DELTA JS AG

**Machine Dynamics**

**Software * Engineering * Consulting**

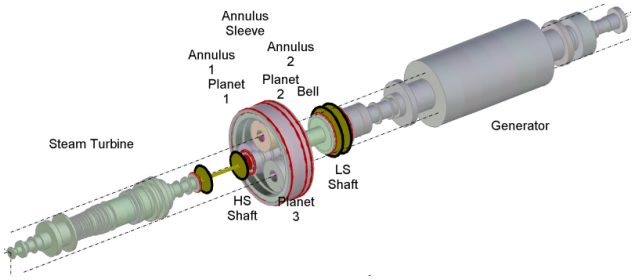
# MADYN 2000: Software for General Rotordynamics

## Unique Modelling Capabilities

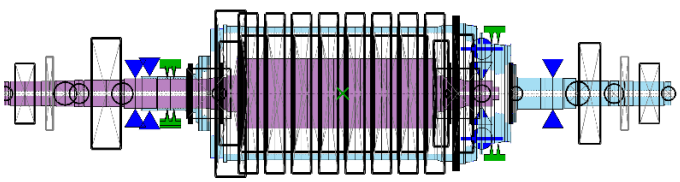
- Rotor gear bearing systems for torsional, lateral, axial and coupled analyses
- Parallel and planetary gears with stationary as well as rotating planet carriers
- Consideration of lateral, torsional and axial coupling in gears
- Bearing types: Spring and damper, linear & nonlinear rolling element bearings, linear & nonlinear fluid film bearings and floating ring bearings, magnetic bearings (radial and axial)
- Rolling element bearings are considered with a 5x5 stiffness matrix taking into account the lateral and rotational stiffness about bending axes and the lateral, axial coupling.
- For fluid film bearings various effects can be considered: 2-phase flow in cavitation zones taking into account ambient pressure, turbulence, different oil supply conditions and axial sealing, thermo-elastic deformation, canting
- Tilting pad bearings with frequency dependent characteristic
- Magnetic bearing controllers can be modelled by proven controller building blocks similar to real systems.
- Squeeze film dampers, linear and nonlinear
- Bearing supports (casings and foundations): Spring mass damper, coupled transfer functions (couplings between different bearings are considered), state space matrices
- General spring (6x6 full stiffness and damper matrix)
- Flexible couplings with linear and nonlinear characteristics
- Fluids (for seal effects) with speed dependent coefficients
- Elastic mounting of masses with an axial offset to their centre of gravity
- Superimposed shaft sections with different material, e.g. to model motor windings
- Temperature dependent materials
- Bending stiffening due to prestress or softening for pressure
- Import of rotor data from text files via a flexible interface
- Active system for torsion allows modelling linear relations by state space matrices between torsional deflections and velocities and torques
- Mechanisms causing hot spots (e.g. Morton effect)
- For further user specific modelling custom blocks can be defined.
- User defined nonlinearities (apart from the standard nonlinearities for fluid film bearings, rolling element bearings and flexible couplings) can be defined with the help of custom blocks and MATLAB code.

## Powerful Analytical Capabilities

- Static analyses: Force, gear, weight loads, misalignment (optional consideration of journal position in fluid films and the deformation in rolling element bearings), alignment optimization for force free coupling
- Damped eigenvalues: Complete systems are considered, e.g. consisting of the rotor, a magnetic bearing system and a stator system (casings and foundations), i.e. no iterative solution for frequency dependent characteristics.
- Harmonic response to unbalance, forces and moments, base acceleration, bent shafts and coupling offsets. Excitation frequencies can be synchronous, non-synchronous, speed multiples, frequency multiples and combinations of speed and frequency multiples.
- Balancing from measured data
- Linear and nonlinear transient response to forces and moments, base acceleration
- Linear and nonlinear transient run ups and downs
- Parameter variation (eigenvalues as a function of a parameter): Undamped critical speed map, Campbell diagram (speed variation), bearing stiffness and damping variation, flexible coupling stiffness variation, general parameter variation
- Hot spot stability, among others Morton effect stability
- Optimization of magnetic bearing controller parameters with respect to damping, bearing forces and robustness
- Alignment optimization considering the oil film



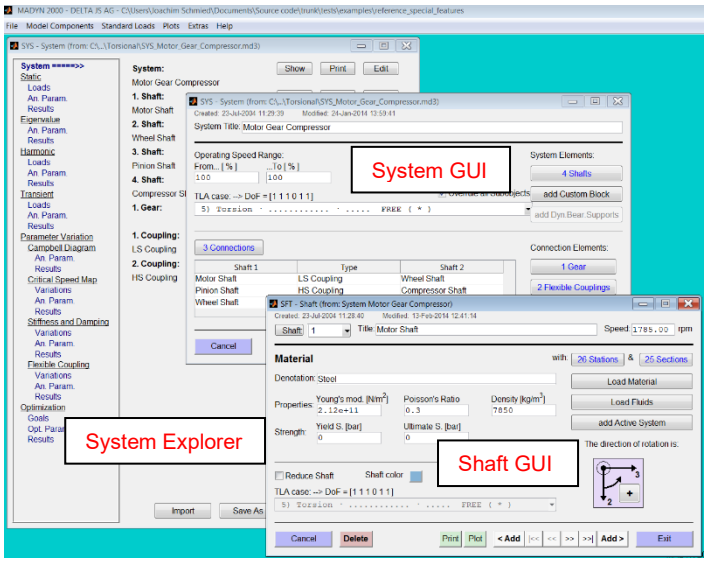

*Model of a steam turbine generator train with planetary gear*



*Model of a pump with inner and outer rotor*

## Easy to Use Graphical User Interfaces (GUIs)

- to model,
- to apply loads,
- to define and start analyses,
- to select and present results.
- The system explorer allows controlling every step of a rotor dynamic analysis: Modelling, defining loads and analysis parameters, viewing results



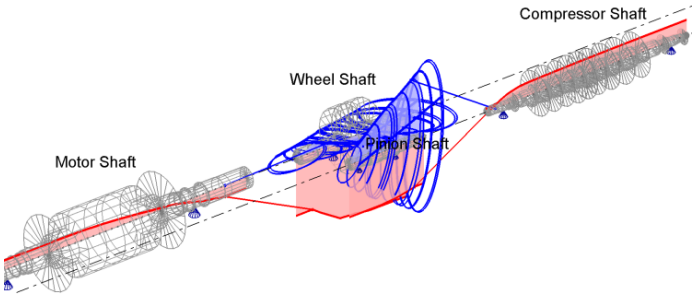

*System explorer with graphical user interfaces*

## Object Oriented Data Structure

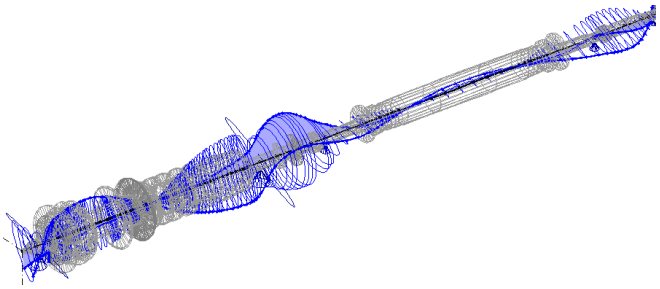
- to have self-contained objects such as bearings, shafts, gears or systems,
- for easy combination and mounting of model parts such as bearings and shafts,
- to simply create libraries by storing objects in appropriate directories.
- Consistent and complete information (model, loads, analysis parameters and results) is stored in a system. Its behaviour is intelligent to maintain consistency, i.e. in case of changes affected results are cleared.

## Plots of Models and Results

- Plots are clear and practice oriented with complete and consistent information. Various options for the presentation of very complex information are offered (add data tips, select individual shafts …).
- Curves of diagrams can be copied and pasted for comparison of results between different systems.
- Model plots are available at all hierarchical levels: Systems, gears, shafts, bearings, couplings.
- Shape plots (results along shaft axes) for deformations, forces and moments, stresses
- Clear presentation of time dependent shapes
- Resonance plots with various options (selectable lateral directions, main axis of orbits, relative vibration, API evaluation of resonances for lateral vibrations)
- Presentation of eigenvalues in Campbell diagrams and other diagrams with sophisticated sorting
- Various other diagrams for parameter variation results
- Plots for the time history, orbits and shapes of transient response results
- Plots can be configured by the user.




*Coupled lateral torsional vibration mode*



*Natural mode of a power generation shaft train*

## Automation of Analyses

- Batch processing files can be created and imported to different systems. The use of denotations for objects allows generalizing loads and analyses parameters for various systems.
- With the help of a command line interface objects can be addressed and their properties changed using WINDOWS scripting.

## Services

- A standard training within a general rotor dynamic seminar takes place twice a year. Individual trainings are offered either in DELTA JS or the client's offices.
- Support by e-mail and telephone
- Maintenance with regular updates. Updates include new features and improvements to enhance the user friendliness and robustness.

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