Quantitative Services

IIT Research Institute
201 Mill Street
Rome, New York 13440-6916

1 - 888 - RAC - USER
(1 - 888 - 722 - 8737)

http://rac.iitri.org

Description:

Quantitative analysis involves the performance of statistical techniques and numerical analysis. This includes the application of advanced statistical techniques to identify and correlate design, manufacturing and operational performance parameters with reliability, maintainability and quality metrics. Requirements for statistical analysis are highly diverse, depending on the nature of the problem being addressed and the amount of data available to support a solution. The range of appropriate statistical techniques can range from the generation of summary statistics (e.g., mean values, standard deviations, etc.) to complex non-linear regression analyses.

How It Can Benefit You:

Quantitative analysis can provide the user with cause and effect conclusions based on specific data and information. These analyses, often in the form of mathematical models that may make use of simulation, can indicate the impact of design and process variables on component yield, cost, performance, reliability and quality.

Quantitative analysis can also indicate the impact of decisions on product/system affordability, life cycle cost and readiness. It can support the full range and complexity of reliability, maintainability and quality-related models throughout the entire product/system life cycle:

- Failure rate models that can be used to estimate component and system reliability to (1) determine the feasibility of a reliability goal, (2) estimate warranty and support costs, (3) trade-off design alternatives, (4) allocate reliability to lower levels of assembly, (5) identify/rank potential failure causes, and (6) estimate sparing needs
- Optimized maintenance planning models that maximize product/system reliability or availability
- Circuit analysis models which can simulate circuit operation and determine if there are overstressed components which could cause reliability problems
- Fracture mechanics models that predict and evaluate the fracture characteristics of different components and materials
- Finite element analysis models that are used to predict failure-causing stresses
- Predictive process models, developed for a variety of manufacturing processes, that predict the quality, cost and process time of manufacturing operations, enabling better planning and optimized operations before dollars and resources are committed to implementation
- Decision support analysis that can be effectively used to make reliability, maintainability and quality decisions related to (1) affordability, (2) life cycle cost, (3) life extension assessment, (4) variability reduction, and (5) root-cause failure analysis

The proper identification of the problem to be addressed, and the availability of the detailed data required to define a solution, are critical to the selection and use of quantitative analysis techniques to provide practical, cost-effective solutions in a timely and cost-effective manner.

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RAC Capability:

RAC customers have a variety of needs that require quantitative analysis. RAC has the expertise to implement techniques that provide practical solutions. The RAC staff has used, developed, modified and expanded analytical tools and methods to:

- develop failure rate models (multiple regression; covariance analysis; F-test)
- model parametric drift characteristics (non-linear multiple regression; polynomial curve fitting)
- assess R&M prediction techniques vs. test results vs. field performance (ratio plots; hypothesis tests; confidence intervals)
- test theoretical field maintenance rates and failure mode trends vs. data (goodness-of-fit tests; graphical techniques; Pareto analysis; Chi-square tests)
- determine and compare screening effectiveness results (covariance analysis; hypothesis tests)
- compare test techniques, or test equipment capabilities (Analysis of Variance - ANOVA; hypothesis tests; graphical techniques)
- evaluate R&M task effectiveness (covariance analysis; hypothesis tests)
- model complex system reliability (Monte Carlo simulation; Markov models)
- analyze electronic circuits using automated tools (P-Spice; Electronic Workbench)

RAC has defined and performed mechanics-based tests to derive data for designers; utilized finite element analysis to determine stress levels for components, products and materials; and utilized failure analysis techniques to identify root-cause failure mechanisms. RAC has also performed decision support analyses to determine the feasibility of extending product/system lifetimes, impacts of design decisions on operations, and maintenance costs savings associated with controlling process variability.

RAC's customer base covers automotive; avionics; biological/chemical; forecasting; materials fabrication; coatings; metallurgy; machining; welding; quality control in manufacturing; material handling; and environmental testing applications. Projects have included experimental design regression modeling; statistical tolerancing; sample size and control chart calculations; prediction interval computations; and R&M predictions. The RAC staff has authored application guidelines on failure analysis techniques, and databooks on failure mode distributions, and have published handbooks which provide insight into quantitative data analysis techniques.

Contact:

Reliability Analysis Center (RAC)
rac-answers@iitri.org (e-mail)
1-888-RAC-USER (phone)
or
315-337-0900 (phone)
315-337-9932 (fax)

Website:

http://rac.iitri.org