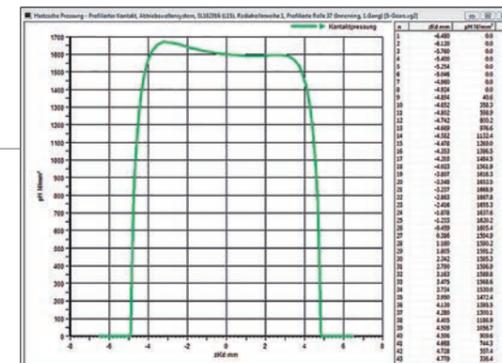
Linear system with actuator units



Wheel bearing unit



Manual automobile transmission in elastic housing (Source: General Motors) in Bearinx



Visualization of results: You can see what it is all about here.

## A good program depends on your “point of view”

A complete gearbox with all its gear stages, shaft systems, and bearings makes for a very complex calculation model that includes numerous parameters and results. The different views available in Bearinx allow design engineers to maintain an overview.

The geometry that has been specified can be visually checked using the 3D view, which includes a detailed depiction of the bearings. Results such as the power flow through the gearbox and the load and pressure distribution of the rolling contacts can also be shown in 3D. The bend lines and load curves of the shafts are displayed in the 2D shaft system view. The power flow through the gearbox is displayed for the various gearshift stages using a logically structured flow diagram.

Important results can be called up as tables or as graphics in the context menus for the individual components. A summary of all important input and results values is available in various document formats, including HTML, Word, and Excel.

## The optimum can be achieved quickly with Bearinx

The path to finding the optimum solution is often laborious, and numerous variations have to be tried out. Bearinx has two integrated tools to help you find the right solution quickly:

- The *parameter analysis* allows individual input parameters in your calculation model (for example bearing positions and the bearing’s internal design) to be automatically adjusted in stages and the influence that this has on selected target parameters (such as safety factors, rating life, rigidity, and power loss) to be displayed in graphical and tabular form.
- The integrated *OptiKit optimization tool* finds the exact configuration that optimally fulfills the target function for multiple variable input parameters, taking boundary conditions into consideration.

## Sometimes less is more: Load data classification

One problem that is frequently encountered when comparing calculation and practical operation is that tests or test runs deliver enormous quantities of data that, in their entirety, are unsuitable or only partially suitable for use as input data for calculation programs. The load data classification tool that is available in Bearinx helps to reduce the measurement data to a manageable number of data sets without any loss of quality.

## Making the most of every strength

Bearinx provides a number of useful interfaces for exchanging data and models with other calculation programs, so the strengths of these programs can be combined in an optimum fashion:

- Import of FE influencing values for elastic bodies into Bearinx
- Simple and automated integration of bearings into FE models
- Simple export of bearing models into Schaeffler’s Caba3D rolling bearing dynamics program
- Export of bearing rigidity data maps from Bearinx-MAP for use in other calculation programs
- Provision of a rolling bearing element for dynamic simulation using Simpla



Further information:  
<https://www.rexs.info>

- Data exchange (REXS) Schaeffler is participating in the project initiated by Forschungsvereinigung Antriebstechnik (FVA) to create a standardized format for exchanging gearbox data. In the gearbox calculation, files can be imported and exported in REXS format (**R**eusable **E**ngineering **E**Xchange **S**tandard).

- Export of contact models for extended analysis using Telos

## New strategy

To provide the customer with optimum support during development and to achieve a shared understanding with the Schaeffler engineering service, we also offer various customer versions of Bearinx.

We offer Bearinx-VIP (preliminary gearbox design) for long-term development partners with a user agreement.

INA/FAG’s direct customers and distribution partners with a user agreement can use our Bearinx-online modules for designing shaft systems, spindle applications, and linear systems free of charge. We also offer bearing data maps (Bearinx-MAP) for multi-body simulations.

The “Easy versions” are freely available online for everybody to use:

- Design of single-axis linear systems with Bearinx-online Easy Linear
- Design of multi-axis linear actuators with Bearinx-online Easy LinearSystem
- Simple calculation of friction and fuel consumption with Bearinx-online Easy Friction
- Design of screw drive bearing supports with Bearinx-online Easy BallScrew
- Design of rope sheave bearing supports with Bearinx-online Easy RopeSheave

**Further information**

[www.schaeffler.de/calculation](http://www.schaeffler.de/calculation)

**Information on other parts of the Bearinx Simulation Suite**

Caba3D – An insight into rolling bearing dynamics

[www.schaeffler.de/Publication\\_CABA3D](http://www.schaeffler.de/Publication_CABA3D)

**Information on other parts of the Bearinx Simulation Suite**

SIMPLA – Dynamic system simulation with rolling bearing expertise

[www.schaeffler.de/Publication\\_SIMPLA](http://www.schaeffler.de/Publication_SIMPLA)

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