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Support@dfrsoft.com, 617-943-9034

Course: Vital Methods for Reliability & Quality

Course Format: 3.5 Hours Webinar

Course Description:

This course is designed to help one enhance their background with key topics in reliability and quality as both are complementary in the daily workplace. Knowledge of one without the other will leave gaps in ones capability and be costly in the workplace. Understanding the analytical methods available, can be of great benefit in making the best choices in products development. Excellent reliability is a partner to high quality and vice versa. This course is put together in a time efficient manner to fit everyone's tight schedule. We will overview important reliability and quality methods that are used for success from a technical point of view. The course will help the attendee acquire a sound technical foundation. On the reliability side, we will cover Field Return Analysis, Exponential analysis and basic Weibull Plotting, Weibull Mixed Modes field return analysis, product Strength and Load usage Interference for assessing reliability, and Availability and Sparing. In the quality area we will not spend time on items like house of quality, but rather work on the technical side of the quality area as these are often not well explained in courses. We will cover Understanding and performing Design of Experiments, the related method of Multiple Regression using Excel, Cpk-Yield analysis, Normality, Six Sigma Analysis, Defects per Million Opportunities, Stack Up, SPC Charting, and Lot Sampling. This is an intense course, be prepared for the full session.

We will start on the reliability side with field data. How best to obtain a good MTBF value from return data? What are the best ways to characterize field failure rate. How do we translate MTBF into percent defective? Can we do something like a Weibull plot to assess field data? This will lead us to the basics of Weibull and Exponential analysis and a discussion on mixed modes, multiple distributions in Weibull analysis.

Often our MTBF can be a poor number that we do not wish to present to our customer. We discuss alternatives like providing customer satisfaction through great availability numbers. High availability includes a successful sparing plan. We discuss how to know what spares one should keep for the highest probability of success.

Course Outline

Reliability Area

- **Field Returns & Supporting Concepts (MTBF, AFR, Device Hours & Exponential Distribution)**
  - Constant Failure Rate/MTBF Math
  - Exponential Distribution Math
  - Company Metrics Often Used MTBF and AFR
  - MTBF and AFR Basic Math
  - Device Hours Concept
  - Percent Failure BX% & MTBF
  - Basics of Field Returns
  - Translating returns data into MTBF
- ***Introduction to Basic Weibull & Exponential Analysis***
  - Weibull Model
  - Concept of Beta and Bathtub curve
  - Life Data Analysis
  - Reliability & Failure % Estimation
  - Returns Data Analysis
- **Plotting Mixed Modes**
  - When to use Weibull methods for field returns
- **Availability, Sparing, Warrantee**
  - Why availability is likely a better number for your customer
  - Availability basics
  - Sparing optimization
  - Warrantee Costs
- **Obtaining Reliability from Product Strength and Applied Load**
  - Assessing reliability from product strength and load variations

Quality Area

- **DOE & Multiple Regression**
  - Introduction – DOE Basics

Lastly, in the reliability area we will look at the concepts of strength and load Interference analysis. How can we determine the reliability from knowledge of applied load and product's strength characteristics?

We will then move into the quality topics diving into the area Design of Experiment (DOE). We will Look at a 2 factor and a 3 Factor L8-type of DOE. Full and fractional DOEs are discussed. We will explain how multiple regression is related to DOE analysis. We will go over the L8 main effects, interactions, and ANOVA table. We then go over some basic quality metrics starting with Cpk, yield, normality and six sigma math and how it is applied. We describe key goals and the best ways to understand how to use these valuable quality tools. We suggest an alternate graphical method to better assess normality other than the bell shaped curve.

We will then look at stack-up which has a compounding effect in parts variation impacting quality control in production. We will go over the basic principles of stack up and also an advanced method where we teach the Monte Carlo stack up approach using Excel.

Studying deviations and defects in this way allows us to move into the area of six sigma which focuses on the improvement of product deviations and defect. Six sigma is a term that is often confused with the statistic itself. We can compare a six sigma calculator to a Cpk calculator to understand these differences. This will lead us to using the quality statistic of defects per million opportunities in testing? We cover these key six sigma statistical tools. We will also look at statistical process control charting. When do we pair X-bar charts with R-charts rather than S-charts? How do we define the SPC lot size? Not to be confused with lot sampling. Lot sampling is also covered to understand how to assure proper lot acceptance or rejection. Understanding risks using the Operational Curves (OC), Average Quality Level (AQL) and its related Lot Tolerance Percent Defective (LTPD). These are key metrics to devising a good sampling plan. Sometimes it can actually be cost effective to do double sampling which is also discussed.

- Factors & Setting
- Measuring the Outcome
- P- Values
- ANOVA Table
- Advanced L8 DOE Example
- Full vs. Fractional
- Multiple Regression & DOE
- Multiple Regression in Excel
- L8 Runs and Outcome
- Main Effects & Interactions

- **Cpk, Yield, Normality**
  - Translating Cpk into Yield
  - Assessing normality
  - Central limit theorem and proper sample size
  - Cpk goal
- **Six Sigma Analysis**
  - Difference between Six Sigma and a Cpk calculator
  - Six sigma goal
- **Defects per Million Opportunities & Your Six Sigma Process Value**
  - Production assessment of defects
- **Normal/Lognormal Histograms and CDF plots**
  - Bell shape curve vs. alternative methods to look at normality
- **Stack Up**
  - Compounding deviations
  - Monte Carlo Method for stack up assessment using Excel
- **SPC Control Charting**
  - X-bar, R Charts or S charts
  - SPC Lot size
  - Charting rules for flagging poor process trends
- **Lot Single & Double Sampling**
  - Hypergeometric vs. Binomial sampling
  - Consumer and producer Risks using OC curves
  - Single sampling
  - Double lot sampling to save money

Instructor: Dr. Alec Feinberg, founder of DfRSoft

Dr. Feinberg has a Ph.D. in Physics and is the principal author of the book, *Design for Reliability*. He is also the author of the software package DfRSoft, which is used worldwide. Alec has provided Reliability & Quality engineering services in all areas and on numerous products in diverse industries for over 35 years that include solar, thin film power electronics, defense, microelectronics, aerospace, wireless electronics, and automotive electrical systems. He has extensive expertise in the area of Design for Reliability & Quality, shock, vibration, and HALT test and analysis methods in working on Military and Commercial products. He has provided training classes in Design for Reliability Quality, Shock and Vibration, HALT, Reliability Growth, Electrostatic Discharge, Dielectric Breakdown, DFMEA and Thermodynamic Reliability Engineering. Alec has presented numerous technical papers and won the 2002 RAMS Alan O. Plait best tutorial award for the topic, "Thermodynamic Reliability Engineering". He is currently an invited author to contribute on a new book on the Physics of Degradation in Engineering Devices and Machines due out early next year. Alec is based in Raleigh, North Carolina.