CARE Overview

The analysis of electronic and mechanical systems is based on the assumption that the system will function in a particular environment and may fail at any time randomly or according to the inherent failure distribution.
At times, a failure in a system might cause the user some inconvenience, but at other times, the impact might be more severe and even cause the loss of human life.

CARE® is a set of software tools that can simulate all kinds of failures in a system and the effects of such failures on the system behavior.

CARE® will help to develop more reliable systems, with a cost effective hardware, while shortening the design and time to market.

CARE® simulates all potential functional and process failures (electrical/ electronic/ mechanical and software). For high availability systems, CARE® recommends the optimal redundancy needed to achieve the highest availability at a minimum hardware cost.

CARE® is used in the preliminary design as Top-Bottom allocation/analysis and in the full -scale development as a Bottom-To-Top prediction/analysis.
CARE® has been integrated in all well-known design CAD/CAE systems and uses the data in real time when generated by the designer. This helps to shorten the design cycle.

CARE® is applicable to electronic and mechanical systems

For Electronic design, CARE® helps select the correct parts according to the stress load & temperature, reduce the PCB size, to insert test points, to improve the Built-in-Test capabilities, to reduce the PCB failure rate and to improve networks availability.

For Mechanical Design, CARE® helps to reduce wear-out, aging, fatigue, cracks, corrosion, loss of strength and reduces the individual part failure rate as well as for complex mechanical system.

CARE includes the following modules:

- MTBF: Mean Time Between Failures (Prediction & Allocation)
- SDTA: Stress Derating and Thermal Analysis
- FMEA/FMECA: Failure Modes Effects and Criticality Analysis
- TA: Testability Analysis
- FTA: Fault Tree Analysis
- MTTR: Mean Time To repair
- RBD: Reliability Block Diagram, Basic, Network and Markov
- MRS: Mechanical Reliability Simulations

Key Benefits:

- Provides reliability measurements during design
- Helps to identify the most unreliable parts for improving
- Provides dictionary for failure modes and the effects on the system behavior
- Reduces the time needed from RAMS analysis and provides results to the designer much faster
- Reduces the time needed to perform RAMS analysis

MTBF: Mean Time Between Failures

Product reliability performance is a major consideration for technology firms. It affects the entire company's bottom line. Poor product reliability may raise the following questions: Will your warranty costs exceed the total predicted costs? Will the firm lose valuable reputation?

Reliability is defined as the probability that an item, product or a system will perform a required function under stated conditions for a stated period of time. A reliability prediction can be stated as the average time (usually expressed in hours) that a part, a component or a system works without failure.

A reliability prediction is usually based on an established model described in MIL-HDBK-217, Bellcore, or some other model before the product is manufactured or marketed. The model can predict MTBF using as little data as the part type and count information. As the design progresses, the MTBF model can be updated to include thermal and electrical stress analysis information.

Key benefits of MTBF prediction:

- Meets reliability objectives
- Saves money on all life cycle costs
- Optimizes maintenance
- Maximizes availability
- Decreases time to market
- Improves product design
- Reduces company warranty and repair costs
- Improves product safety
- Ensures return on investment

MTBF Prediction: Failure rate and MTBF calculation for components and blocks using prediction methods and conditions

Predicts Failure Rates according to:

- MIL-HDBK-217F Notice 2
- 217Plus
- British-Telecom HRD5
- Siemens SN-29500
- IEC62380 - RDF2000 / UTEC80810
- NSWC98 mechanical
- Non-Operating (RAC Tool kit)
- Bellcore Issue 6
- CNET 2000
- Chinese GJB299
- FIDES, available soon
- Component libraries (only for M217, HRD5 and Bellcore)
- Interface for direct import from CAD/CAE interfaces
- CARE® MTBF CAD/CAE/ERP Interfaces
- Importing your part list into CARE-MTBF
- Mentor Graphics
- Cadence
- Or-Cad
- Excel CSV
- ERP – SAP
- ERP – MFG-Pro

Global change, optimization and curve sensitivity for: Ambient/Case temperature, Quality-Levels, Environments and Prediction-Methods.

Handles Project Trees, CORE Database & the HTML report generator.

User defined prediction models for components and assemblies, based on field data .

3 Pareto tables by: Reference-Designator, Part-Numbers & Part-Categories

MTBF Allocation

- Top-Down Allocation Algorithm for RAMS requirements-Serial Model.
- For redundant models the RBD module is used.

SDTA: Stress De-rating and Thermal Analysis

Reliability is a major factor in product design. For this reason there is an increasing need for proper component selection to match end customer operating environments.

Components tend to fail when operating near their rated stress values and therefore, operation at derated conditions is mandatory.

SDTA compares the actual operating stress of each component with the allowed component stress within its operating environment. It assists the designer to evaluate the best derating decisions - either to reduce the stress of the part or increase the stress rating of the component.

SDTA examines all types of stress characteristics such as power, voltage, current and temperature.

Key Benefits of the SDTA

- Optimizes the component size and cost vs. reliability
- Increases reliability performance
- Identifies components over specified de-rating limits
- Identifies design improvements for electrical parameters
- Compares the operating values and the allowed de-rated values
- Recommends to replace over-stressed components - improves reliability
- Recommends to replace under-stressed components - reduce PCB area, thus reducing costs
- Ready de-rating curves according to Military and Industrial criteria
- Ready de-rating curves according to NAVSEA TE000-AB-GTP-010 Revision 2
- User defined De-rating Curve

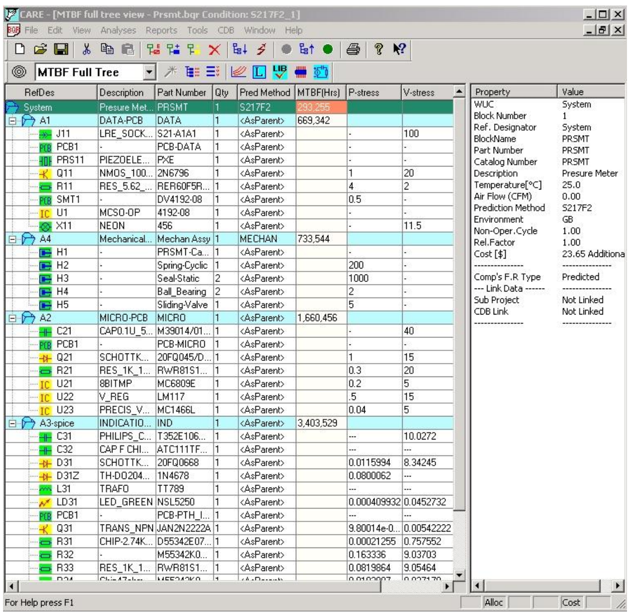
Testability: Testability Analysis

The Testability Analysis allows users to analyze the coverage level of the built in tests of a system, and to check the isolation level of those tests.

The Testability module is an extension of the FMECA software.

Key Benefits of the Testability

- Calculates the Detection level of a system's Built In Tests
- Calculates the Isolation level of a system's Built In Tests
- Presents the percentage of the Bit Fail and False Alarm in a system
- Uses the FMECA functional tree to calculate the system Fault Detection and Fault Isolation by means of BIT and ATE
- Calculates False Alarm and BIT fail rates
- Provides Pareto Non-detected failure modes
- Provides Pareto Non-isolated failure modes
- Detection and Isolation reports for all data, for each severity for each BIT and for each combination severity & BIT
- Different forms of tests library definitions for different BIT
- User defined BIT types and associated test points/procedures
- Provides on screen results, Fault detection and Fault isolation for each assembly and for each Failure Mode



FMEA/CA: Failures Modes, Effect and Criticality Analysis

The FMEA is a reliability modeling method, based on an qualitative approach, whilst the FMECA (Extension of FMEA) takes a quantitative approach and assigns a criticality and probability of occurrence for each given failure mode. FMECA is a procedure, which should be implemented during the design phase to identify potential design weaknesses (failure modes) in a system and classify them according to their severity and probability of consequences.

The main objective of the FMECA is to improve design thus eliminating as many system failures and hazards as possible, to increase the probability of a fail-safe operating, and to reduce the risk and failure rate of consequential damage.

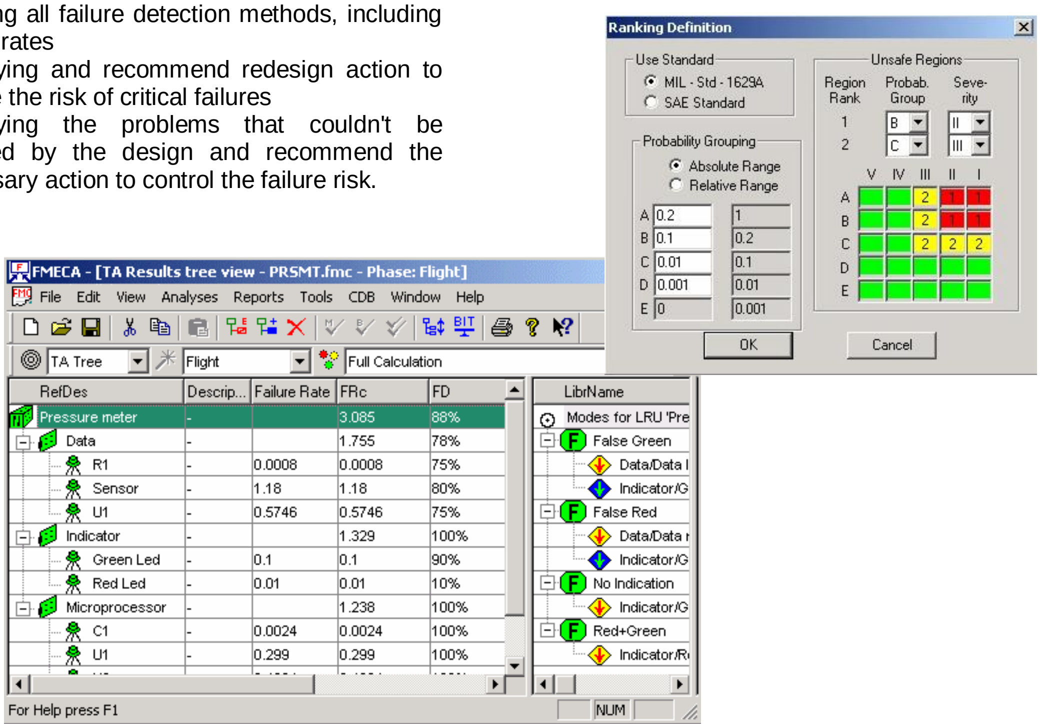
The FMECA is a bottom to top analysis in which the designer assigns for each part a list of failure modes and the effects of those failure modes on the system behavior.

FMEA/FMECA requires the following steps in the design process:

- Defining system block diagram and functional interrelationships
- Identifying all potential failure modes in the system including effects of the failure mode from the basic function of the system up to the upper system function
- Analyzing the system failure modes and their potential severity category
- Defining all failure detection methods, including failure rates
- Identifying and recommend redesign action to reduce the risk of critical failures
- Identifying the problems that couldn't be reduced by the design and recommend the necessary action to control the failure risk.

Key Features:

- Handles hardware/software functional trees with no limit on function levels, number of assemblies, or number of failure modes
- Calculates failure mode probabilities
- Automatically propagates failure mode effects to the next-highest block. This methodology is utilized throughout the product tree to assign the system end effects.
- Provides a new type of effect: Sibling Effect. A Sibling Effect propagates failure modes to an effect of a sibling block in a similar manner as described above for next-higher effects.
- Allows defining good modes as well as failure modes.
- Converts the FMECA tree into a Fault Tree (if the Fault Tree Module is available for the user) that includes all causes and effects.
- Performs safety and hazard analysis with user defined severity & probabilities.
- Contains libraries for components and assembly information. (Failure modes only- not reliability prediction rates)
- Provides access to a library of both standard and user defined failure mode names, causes, effects, compensating provisions, and detection methods.



RBD: Reliability Block Diagram – Basic / Network / Markov

Reliability Block Diagram is a technique and a graphical representation that is used to model and analyze the reliability and availability of large and complex systems, which includes redundancies in non-serial architecture or the blocks with multiple states. The RBD enables analysis of real world scenarios with combination of redundant or various system states.

The RBD Module uses bottom-to-top calculation or top–down requirements allocation providing standard system and sub-system parameters such as reliability, availability, down time, failure rates, and more. BQR's RBD provides a simple way to compare various reliability configurations in an attempt to find the best inclusive system design.

Under the Hood of BQR's RBD
BQR's RBD calculation program does not use a Monte-Carlo method of statistical simulation. It contains analytical formulas and numerical algorithms providing quick calculations with control for higher accuracy.

The tool's core engine is based on a Hierarchical Graphical Reliability Architecture Builder and a mathematical solver for the development of Complex Redundant & Maintenance Concepts while minimizing Life-Cycle-Cost. The RBD provides sensitivity analysis utility for the development and guidelines of System designers and managers.

Tool for Complex Systems
The RBD Package is an advanced tool for the analyzing and modeling complex hi-tech systems and sub-systems, such as: telecommunications, semiconductors, satellites, broadband, wired & wire-less, storage, safety systems and others. BQR's RBD provides a full flexibility tool tailored to specific applications. BQR's RBD data may be used in all BQR's Software packages to provide shared data and advanced analysis covering all aspects of Reliability, Availability and Maintainability.

Technical description of the BQR's RBD

- Supported models: Serial, Parallel, K-out of N (with identical and different sub blocks), Standby, Markov, Network, and any of their combinations in hierarchic tree.
- Types of failure time distributions for lowest components: Exponential, Normal (truncated at 0), Lognormal, Uniform, Pareto, Rayleigh, Weibull, Bathtube.
- For composite blocks (having sub blocks) the failure time distributions are calculated (non-parametric, as Reliability (Density, Hazard rate) – time arrays)
- Available Repair types of a block:
  - Replacement of entire block (together with all sub blocks),
  - Disassembly, with sub blocks repair or replacement
  - No repair
- Available Repair types of sub blocks:
  - Cold repair (after the parent block failure and stopping),
  - Hot repair (during the parent block operation, if the other redundant sub blocks operate)
  - No repair
- Available reliability parameters for each block: Mission Reliability, Availability, Mean Time Between Critical Failures (MTBCF), Mean Time To Failure (MTTR), Average Failure Rate Per Million Hours (FPMH), Down Time during mission due to failures and corrective maintenance.
- Available safety parameters (for the blocks of Safety Related System according to IEC-61508): Safe Failure Ratio, Diagnostic Coverage, Diagnostic Test Interval, Proof Test interval, Safe Failure Fraction, Mean Time Between Dangerous Failures (MTBDF), Safety Function Demand Type, Probability of Failure on Demand (PFD), Probability of Failure per Hour (PFH), Safety Integrity Level (SIL), Failure Damage, Unsafe Failure Probability, Damage Risk

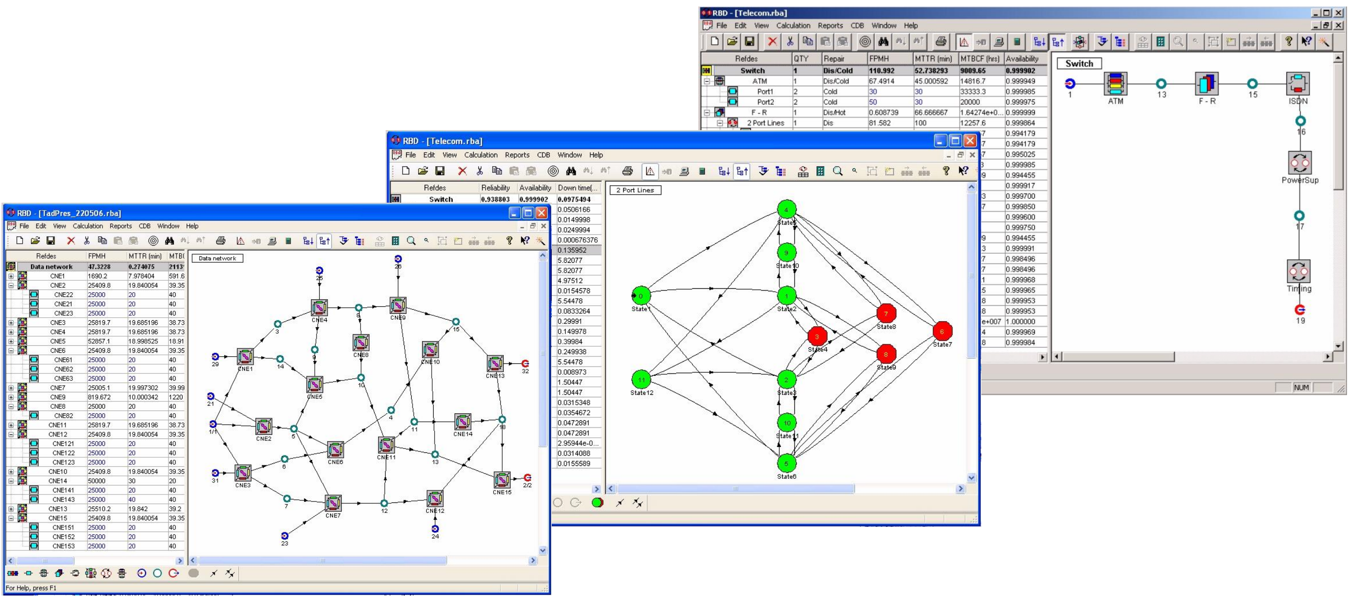
The RBD Platform

The user interface of the RBD provides advanced graphical representation of system hierarchy and easy navigation features. It covers comprehensive and customized reporting capabilities, graphs and users wizard. The user can easily navigate between sub-systems or view and edit any sub-systems. The RBD provides import/export mechanism to other BQR's packages and for a variety of other analysis performed by other CARE software packages.

Key Features:

- Assesses the level of failure tolerance achieved
- Performs trade-off scenarios to optimize the reliability and cost within a system
- Quantifies the reliability of a system or subsystem
- Identifies intersystem disconnects as well as areas of incomplete design definition (network model)
- Identifies possible system design matrix
- Provides the real Critical MTBF of a redundant system
- Can combine various Reliability models (basic, Markov and Network) in one project
- Provides results for all reliability parameters in needed to evaluate a system
- Helps to design the correct redundancy to achieve certain availability

- Available calculation types:
  - Reliability and safety parameters calculation bottom-to-top basing on lowest blocks distributions, reliability and maintainability models of all blocks;
  - Reliability requirements allocation top-down based on Availability, Reliability and MTBCF requirements for system level and lowest blocks failure rate relation (complexity factors)
- Available import-export capabilities:
  - Importing a project from BQR Core Data Base (CDB) and exporting to CDB
  - Copy – Paste a project or sub project to another project
  - Creating a project from a template
- Help capabilities:
  - Sensitive wizard
  - Systematic Help menu
  - ON-line Help
  - Tutorial from Help menu
  - Guide
  - Status bar and tool tip help



FTA: Fault Tree Analysis

Fault Tree Analysis (FTA) is an analytical technique using a top-down approach to analyze various system combinations of hardware, software and human failures. The FTA starts with a potential undesirable event such as a crash of an aircraft and then identifies all related sub events that could cause that top event to occur.
The FTA provides easy to use symbolic representation of logical structure and relationship that exists between undesired basic potential events and may occur together in order for top event to occur. The main objective of the FTA is to determine the probability of top event occurrence.

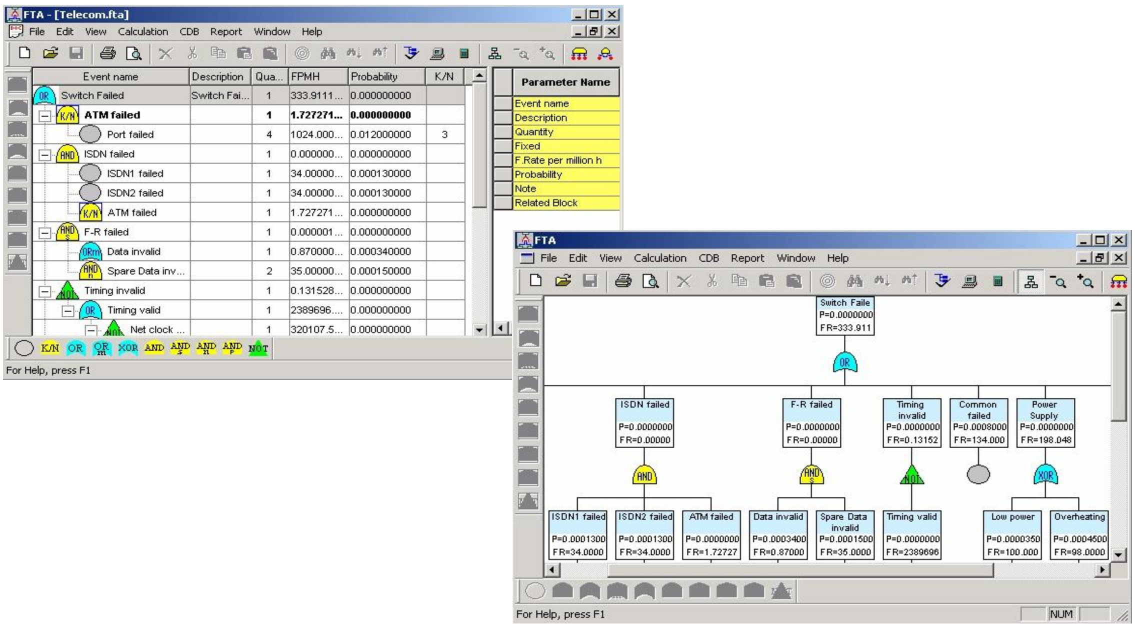
Key Benefits of the FTA

- Identifies system safety issues and critical components
- Compiles with safety and reliability requirements
- Enables Calculation of top event occurrence probability
- Evaluates product risk
- Identifies causes and consequences of events (accidents/incidents)
- Identifies design changes and attention

Fault tree analysis is useful both in designing new products / services or in dealing with identified problems in existing products/services.

Features:

- Handles Hardware/Software Fault & Event trees to calculate events probability and rate.
- K-out-of-N, OR, OR-Markov, AND, AND-stand-by, AND-network, priority AND, NOT and XOR Gates.
- Multiple events (Common Causes).
- Dormant events and inspections.
- Minimal Cut sets calculation with probabilities.
- Only up/down scroll - no need to scroll right & left or between pages for large trees.
- Quick and accurate calculation of probability and rates for all events.
- Conditional effects probability may be given under OR gates.
- Traditional Fault Tree report with multi page printing.
- The FTA tree can be built-up from the project tree assemblies or components and/or from the functional FMECA tree and/or from the RBD model tree.
- Simple on screen presentation of the tree using + and - to expand & collapse trees.
- Shares data with other CARE/CAME modules via the core database.
- Builds FTA models automatically from MTBF, FMECA, RBD & CAME.



MTTR: Mean Time to Repair

MTTR is the most common measure of maintainability prediction. It is the average time required to repair a failure (corrective maintenance) and return the equipment to normal operating condition in which it can perform its intended function.

The MTTR module uses provided data about the removable (replaceable) components in a system to generate maintenance parameters and calculations such as task definitions, preparation, Localization, percent Isolation, Alignment and more. The MTTR can be used to calculate availability of equipment or a system. Availability is the probability that a system is in an operable state at any given time and is based on a combination of failure rate and MTTR.

Key Benefits of the MTTR

- Identifies potential down time and maintainability problems
- Assists in repair/replace analysis
- Assists in planning necessary resources (personnel, tools, test equipment, etc.)

Features:

- MTTR for each composite block is calculated as average (by failure rates) of sub blocks maintenance time (replacement or/and repair time depending on sub block repair type)
- MCTmax for each block presents maximal confident repair time for specified confidence, supposing lognormal repair time density
- Allocates top-down MTTR requirements
- Defines different failure modes with different tasks for every assembly
- Task definitions such as: Preparation, Localization, Isolation, Alignment and Checkout
- Handles the maintenance trees (no limit of maintenance levels & number of assemblies)
- The MTTR tree can be built-up from the CARE® project tree assemblies or components
- For every project tree, many maintenance trees can be defined according to the maintenance concept
- Simple definition of assemblies connections using a standard library of standard Remove and Replace times

Mini LSA: Mini Logistic Support Analysis

LSA is an engineering process tool, which provides the basis for supportability activities of a system and provides the foundation for ILS aspects such as technical publication, training and provisioning.

It provides reliability and maintainability engineering data and other subcontractors and vendor data sources and shall be conducted on interactive basis through all phases of the system life cycle. The objective of LSA program is to achieve the optimum balance between capability preparedness (availability), cost and support in accordance with the individual ILS goals.

Key Benefits of Mini-LSA

- Provides direct input for supportability cost reduction
- Ensures that supportability is integral part of system design and requirements
- Manages quantity maintenance needs, maintenance equipment, personnel, and spares

Features:

- Calculates the Initial Spares providing a confident spare availability in stock (Poisson formula)
- Easy to define the maintenance concept for each assembly by using predefined templates
- Generates ICL, MAC and MEA reports
- Supports the new approach of COTS assemblies
- Supports obsolete definitions for non-continuous manufacturing components to reduce maintenance costs

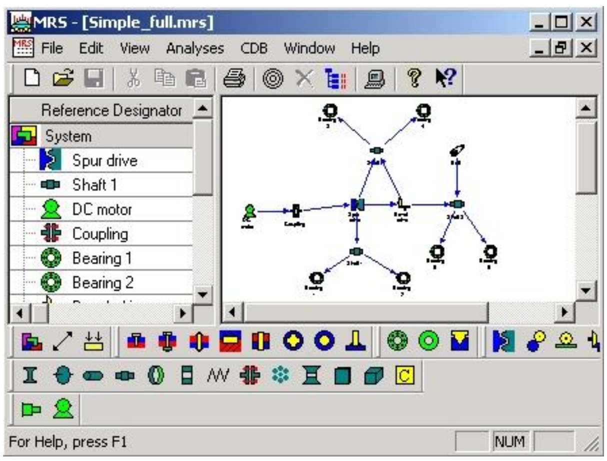
MRS: Mechanical Reliability Simulation

Today's market requires rapid product development cycle and increasing emphasis on reduced cost and time to market. Advanced simulation methodologies now routinely used to predict the behavior and response of complex systems as a means of reducing testing. The MRS assists designers to assess reliability performance during system development to achieve competitive product with high performances.

MRS is a unique modeling and simulation tool, design to address the root cause failure and reliability prediction of mechanical systems. Reliability prediction of mechanical systems is very sensitive to material types, loadings, friction, forces, corrosion, vibration etc. Failure data, which relies only on operating time, is inadequate to predict the reliability of a mechanical system. Failure rates of mechanical systems cannot usually be described by a persistence failure rate distribution.

In addition, constant failure rate distribution cannot be specified for generic use. Therefore, estimating the reliability of mechanical equipments is a difficult task to perform in the design phase. Unlike other mechanical reliability prediction models, the MRS model considers dependencies between the mechanical sub elements, different failure modes, different operating limits and more.

The MRS is an analytical prediction and probabilistic method with generic failure models incorporate reliability into the design process establishing a scientific basis for evaluating mechanical Stress margins, potential failure mechanism, relevant geometry, operating loads, environmental parameters, structure, corrosions, dimension and fatigues.



MRS enables designers to simulate virtually any type of mechanical system. It includes project tree and full associated structural builder. Builder includes set of machinery parts icons and links between parts:

- Machine elements (e.g. Rotating disk, Shafts/Axle, Couplings, and more)
- Drives/Transmission (e.g. Spur Gear drive, Belt drive, Cam drive and more)
- Bearings (e.g. Ball/roller bearing, Rotary Sliding bearing/bushing, and more)
- Actuators (e.g. Hydraulic/Pneumatic line actuator, Electric Motors)
- Fastener/Fixing elements (e.g. Screws, Pins, Press fit and more)

MRS - Work Flow

The MRS consists of the following main modules:

• Physical, material properties, geometric forms, sizes, surfaces, thermal treatment properties, environment properties, static and dynamic loads (forces, torque moments, revolving speed) and their related statistical distributions

• Mechanical Reliability modeling using component functional interrelations and failure models of individual components

• Stochastic dissipation simulator for all input parameters

• Procedures of time to failure calculation using theoretical and experimental dependences

During mechanical system design, it is essential to provide critical failure information to determine the potential modes of failures (physical event/mechanism that gave rise to a failure e.g. corrosion/fatigue/wear) a product might encounter during its lifetime. When new products are being considered and designed, this knowledge and information is expanded upon to help designers extrapolate, based on similarity with existing products and the potential design tradeoffs.

The MRS provides an apportionment library facility, which allows designers the ability to generate basic failure modes and failure causes for each mechanical component within the system. The characteristics of failure modes includes hidden, predictable, preventable and random. The cause ratio for any particular failure mode must be assessed according to designers experience or through a Field Failure Analysis (a systemic study of the nature of various modes of material failure).

BQR
Reliable Engineering. Optimized Maintenance.

Key Features

- Fast Analytical prediction of MTBF for each type of mechanical component.
- Wide range of machine elements, drives/transmissions, bearings, fasteners and actuators – enables faster creation of various mechanical assemblies for further reliability prediction
- Wide range of distribution enabling description of real world load conditions and material properties
- Link element enables: automatic transmission of kinematics and load parameters: Torque moments, Speeds and Forces between connected components – resulting in reduced time-for-input data and user mistakes
- Calculate MTBF and failure distribution for customized component
- Large Component material properties library
- Automated generated basic failure modes and failure causes for each mechanical component to be used in FMEA/FMECA, FTA, RBD analyses
- Enables export of Reliability distribution for automatic Preventive Maintenance Optimization using SAMO.
- Coupled Motion, Structure, Creep, Thermal, Wear, and Corrosion Fatigue analysis with new developed analytical equations

Key benefits of the MRS

- Evaluates the reliability of a mechanical system early in the design phase
- Provides the basis for spare parts and preventive maintenance calculation
- Evaluates degradation (system or subsystem) with time for particular operating environment, forces, material types etc.
- Provides standardized reliability evaluation method
- Assists engineers with evaluating extreme working condition results
- Reduce and eliminate unnecessary and expensive tests
- Faster time-to-market at a lower cost
- Simple trade-offs analysis
- Allows sensitivity analysis for design and operation parameters
- Allows selecting the optimal component for the application use
- Minimize over-design
- Minimize over-stress