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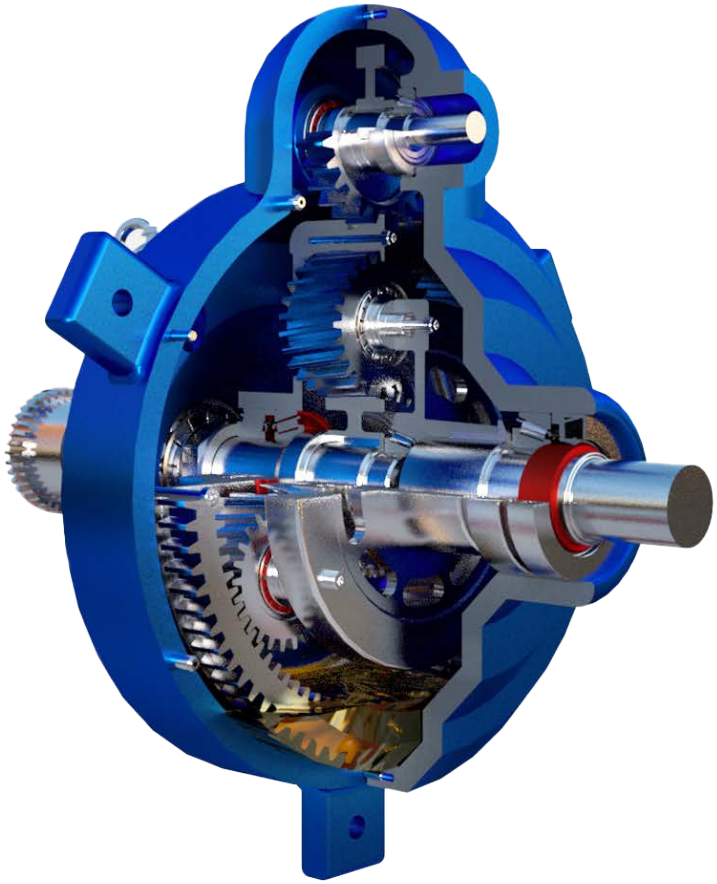

SABR

PROVEN SHAFT, GEAR AND BEARING CONCEPT DESIGN PACKAGE

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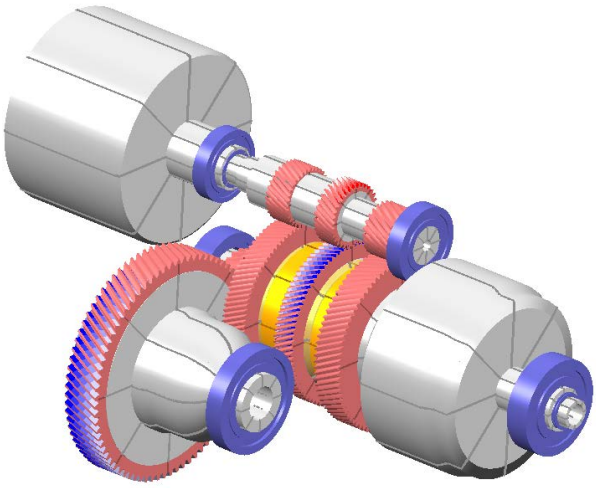
What is SABR ?

SABR is a proven shaft, gear and bearing concept design package. It has been developed to integrate into the design process, reducing product development time by saving months of expensive durability testing. Using an intuitive graphical user interface, all or part of the transmission system can be modelled at a level of detail appropriate to the current design phase. Sensitivity studies to determine the effect of different geometric features, such as bearing types and gear positions can be performed quickly, delivering immediate results. SABR guides durability improvements and directs early NVH solutions whilst reducing gearbox losses, cost and weight, all instrumental in transmission efficiency.

Key features

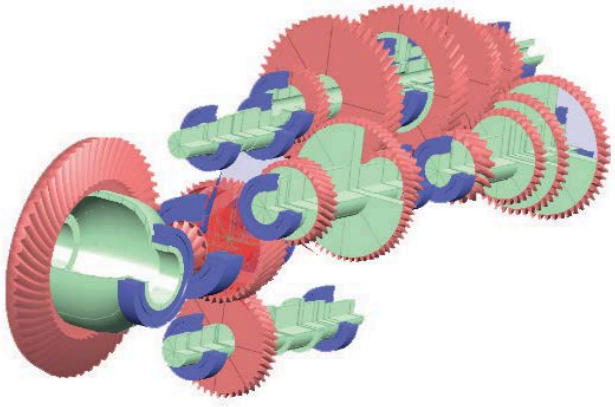
- Simple intuitive GUI, with solver based on latest engineering standards
- Continually updated with real-world test and development data
- Capability to model EDUs, manual, DCT, automatic, complex planetary and bevel applications
- Hybrid and split path gearboxes can easily be modelled with any number of power sources, absorbers or auxiliary drives
- Design for balanced input and output gear life to achieve target NVH criteria
- Tooth Contact Analysis (TCA) for micro-geometry design, transmission error, scuffing and micro-pitting analysis
- Bearing analysis with life calculation and stress plots accounting for loading, roller profiling and misalignment
- Casing stiffness matrices can be imported from major FE packages, or reduced using the Realis Simulation FEARCE solver
- Shaft design and fatigue analysis
- Transmission error export for NVH excitation of dynamic models



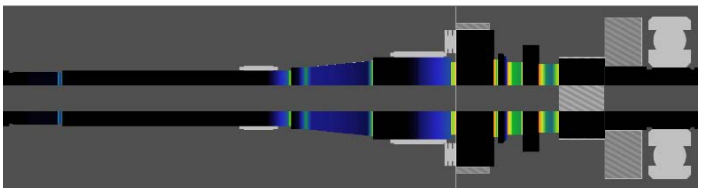
Shaft design

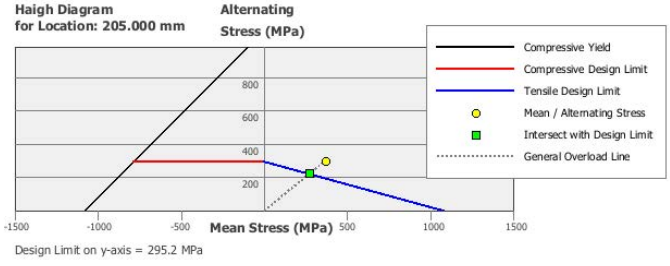
SABR allows the user to quickly and accurately model transmission shafts, ranging from single section shafts for initial concept sizing through to complex multi-node arrangements for full and detailed system analysis, quickly and accurately. 2D CAD can be imported and shaft profiles built up with simple click and drag on the overlaid CAD, making complex shaft building trivial.

Stress concentration factors are automatically calculated and can include oil holes, circlip grooves and fillet radii at changes of diameter. Material properties are combined with automatically calculated size and surface finish factors for use in fatigue analysis. The results are plotted on a Haigh diagram using the modified Goodman criteria to give safety factors at every location against infinite life.



- Interactive 3D Graphical User Interface
- Ability to assess all levels of shaft complexity using 2D profiler with simple click and drag and overlaid imported 2D CAD
- Automated stress concentration, size factor and surface finish factor calculation
- Haigh diagram plots of every location and tables of stress and safety factor. Colour plots of stress and fatigue safety factor for quick identification of critical areas
- Tabulated and graphical results showing breakdown of all stresses

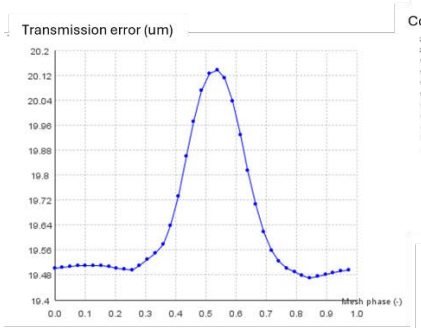


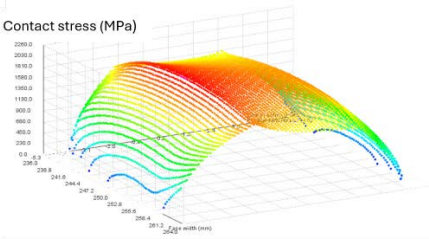


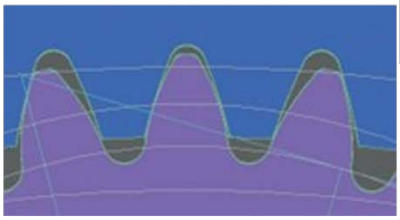
Gear design

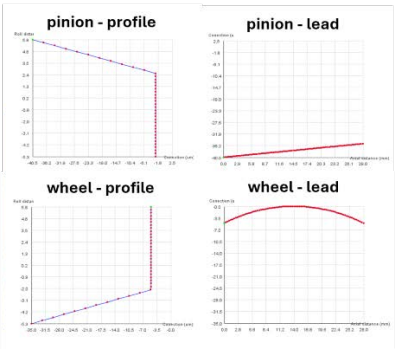
SABR's transmission assessment capabilities are enhanced by SABR-Gear an integral part of the suite. Users can define initial gear sizes and rate parallel axis gears according to the ISO 6336 standard, including the effect of calculated gear misalignment. This powerful tool enables non-specialists to optimise gear geometry and determine the effect of misalignment on gear life. The designer receives immediate feedback of any change to input parameters both graphically and numerically.

Parameter sweeps can be carried out on multiple input parameters with results filtered to focus on the optimum areas of interest to deliver the highest efficiency gear pair combinations. Tooth Contact Analysis (TCA) considers the effect of micro-geometry and misalignments for all operating conditions, running in seconds where stress, transmission error, flash temperature and oil film thickness are all outputs by default. Transmission error can be exported seamlessly to Realis Simulation VALDYN to perform non-linear time domain Multi-Body System (MBS) analyses of the transmission for NVH assessment.







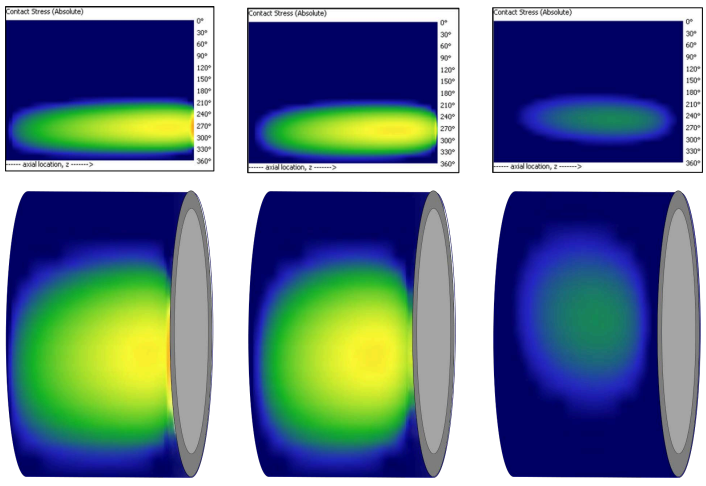


- Powerful rapid optimiser delivers viable robust geometry designs
- Visual representations of clearances and key design attributes, providing immediate feedback
- Direct import / export interface to SABR. Link mode ensures synchronisation between the two programs
- Detailed duty cycle function allows multiple loading regimes to be analysed to assess cumulative damage
- Efficiency calculations combining load and speed dependent losses according to ISO 14179
- Parametric sweep function helps to explore the design space more comprehensively and filter on critical design metrics for NVH, durability and efficiency
- TCA for stress, transmission error, flash temperature and micro-pitting assessment with all duty cycle and misalignments passed from SABR
- Export to GearLab LDP and DONTYNE Load Analysis Model is also available

Bearing selection and rating

SABR is able to model deep-groove and angular-contact ball bearings, as well as tapered, cylindrical and needle roller bearings that are casing mounted or encapsulated within two rotating components. The bearing life, misalignment and loading algorithms form the backbone of SABR and are based on bearing calculations used by bearing design and manufacturing companies, including the ISO 281 and ISO 16281 standards. A close relationship with bearing companies has advanced the evolution of SABR with Koyo, SKF and Timken bearing catalogues included as part of the suite. SABR can calculate and visually represent the exact loading regime of the bearing, showing the stress distribution and utilisation of the bearing race as well as potential areas of excessive load.

- Analysis of standard and custom bearings
- Life calculation, taking into account bearing misalignment, roller crowning along with loading, preload and clearance
- Editable roller and raceway profiles allow all bearing designs and their application to be considered
- Visual display of loading regime on the bearing raceways
- Preload assessment to understand how stiffness, stress, durability and frictional loss are impacted by applying preload
- Efficiency calculations combining load and speed dependent losses according to ISO 15312
- Bearing positioning tool allows fast iterative assessments of transmission layout
- Integrated bearing catalogue and ability to define bespoke bearing catalogue
- Casing stiffness matrices can be imported from major FE packages, or reduced using Realis Simulation FEARCE solver
- Bearing loads can be exported for visualisation on finite element (FE) meshes of the outer races, and as input for casing FE contact analysis to aid casing design decisions



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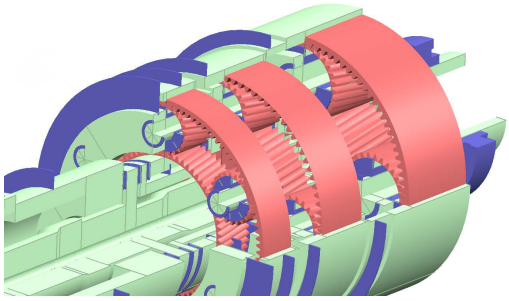
Fast multi-core solver

SABR can assess multiple load path regimes defined by time, torque and speed inputs. The setup of complex load paths across any number of gear sets is effortless for all gearbox types including automatics, dual clutch, hybrids and split-path transmissions. The analysis includes the effects of any back-driven components.

The fast non-linear solver takes advantage of multi-core processors, allowing users to assess design changes in seconds.

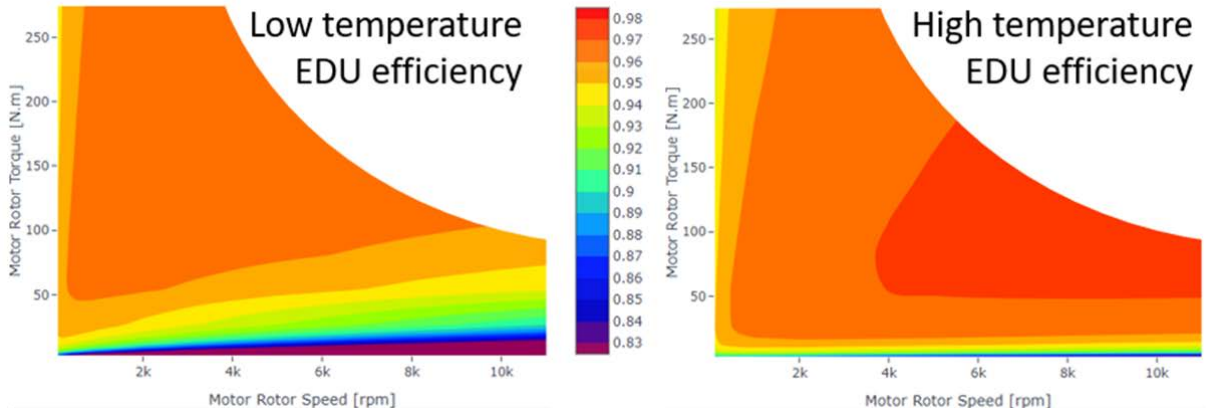


- Ability to enter as many loading regimes as required
- Simple graphical interface, enabling precise and quick data entry
- Hybrid power flows with any number of power sources
- Fastest non-linear bearing solver with multi-core processing as standard
- Duty cycle import from .csv format allowing full road load data or test rig regimes to be considered
- Duty cycle compression into a smaller number of fatigue load and speed bins

Efficiency maps

SABR calculates the speed and load related losses of all bearings and gears in the transmission according to ISO standards 15312 and 14179. The loadcase generator and fast solver allow temperature dependent torque and speed efficiency maps to be generated in seconds.

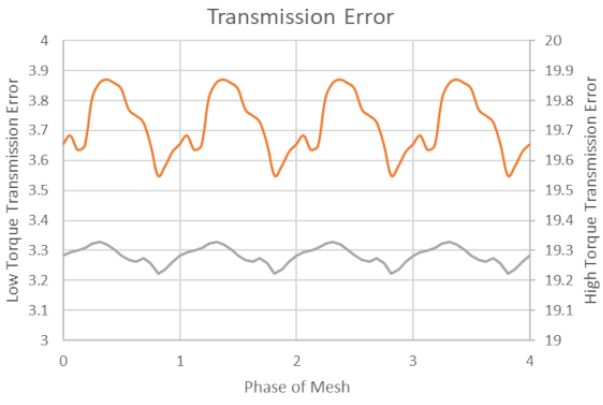
- Creation of all loadcases across the torque and speed range
- Fast solver derives complete maps in seconds
- Temperature dependency is included
- Maps exported for inclusion in system models such as Realis Simulation IGNITE to calculate accurate energy consumption across any drive cycle



Noise, Vibration, Harshness (NVH)

SABR provides the user with all of the tools and guidance to reduce gear excitation during the design phase. Parameter study results can be filtered on critical NVH metrics. Fast Tooth Contact Analysis (TCA) accounting for system stiffness is used to minimise transmission error excitation across the torque range.

The SABR model, including transmission error, can be exported seamlessly to Realis Simulation VALDYN to perform non-linear time domain Multi-Body System (MBS) analyses of the transmission for NVH assessment.



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