KISSdesign, modal analysis

The eigenfrequencies and eigenmodes of a complete shaft system, including the effect of gear connections between shafts are calculated.

Meshing Stiffness

- ISO 6336 Method B
- Contact analysis per gear pair: with this option, the contact analysis of all active gears is carried out to calculate the mean value of the tangent stiffness at mating gears.
- Infinite: the tooth contact stiffness is assumed to be infinite. Select this option if you want to check limiting conditions.
- Ignored: the tooth contact stiffness is assumed to be zero and therefore, no connection between the vibrating shafts is considered.

Modelling approach

- Only torsional vibrations
- Torsional and bending vibrations
- Gyroscopic effect can be activated or deactivated.

Graphics

- Normalized displacements and rotations
- 3D deformation

Campbell diagram

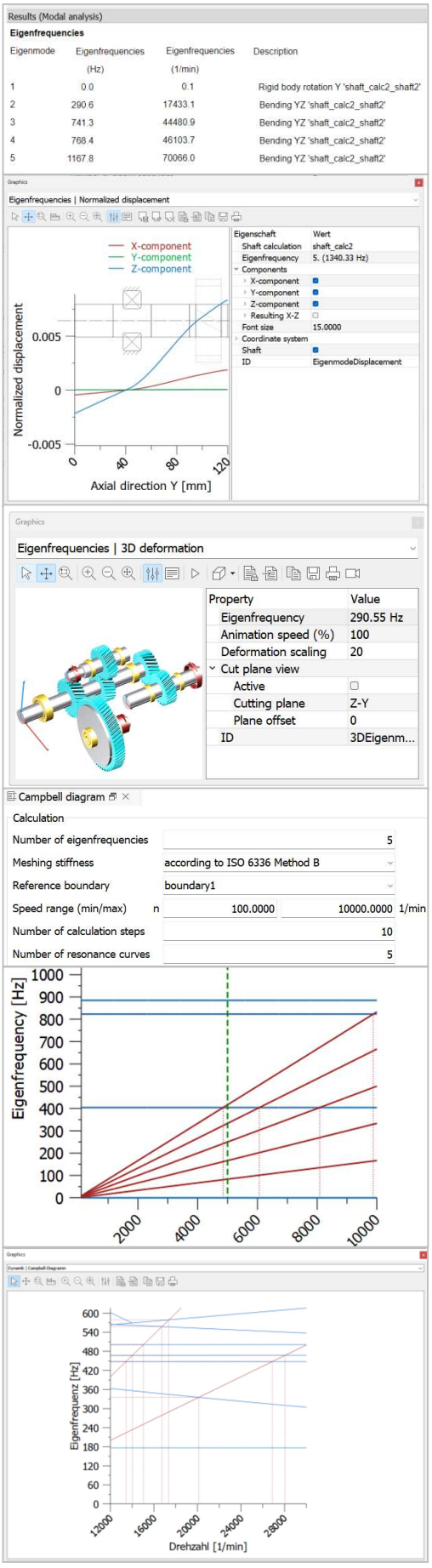
A Campbell diagram can be used to investigate the effect of shaft speed on the eigenfrequencies. This calculation can be used to define the critical eigenfrequencies for each speed.

Meshing Stiffness

- Includes the same four options as in the modal analysis.

Speed range and number of speeds

- The minimum and maximum values of the speed range of the reference boundary can be given. The Campbell diagram calculation iteratively is carried out at all speeds in the given speed range and produce the required outputs.
- Number of resonance curves can be assigned to see the intersection of orders and eigenfrequencies.



KISSdesign, forced response

Introduction

The powerful and user-friendly forced response analysis in KISSsoft provides the analysists and engineers to perform the dynamic analysis of powertrain systems quickly and efficiently. The vibration characterization of the system under periodic excitations is performed to assess the NVH behavior of a system.

Excitation sources

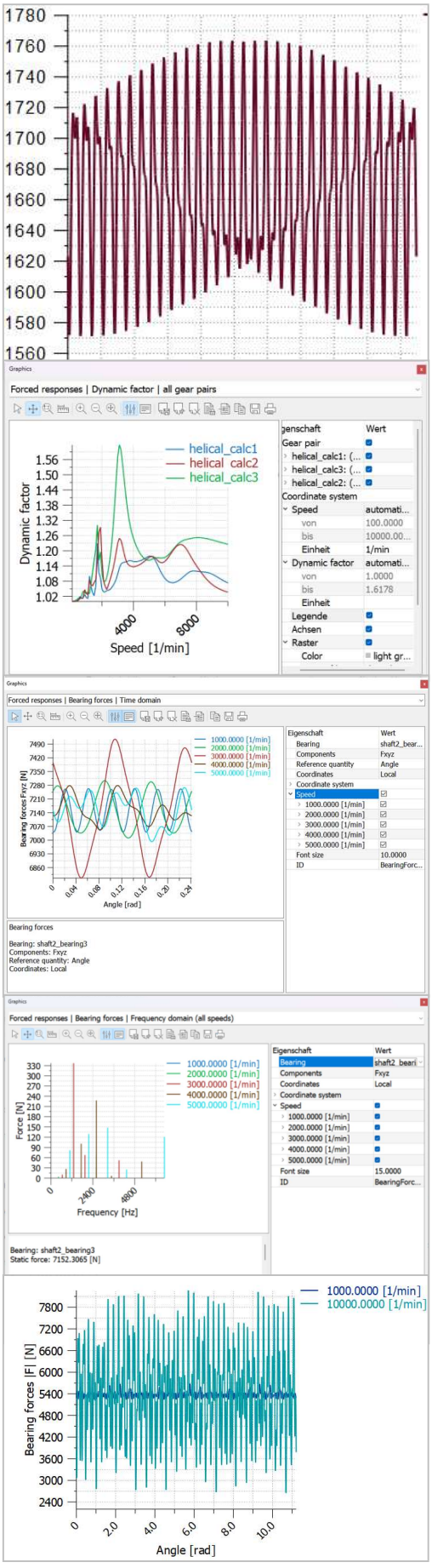
Three sources of excitation can be modeled:

- Unbalanced masses
- Gear meshing forces: as the main source of excitation, the effects of variable meshing stiffness and transmission error at mating gears are considered.
- Torque ripples: they are periodic excitations in torque, which can result in vibration and noise.
- This effect can usually be observed in many electric motor and combustion engine designs, referring to a periodic fluctuation in the output torque as the motor shaft rotates.

Calculation

The main settings for the calculation process include:

- Minimum and maximum values of the speed range of the reference boundary for the analysis can be given. Forced response iteratively solves the system at all speeds in the given speed range and produce the required outputs.
- Number of harmonics: The number of frequencies of the excitation forces from different sources can be considered.
- Meshing stiffness and transmission error are used to calculate the excitation forces. Forced response offers different types of stiffness calculation based on contact analysis per gear pair as well as the system contact analysis.
- Excitation force type: three different approaches including “tangential stiffness”, “secant stiffness”, and “excitations forces in contact module”.
- Two modelling strategies are available; eighter to consider only torsional DOF, or bending and torsional DOFs of the flexible shafts to calculate system dynamic responses.



Material damping

In powertrain systems, all deformable elements can dissipate energy when subjected to dynamic deformations. In the forced response analysis of a model in KISSsoft, three different damping sources can be given:

- Damping of bearings and supports
- Structural damping of shafts
- Gear mesh damping

Output data specification

- The results of the forced response analysis can be generated in both the frequency and time domains.
- The quality of the results in time domain can be adjusted by setting the resolution to low, medium, high, or very high.
- In time domain analysis, the end time and step time for generating the output data is adjusted in a way to capture all possible excitations and to complete full periods of the vibrations for all excitation frequencies.
- The output data can be saved in a user-defined folders for further process in other software packages.
- The response and movement of the system`s elements as the result of the excitations can be visualized in a 3D view to provide more insights to the response of the system`s elements.

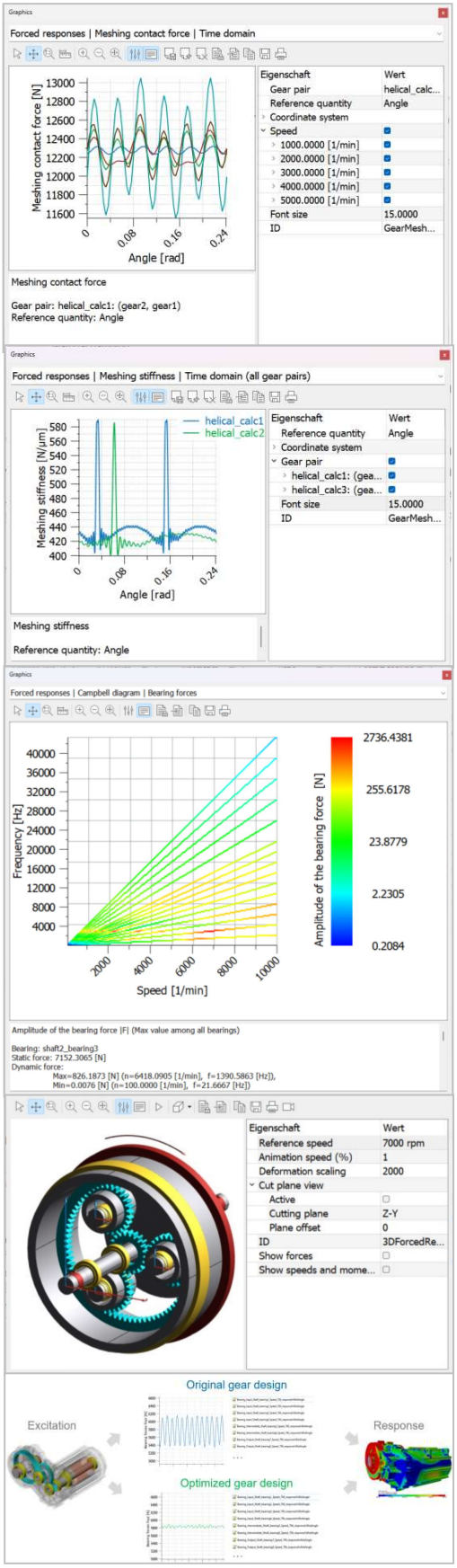
Result window

For all active gear pairs, some important results such as gear meshing frequency, maximum dynamic force and dynamic factor at all running speeds are presented.

Graphics

The results and outputs of the forced response analysis can be accessed in the graphics menu including:

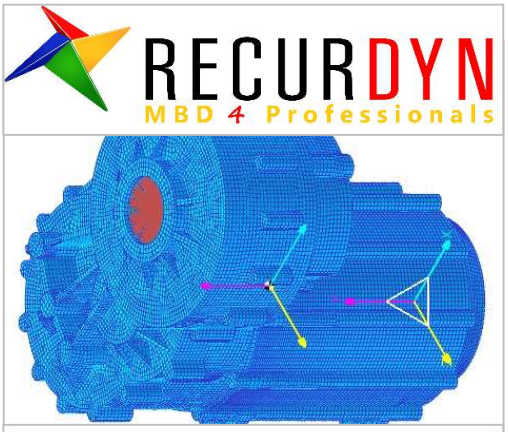
- Dynamic factor
- Bearing force and moments
- Shaft outputs
- Gear mesh outputs
- Campbell diagram
- Whirl orbit parameters



Housing vibration and noise

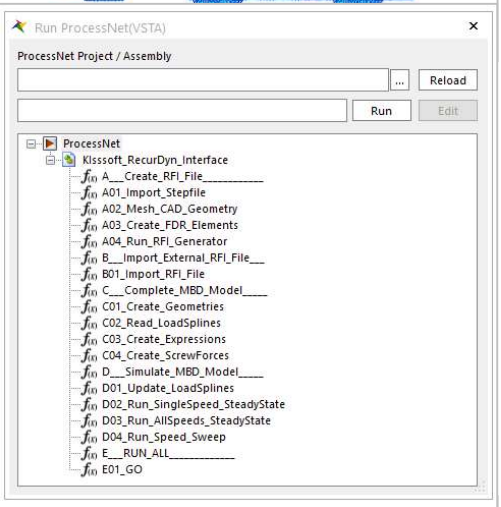
Overview

For characterization of the NVH properties, a calculation process using KISSsoft and RecurDyn software is offered. By exporting the transient bearing forces from KISSsoft to RecurDyn and applying them to a housing, the housing response may be computed. The approach is fully automated through an interface window in RecurDyn.



Linking KISSdesign and RecurDyn

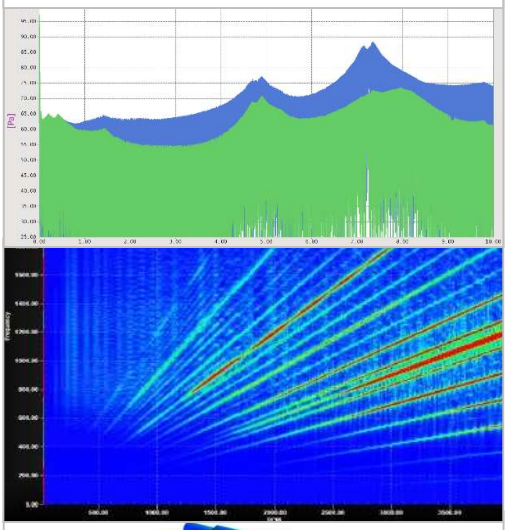
RecurDyn, by FunctionBay, is a Multibody Dynamics based software with an integrated nonlinear Finite Element Method and a noise tool kit extension. RecurDyn/Acoustics is a noise analysis toolkit that performs the predictive analysis for noise of the mechanical system by confirming which parts of the surface of a flexible body emit more noise and which frequency band ERP is dominant.



Modelling in RecurDyn

FEM modelling in pre-processor, housing or housing with internals

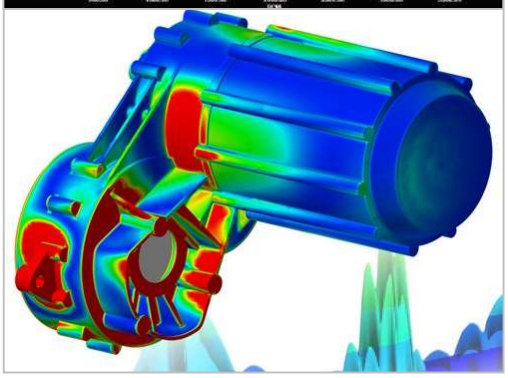
- Mesh generation, define bearing points
- Fix housing to ground, add force distributing element, set damping ratio
- Reading load splines from KISSdesign



Data exchange from KISSdesign to RecurDyn

The forced response calculation in KISSdesign generates the load data used to excite the housing modelled in RecurDyn

- Force vector for each bearing in time domain
- Speed sweep, user defined speed increments
- Export of text files from KISSdesign, import in RecurDyn using script



Results

Distribution of ERP over housing surfaces is as basis for predictive analysis of noise emitted.

- Accelerometer evaluation
- ERP (effective radiated power) for structure borne noise assessment, in time and frequency domain
- SPL (sound pressure level) measured using virtual microphones
- NVH analysis for speed ramp, by interpolation between singular speed levels
- Campbell diagram 2D and 3D
- Evaluation of individual modes in time domain and frequency domain