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## NEW MODELS AND CUSTOMER-CENTRIC MEASURES FOR RELIABILITY USING FUZZY THINKING

## We are working on a new perspective and methodology to model the reliability of the system/component using the theory and methods for fuzzy sets. We use the indicator or performance or substitute variable which is based on the voice of the customer to develop customer-centric system reliability performance measures. This performance/substitute variable is well understood by the customer and is used to fuzzify the states of the system. Thus success/failure events are treated as fuzzy sets based on the language of the customer. Fuzzy reliability is defined and compared to the traditional binary states and multi-state reliability models. The concept of fuzzy random variable is introduced to model the dynamic behavior of time to fuzzy failure. We are working on many applications of these models.

## DYNAMIC RELIABILITY PERFORMANCE MEASURES & ANALYSIS FOR MULTI-STATE SYSTEMS

## There is tremendous interest these days to design and develop all types of complex systems including industrial, infrastructure, communication, logistics and distribution systems that are not only reliable and maintainable but are also safe, robust, resilient and sustainable. Customer-centered complex systems and their components have multi-states. We propose new measures for system performance which are realistic and useful. For this research, motivation for these new measures and their applications for decision making and risk analysis are provided based on systems oriented, integrated and distributed, customer-centered multi-state system reliability and maintainability methodology [53, 59, 60, 62, 65, 66].

## RELIABILITY ANALYSIS FOR MULTISTATE SYSTEMS WITH MULTISTATE COMPONENTS

## An important problem in reliability theory is to determine the reliability of a complex system give the reliabilities of its components. In real life, the system and its components can be found in a range of states varying from perfect functioning through various levels of performance degradation to complete failure. The focus of this research is to develop properties of system structure function and to develop computational methods for estimating system reliability measures. Multi-level modular decomposition methods are also being developed for such systems [26-30, 33, 47, 48, 56, 57].

## OPTIMUM SPECIFICATIONS FOR QUALITY IMPROVEMENT & APPLICATIONS

**The object of any quality program is to minimize total losses to both the producer and the consumer - thus the whole society. Optimum specifications should be developed based on total quality costs due to variation from target, measurement or inspection costs, costs associated with nonconforming units and/or rework, etc. The objective of this research is to develop an economic based methodology to define optimum specifications [32, 34, 37, 41, 52, 55, 61, 63].**

## QUALITY ENGINEERING: DESIGN, OPTIMIZATION, AND CONTROL

**The objective of the research is to develop a generic optimization model for any product or process. For any performance characteristic, we have a target value and we like to minimize the variation from target due to noise factors. For dynamics systems, the target changes are based on the intent of the customer. This research focus on various measures of robustness of the system, such as signal to noise ratio, and evaluates their effectiveness. Optimization and control issues in the context of design of experiments are being explored to improve quality and productivity** **[31, 40, 45, 54].**

**CUSTOMER-FOCUSSED RELIABILITY**

**Reliability of any product must be defined and evaluated by the customer. The purpose of this research is to develop customer-focused reliability models which capture the total experience by the customer with the product [36, 38, 43, 44, 53, 59, 60, 66].**

**FEEDFORWARD CONTROL AND PROCESS IMPROVEMENT**

**Process adjustment strategies are an important part of the process improvement methods. The feedback control technique is used to compensate for the deviation of the output, and it has been intensively investigated. For continuous improvement and proactive strategies, feedback has a delay and is not the ideal solution. We use the philosophy of feedforward control in our process adjustment procedures. We build a new process adjustment model based on the time series process and some disturbance variable which can be monitored or measured and used for the feedforward strategies. Finally we combine the feedforward control with the traditional feedback control in our adjustment system for maintaining the stability of the process and delivering products at target values.**

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