*Designed for Six Sigma (DFSS): Improving the Failure Rate or Mean Time Between Failure(MTBF) of Products **

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Described is a methodology that can dramatically reduce the reliability testing time for products where effort is given to determine product failure rates and Mean Time Between Failure (MTBF) rates. In addition, this reliability assessment and improvement approach can yield a more accurate projection of MTBF and failure rates for future product designs than with a traditional approach. The reliability assessment and improvement approach is applicable to both components and repairable systems (constant and non-constant failure rates), which might follow a Weibull, Poisson, or some other distribution. This approach not only quantifies a rate but also focuses on what could be done to improve the design to achieve the best possible reliability and customer satisfaction for the current technology.

Often test organizations are asked to predict or certify future field failure rates or the reliability of a device that is to be released from development. This question is basically impossible to accurately answer using only prototype samples. To support the logic behind this statement consider the following. First, prototype samples can not really be considered a random sample of future product since the variability of future manufacturing processes over time is not represented in the sample. Secondly, test acceleration models often do not accurately correlate and project field failure rates. Thirdly, usually there is not enough time and/or samples to adequately test the device or system.

There is an alternative to this traditional reliability test approach that can give more information with less effort; however, some issues need to be addressed differently. First, we need to recognize that the failure rate of a product cannot be any better than the technology within the product. To illustrate this, consider televisions from the 1950's. A company could specify a Mean Time Between Failure (MTBF) rate target of 100,000 hours; however, that does not mean the product could physical achieve such a criterion. Television reliability is not only a function of manufacturing processes it is also a functional of the technology that comprises the television. Television reliability can not be improved to meet such an aggressive reliability criterion until tubes are replaced with a newer technology. The best product developers and manufacturers can expect to do is to create a design that will yield the lowest failure rate within current technology and monetary constraints.

This test dilemma does not mean an organization has no hope of estimating a failure rate or Mean Time Between Failure (MTBF) for a product. Typically one can determine an expected failure rate of a new product by looking at field data from previous product designs that are similar. These different product design vintages can be combined using control charts and normal probability plotting techniques [1] to describe expected product-to-product variabilities that were developed using the same basic process. Technology changes within a new product could be addressed as percentile uplift or degrade to a historical average number. This evaluation would be much less costly than performing an elaborate test that tries to quantify this number and would probably be more accurate.

It is not suggested here that all tests be abandoned since an accurate failure rate cannot be determined. However, instead of using a test that is to certify or predict a failure rate, a more powerful test is one that focuses on potential problem areas of a new design. These problem areas can be determined by examining field data using a Pareto chart and/or through a brainstorming session that identifies high risk new technology areas. Identification and then resolution of these problem areas will reduce future field problems.

Multivariable Testing (MVT) and Design of Experiments (DOE) techniques are an efficient approach to quickly address issues in high risk areas. Example 43-3 [1] describes a situation where a sophisticated power supply design needed to be tested 23x10*6 hours with no failures in order to "certify" a 100,000 hour Mean Time Between Failure (MTBF) criterion [1]. In lieu of this
expensive/impossible approach, a Multivariable Testing (MVT) and Design of Experiments (DOE) approach [2] using 11 factors in 32 trials on one power supply identified a design problem. This type of problem would not, in all likelihood, have been detected by the previously described "traditional" reliability test.

An extension of traditional Multivariable Testing (MVT) and Design of Experiments (DOE) techniques is described in reference 3. In this reference a methodology is described that can efficiently detect combinational problems, which could affect the field failure rates of products.

Additional information on this reliability test strategy and a roadmap for integrating measurements with process improvement activities can be found within Implementing Six Sigma: Smarter Solutions using Statistical Methods, Forrest W. Breyfogle III, John Wiley and Sons, New York, NY, 1999. The wise integration of reliability assessments and other Six Sigma tools is described within our training. Focus during the training is given to building effective implementation procedures that have bottom line results for the application situations described by attendees.

References

1. *Implementing Six Sigma: Smarter Solutions using Statistical Methods*, Forrest W. Breyfogle III, John Wiley and Sons, New York, NY, 1999
2. "Improving Processes using Multivariable Testing (MVT) and Design of Experiments (DOE) Matrices" Forrest W. Breyfogle III
3. "Designed for Six Sigma (DFSS): Improving and Quantifying Hardware Test and Software Test Coverage," Forrest W. Breyfogle III.