Course Description

Lean Six Sigma Black Belt

This 4-week hands-on workshop provides participants with the detailed methodology and tools of Lean Six Sigma to lead their organization toward "World Class" status. The workshop combines the proven and powerful elements of both traditional Lean and traditional Six Sigma into a blended approach. The emphasis is on 1) gaining process and product knowledge with critical thinking 2) reducing variability and non-value added activities and 3) developing leaders in the organization who are focused on enhancing customer value, decreasing defect rates and wasted efforts, reducing cost and cycle time, and generating business growth and breakthrough improvements. The Lean Six Sigma methodology is taught with a "Keep It Simple Statistically" (KISS) approach and makes use of many in-class examples, simulations, and hands-on exercises to ensure that participants have a practical, working knowledge of the tools.

Participants in the Lean Six Sigma Black Belt Training learn the details of the Define, Measure, Analyze, Improve and Control (DMAIC) methodology and tools for achieving better, faster, and lower cost products and processes. We use a knowledge-based approach to "pull" the use of Lean and Six Sigma tools, not push them. Participants learn to select and apply the right tools for a particular problem or question. The intended audience is anyone who desires to become a practitioner of the Lean Six Sigma methodology and tool set and who will be leading Lean Six Sigma projects within an organization.

As a part of the course, it is expected that participants come with a project to work on so that they can immediately apply their knowledge and realize return on investment on a specific business issue. The course is taught in four one-week sessions, with each week of training separated by a month. The time between training weeks is designed to facilitate project work. Our Lean Six Sigma Black Belt Training uses the "Present/Practice/Apply/Review" strategy. That is, we present tools and methods, give participants the opportunity to practice them in class, and then apply the tools to their project, and finally review the results of the application to the projects.

Course Agenda

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Detailed Course Content, by week

Week 1:

Lean Six Sigma: The Journey Begins

- The What and Why of Lean Six Sigma
- Key Elements and Infrastructure
- Roles and Responsibilities
- Lean Six Sigma Project Master Strategy
- Factors Critical to the Implementation of Lean Six Sigma
- Importance of Knowledge and the Role of Questions

Lean Six Sigma Fundamentals

- Core Lean Six Sigma Principles
- Concepts of Value and Value Stream
- Defining Processes Using IPO Diagrams
- Key Terminology (Distribution, Mean, Median, Standard Deviation, Cp, Cpk, sigma level, first pass yield, defects)
- PF/CE/CNX/SOP (the first line of defense against variation)
- Measuring and Understanding the Cost of Poor Quality/Cost of Waste

Defining the Project and Managing Change

- Elements of the Define Phase of DMAIC
- Selecting and Defining a Lean Six Sigma Project
- Elements of the Project Charter
- Problem Statements, Project Goals, and Measures
- Stakeholder Analysis
- Importance of Good Project Management
- Teamwork
- Understanding Change and Ingredients for Successful Change

Understanding the Voice of the Customer (VOC) and Defining a Process

- Understanding the Voice of the Customer
- Managing the Customer Experience
- Kano's Model
- Introduction to Quality Function Deployment (QFD)
- Building a Simple House of Quality
- Creating a High Level Process Map using a SIPOC Diagram

Measure…Making Sense out of Data using Graphical and Measurement Tools

- Detailed Process Mapping (process flow, simple value stream maps, spaghetti diagrams, time value maps)
- Planning for Data Collection

- Graphical Analysis of Data
  - Pareto charts
  - Histograms
  - Box plots
  - Run charts
  - Scatter diagrams
- Numerical measures
  - Measures of Location and Dispersion
  - Measures of Quality for Variables Data
  - Measures of Quality for Attribute Data
  - Measuring Correlation
- Using SPC XL software and Interpreting Output

Measurement System Analysis

- Properties of a Good Measurement System
- Impact of Measurement System Variation
- How to Set Up, Conduct, and Perform a Measurement System Analysis
  - Variables Data
  - Attribute Data
- Interpretation of MSA Results and Metrics
  - Repeatability
  - Reproducibility
  - P/Tol ratio
  - Discrimination (resolution)
  - Effectiveness, Probability of False Rejects, Probability of False Accepts

Week 2:

Analyzing the Causes of Poor Performance

- Techniques for Identifying Potential Causes of Variation
- Identifying Waste and the Seven Classic Types of Waste
- Evaluating the Cost of Poor Quality
- Value and Non-Value Added Activities
- Analyzing Work
  - Takt time
  - Cycle Time
  - Operator Loading

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Techniques for Narrowing the Focus

- Data Collection and Sampling Considerations
- Confidence Intervals and Sample Size Calculations using SPC XL software
- Techniques for Narrowing the Focus when Data is Limited
  - Voting
  - Nominal Group Technique
  - Effort / Impact Analysis
  - Pairwise Comparisons
  - Prioritization matrix
  - Five Why's

Drawing Conclusions From Sampled Data

- Elements of the Analyze and Improve Phases of DMAIC
- Using Hypothesis Tests for Comparing Data Sets
- How to Conduct and Interpret Hypothesis Tests
- How to Apply rules of Thumb (ROT) When Comparing Data Sets
- Using SPC XL for Hypothesis Testing

Improving the Process and Work Flow

- Elements of the Improve Phase of DMAIC
- Reducing Setup and Changeover Times using SMED
- Comparison of Batch vs. Single Piece Flow
- Cellular Manufacturing and Principles of Cell Design / Layout
- Applying the Principles to Improve a Simulated Process
- Mistake Proofing the Process Using FMEA and Error-Proofing (Poka Yoke)

Lean Six Sigma Mini-Project: Applying the Tools

- Simulate A Process
- Evaluate the Current State, Collect Baseline Data, and Identify Opportunities for Improvement
- Make Improvements to the Process
- Simulate the Improved Process and Measure Results

Controlling Process Performance / Realizing and Holding the Gains

- Basic Concepts of Statistical Process Control (SPC)
- Difference Between Process Control and Process Capability
- Construction, Interpretation, and Application of Control Charts
  - Types of Charts
  - Control Limits
  - Out of Control Symptoms
  - Subgrouping Strategy

- Elements of an Effective Control Strategy
- Visual Control and 5S for Workplace Organization
- Project Documentation

DMAIC Summary – Putting it All Together

- Review of the Lean Six Sigma Master Strategy and Key Principles
- DMAIC Phase Tollgates and Completion Checklists
- Building a DMAIC Tools Memory Jogger

References, Glossary of Terms and Course Evaluation Forms (Volume 1)

Week 3:

Review of DMAIC Tools and Techniques

- Additional Practice Using the Tools and Concepts of Lean Six Sigma to Answer Questions and Solve Real World Problems
- Workshop / Practice problems

Additional Lean Tools to Define and Measure

- Reviewing the Relationship between Lean and Six Sigma
- Value Stream Mapping (VSM)
- Introduction to VSM Software

Analyze Data using Probability Distributions

- Basic Concepts of Probability
- Fact that Probability is Often Not Intuitive
- Three Common Distributions and Their Application to Problem Solving
  - Binomial distribution
  - Poisson distribution
  - Normal distribution
- How to Transform Non-Normal Data
- Using SPC XL for Calculating Probabilities

Regression Modeling to Analyze and Improve

- What is Regression and What is it Used For?
- Terminology Involved in Simple Linear Regression
  - Intercept
  - Slope
  - Prediction Equation
  - Residual
  - R-Squared

- Use of SPC XL for Regression Analysis and Interpretation of Output
- Problems with Using Data that is Not from a Designed Experiment

Introduction to the Use of Design of Experiments (DOE) to Analyze and Improve

- Purpose of Design of Experiments
- Key DOE Terminology
- Experimentation Strategies
- Introduction to Basic Graphical and Statistical Analysis of Data
- Interactions
- Introduction to DOE KISS Software and Hands-On Experimentation Using the Statapult®
- DOE 12 Step Process

Two Level Designs

- Screening Designs
- Statapult® Screening Exercise
- Full and Fractional Factorial Designs
- Use and Application of Two Level Designs
- Transactional DOE Examples
- Practice with DOE KISS Software
- Reasons why Experiments May Fail to Confirm

Three Level Designs

- Qualitative vs. Quantitative Factors in DOE
- Use and Application of Three Level Designs
- Screening Designs
- Full Factorial Designs
- Box Behnken and Central Composite Designs
- Setting Up, Conducting, Analyzing, and Confirming a Quadratic Model Using the Statapult®

Rules of Thumb and DOE Design Selection

- Sample Size Guidelines for DOE
- Selecting the Best Design
- Determining Statistical Significance
- Interpreting R-square, Adjusted R-square, Tolerance and p-Values
- Practice Choosing the Correct DOE Design to Use

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Week 4:

Quick Review of DMAIC and DOE

- Review of the DMAIC Process
- Mapping Tools to Different Tasks Based on the Type of Data
- DOE Rules of Thumb
- Testing for Relationships between Inputs and Outputs
- Use of SimWare software to practice DOE

Additional Lean Improvement Tools

- Total Productive Maintenance (TPM)
- Overall Equipment Effectiveness (OEE)
- Flow and Pull
- Kanbans
- Inventory
- Production Sequencing
- Little's Law

Historical Data Analysis

- Review of Orthogonality and its Importance
- Options for Improving Orthogonality
- Problems with Historical Data
- Strategies for Dealing with Historical Data
- Historical Data Examples

Additional Hypothesis Tests to Analyze and Improve

- Review of Previously Covered Hypothesis Tests
- Hypothesis Testing with One Sample and Paired Data
- Analysis of Variance (ANOVA) for Comparing More than Two Data Sets

DOE Diagnostics and Assessments

- Residual Analysis
- Additional DOE Diagnostics
- Assessing Lack of Fit using DOE PRO software
- Reasons and Potential Solutions for Low R-Squared Values or Lack of Confirmation when Modeling

Advanced DOE Analysis Techniques and Designs

- Randomization Techniques and Reasons
- Analyzing and Optimizing Multiple Responses using DOE PRO software
- Review of Variance Reduction Techniques
- Robust Design with Exercises
- Taking Advantage of Interactions to Reduce Variation

Lean Six Sigma Mini-Project

- Capstone Exercise: Hiring Process Simulation
- Using the DMAIC Process and Tools to Evaluate the Current State, Collect Baseline Data, Identify Opportunities for Improvements, and Improve a Simulated Process
- Measuring Success and Building a Knowledge Notebook

Advanced Black Belt Topics and Training

- Sources for Continued Learning
- Introduction to Design for Six Sigma (DFSS)
- Introduction to Discrete-Event Simulation and Using it For Gathering Process Data
- Need for High Throughput Testing (HTT) with Software Demonstration

References, Glossary of Terms, and Course Evaluation (Volume 2)

Course Materials

Participants receive the following materials which are integrated and used throughout the class:

Participant Guide

Textbooks:

- Knowledge-Based Management by Kiemele, Murrow and Pollock (Air Academy Press and Associates)
- Basic Statistics: Tools for Continuous Improvement by Kiemele, Schmidt, and Berdine (Air Academy Press and Associates)
- Understanding Industrial Designed Experiments by Schmidt and Launsby (Air Academy Press and Associates)
- Lean Six Sigma: A Tools Guide by Adams, Kiemele, Pollock, and Quan (Air Academy Press and Associates)

Software:

- SPC XL
- DOE Pro
- SimWare Pro

Prerequisites

Participants are expected to have management sponsorship and a project selected prior to attending the training. Projects will be worked on over the duration of the course and should be completed within a reasonable timeframe, typically near the end of the training but no longer than 6 months after the start of the training.

Participants are strongly encouraged to bring a laptop computer to class with Excel 2000(or above) so that they can install the supplied software and practice using it during many in-class exercises. A basic working knowledge of Windows and Excel is helpful. Basic math and algebra skills are also desirable.