2 DAY WORKSHOP

OVERVIEW

Quality, performance and cost effectiveness have been an integral part of organizations in search of global excellence and market leadership. These organizations continuously make business decisions under increasingly uncertain market conditions. To cope effectively, modern organizations expect:

- *engineers to predict the variation of new products before prototypes are built;*
- *manufacturing managers to manage and control variation of production processes;*
- *project managers to understand the risk of cost and deadline overruns.*

In response to these challenges, this course will focus on the use of Monte Carlo simulation, risk analysis and stochastic optimization using the software Crystal Ball within the Excel framework. Specific focus will be placed on using Monte Carlo within the context of tolerance analysis and production process variation.

Participants will learn how to navigate Crystal Ball and understand when and where the different Crystal Ball analysis tools fit with other statistical tools such as Minitab and Process Simulator. These techniques are critical for design, manufacturing and production engineers, executives, managers and others who want to improve their decision batting average.

COURSE OBJECTIVES

- Apply Monte Carlo simulation to business models to identify the areas of greatest opportunity for generating the largest business returns
- View the variance of process and visually examine how changing decisions (inputs) affects quality (output)
- Identify the benefits of simulation forecasting, sensitivity analysis and stochastic optimization and where they fit within DMAIC, DMADV and LEAN methodologies.
- Communicate the concepts and effects of variability or uncertainty to other members of your organization

CONTENT (DAY 1)

Introduction to Monte Carlo Analysis and Crystal Ball

- **We Live in an Uncertain World (or How Does One Account for Uncertainty?)**
  - Most Likely Outcome
  - Best Case / Worst Case
  - What If…. (Multiple Scenario) Analysis
  - What is Monte Carlo Analysis?
  - What is Crystal Ball?
- **Crystal Ball and Continuous Improvement**
  - What is & Why do Continuous Improvement?
  - Three Paths to Continuous Improvement
  - Benefits of Simulation in Six Sigma, DFSS and Lean Projects
- **Using Crystal Ball in 3 Steps**
  - Define CB “Elements” (Cell Definitions)
  - Run Simulation
  - Analyze Results
- **Class Exercise 1:** *Building a “1-2-3” Model on Blank Spreadsheet*

2 DAY WORKSHOP

Stack Tolerance Analysis using Crystal Ball

- **Models & Simulation**
- **Where do Models Come From?** (examples of different classes of models)
- **What is Stack Tolerance Analysis?**
    - MMC vs RMS Approach
    - Monte Carlo Analysis Comparison to Traditional Tolerance Methods
- **Review of Basic Statistical Concepts**
    - Probability Distributions
    - Statistical Measures (mean, median, stdev, etc…)
- **Crystal Ball Interface Overview (Functionality & Tools)**
    - Define Crystal Ball Elements: Assumptions, Forecasts, Copy, Clear & Paste CB Cell Definitions
    - Run Simulation
    - OptQuest
    - Analyze Forecasts (Alternate Views, Split View) & Sensitivity Chart
- **Class Exercise 2:** *Linear Stack-Up Tolerance Analysis (One-Way Clutch)*

Module 3 – Crystal Ball and Six Sigma

- **Six Sigma Metrics in Crystal Ball**
    - How Do We Measure Quality?
    - Capability indices
    - Sigma Shift
    - Normality Test
    - Six Sigma Metrics in Crystal Ball & OptQuest
    - Advanced Crystal Ball Analysis Features: Overlay Charts, Trend Charts, Reports, Extract Data)
- **Class Exercise 3:** *Non-Linear Stack-Up Tolerance Analysis (Piston Head Position)*
- **Student Exercise 1:** *Electronic Circuit Quality Comparison of Alternative Designs (Output Voltage)*

CONTENT (DAY 2)

Incorporating Process Data into Crystal Ball

- **Which Distribution Does One Choose?**
    - Data (Good data (GRR)? Appropriate sample size? Surrogate data?)
    - Expert Opinion (SME)
    - Simple Distributions (Normal, Triangular, Uniform - Impact of Conservative Estimates)
- **Fitting of Distributions**
- **Other Considerations in Distribution Selection**
    - Distribution Truncations
    - Modeling for Multiple Suppliers
    - Modeling for Multiple Usage Scenarios
- **Class Exercise 4:** *Stack Tolerance Design Progression Comparison (One-Way Clutch)*
- **Class Exercise 5:** *Electronic Circuit Design with Multiple Component Suppliers*

Advanced Crystal Ball Considerations

- **Confidence Intervals & Precision Control**
- **Correlations**
    - What Are Correlations?
    - Why Are Correlations Important?
- **Excel / Crystal Ball Modeling Best Practices**
- **Class Exercise 6:** *What Does 95% Confidence Mean?*
- **Class Exercise 7:** *Stack Tolerance Analysis w/ Correlations & Precision Control (One-Way Clutch)*

Optimizing Stack Tolerance Design using OptQuest

- **What is Optimization?**
    - Single Objective versus Multiple Objective Optimization
    - Deterministic versus Stochastic Optimization
    - Defining Decision Variables

- **OptQuest Interface:** Decision Variable Selection and Modification, Constraints, Status & Solutions, Bar Graph, Solution Analysis
- **Cost Tolerance Functions**
- **Optimization Performance Tips**
- **Class Exercise 8:** *Cost Optimization of Stack Tolerance Design (One-Way Clutch)*
- **Student Exercise 2:** *Supplier and Component Optimization of Electronic Circuit*
- **Student Exercise 3:** *Material Usage Optimization of Attachment Finger*

Generating benefits across the business

- Why Do Monte Carlo Analysis?
- Other Monte Carlo Analysis Business Applications (Mf'g Process, Transactional Process, Financial, Inventory, etc...)
- Benefits of Simulation in Six Sigma, DFSS and Lean Projects

BENEFITS

At the end of this 2 day workshop, participants will be able to:

- Understand and apply Monte-Carlo simulation and optimization in their day-to-day activities
- Make better and more informed business decisions while quantifying risk
- Quickly build effective models or customize existing ones with Crystal Ball
- Simulate the impact of tolerances on the fit of parts in a product
- Manage and control variation of production processes via stochastic optimization