

Six Sigma Quality: Concepts & Cases- Volume I
(Statistical Tools in Six Sigma DMAIC process with MINITAB Applications)

Chapter 1—

Introduction to Six Sigma, Lean and Design for Six Sigma (DFSS)

Chapter Outline

<i>What is Six Sigma?</i>	<i>Six Sigma Analysis Phase</i>
<i>Business Success of Six Sigma</i>	<i>Six Sigma Improvement Phase</i>
<i>Six Sigma Costs and Savings</i>	<i>Six Sigma Control Phase</i>
<i>Six Sigma Current Trends</i>	<i>Lean Six Sigma</i>
<i>Statistical Basis of Six Sigma</i>	<i>Difference between Lean and Six Sigma</i>
<i>Comparing a Three Sigma to a Six Sigma Process</i>	<i>Integrating Lean and Six Sigma</i>
<i>Percent Conforming in a Three Sigma and a Six Sigma Process</i>	<i>Lean and Six Sigma Project Selection</i>
<i>Metrics and Measurements in Six Sigma</i>	<i>Lean and Six Sigma Tools</i>
<i>Relationship between Six Sigma and Process Capability Indexes Cp and Cpk</i>	<i>Concept and Explanation of Lean and Related Tools</i>
<i>Relationship between Cp and Cpk</i>	<i>Design for Six Sigma</i>
<i>What Percent of the Specification Band does the Process use?</i>	<i>Concept Development and Concept Engineering</i>
<i>How are Cp and Cpk Related to Six Sigma?</i>	<i>Design Development</i>
<i>Conducting a Process Capability Study</i>	<i>Quality Function Deployment of Quality Effort</i>
<i>Service Successes of Six Sigma</i>	<i>Concurrent Engineering</i>
<i>Six Sigma Methodologies</i>	<i>Computer-Aided Design and Manufacturing</i>
<i>Six Sigma Define Phase</i>	<i>Robust Design</i>
<i>Six Sigma Project Organization and Management</i>	<i>Detailed Design and Analysis</i>
<i>Six Sigma Project Selection</i>	<i>Failure Mode and Effects Analysis</i>
<i>Factors Affecting Project Selection</i>	<i>Reliability and Reliability Testing</i>
<i>Quality Costs</i>	<i>Design Optimization</i>
<i>Project Definition</i>	<i>Design Verification</i>
<i>Critical to Quality Characteristics</i>	<i>Difference between Six Sigma and Design for Six Sigma</i>
<i>Six Sigma Measure Phase</i>	<i>Summary</i>

Chapter 2 —

Introduction to MINITAB Statistical Software: Getting Started with MINITAB

Chapter Outline

Objectives and Overview

MINITAB Statistical Software: An Overview

Worksheet (Data Window)

Session Window

History Window

Analyzing Your Data

Graphing Your Data: Scale, Labels, Data View, Multiple Graphs, Data Options

Printing and Saving Your Work

Command Sequence Used In This Text

Preparing Your Report

Changing data from Numeric to Text or Text to Numeric

Editing Your Graphs and Plots

An Interactive Session with MINITAB (Tutorial)

Chapter 3—

Visual Representation of Data: Charts and Graphs for Six Sigma

Chapter Outline & Objectives

The chapter will teach you to master powerful visual tools used in Six Sigma and data analysis. You will learn summarizing and describing data using charts and graphs. You will also learn how to construct and interpret the following graphs and charts using computer.

Histograms

Graphical Summary of Data

Stem-and-leaf Plots

Box-Plots

Dotplots

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Character Graphs

Bar Charts

Pie Charts

Scatter Plots

Interval Plots

Time Series Plots

Graphing Empirical Cumulative Density Function (CDF)

Probability Plots

Matrix Plot

Marginal Plot

3D Scatter Plot

3D Scatter Plot with Groups

3D Scatter Plot with Projected Lines

3D Scatter Plot

Surface Plot/ Contour Plot

Summary of Some Plots and Their Application

Hands-on Exercises

Chapter 4—

Using Statistics to Summarize Data: Concepts and Computer Analysis

Descriptive Statistics: Numerical Methods

- Measures of Central Tendency
- Different Measures of Variation or Dispersion
- Chebyshev's Theorem
- Empirical Rule

Calculating Descriptive Statistics

The Empirical Rule

Application of the Empirical Rule

- Construct a Histogram of the Data

Use Random Number Generator, Descriptive Statistics, and Graphs to Check if the Random Number Generator Produces a Uniform Distributio

Describing Data: An Example

- Sort the Data
- Calculate the Statistics based on Ordered Values
- Construct a stem-and-leaf plot of Data
- Calculate the Statistics based on Averages
- Interpret the Confidence Intervals
- Confidence Interval for the Mean
- Confidence Interval for the Standard Deviation
- Confidence Interval for the Median

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-Determine Appropriate Class-intervals

Relating Continuous Variables: Scatterplots and Correlation

-Constructing a Simple Scatterplot

-Adding Reference Lines to the Scatterplot

-Scatterplot with a Categorical Variable

-A 3D Scatterplot

Correlaton

-Calculating Coefficient of Correlation (r)

-Scatterplot with Regression

Describing Categorical Variables

-Creating a Simple Tally

-Bar Chart for Product 1 Rating

-Tally and Bar Chart for Product 2 Rating

-Another Example of Tally

Cross Tabulation: Two-Way Table

-Cross Tabulation with Two and Three Categorical Variables

Hands-on Exercises

Chapter 5—

Quality Tools for Six Sigma

Chapter Outline

Histograms

Evaluating Process Capability Using Histogram

Stem-and-leaf Plot

Box Plot

Run Chart

Example 1: Constructing a Run Chart

Example 2: A Run Chart with Subgroup Size Greater than 1

Example 3: A Run Chart with Subgroup Size Greater than 1

(Data across the Row)

Example 4: Run Chart Showing a Stable Process, a Shift, and a Trend

Pareto Chart

Example 5: A Simple Pareto Chart

Example 6: Pareto Chart with Cumulative Percentage

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Example 7: Pareto Chart with Cumulative Percentage when Data are in One Column

Example 8: Pareto Chart By Variable

Cause-and-Effect Diagram or Fishbone Diagram

Example 9: Cause-and-Effect Diagram (1)

Example 10: Cause-and-effect Diagram (2)

Example 11: Creating other Types of Cause-and-effect Diagram

Summary and Application of Plots

Bivariate Data: Measuring and Describing Two Variables

Scatter Plots

Example 12: Scatterplots with Histogram, Box-plots and Dot plots

Example 13: Scatterplot with Fitted Line or Curve

Example 14: Scatterplot Showing an Inverse Relationship between X and Y

Example 15: Scatterplot Showing a Nonlinear Relationship between X and Y

Example 16: Scatterplot Showing a Nonlinear (Cubic) Relationship between X and Y

Multi-Vari Chart and Other Plots Useful to Investigate Relationships Before Running Analysis of Variance

Example 17: A Multi-vari Chart for Two-factor Design

Main Effects Plot

Interaction Plot

Example 18: Another Multi-vari Chart for a Two-factor Design

Multi-Vari plot

Box Plots

Main Effects Plot

Interaction Plot

Example 19: Multi-vari chart for a Three-factor Design

Multi-Vari Chart

Box Plots

Main Effects Plot

Example 20: Multi-vari Chart for a Four-factor Design

Multi-Vari Chart

Box Plots

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Main Effects and Interaction Plots

*Example 21: Determine a Machine-to-Machine, Time-to-Time variation
Part-to-Part Variation in a Production Run using Multi-vari and Other Plots*

Symmetry Plot

Summary and Applications

Chapter 6—

Process Capability Analysis for Six Sigma

Chapter Outline

Process Capability

Process Capability Analysis

Determining Process Capability

Important Terms and Their Definitions

Short-term and Long-term Variations

Process Capability Using Histograms

Process Capability Using Probability Plot

Estimating Percentage Nonconforming for Non-normal Data: Example 1

Estimating Nonconformance Rate for Non-normal Data : Example 2

Capability Indexes for Normally Distributed Process Data

Determining Process Capability Using Normal Distribution

Formulas for the Process Capability Using Normal Distribution

Relationship between Cp and Cpk

The Percent of the Specification Band used by the Process

Overall Process Capability Indexes (or Performance Indexes)

Case 1: Process Capability Analysis (Using Normal Distribution)

Case 2: Process Capability of Pipe Diameter (Production Run 2)

Case 3: Process Capability of Pipe Diameter (Production Run 3)

Case 4: Process Capability Analysis of Pizza Delivery

Case 5: Process Capability Analysis: Data in One Column (Subgroup size=1)

(a) Data Generated in a Sequence, (b) Data Generated Randomly

Case 6: Performing Process Capability Analysis: When the Process

Measurements do not follow a Normal Distribution

Process Capability using Box Cox Transformation

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Process Capability of Non-normal Data Using Box-Cox Transformation
Process Capability of Nonnormal Data Using Johnson's Transformation
Process Capability Using Distribution Fit
Process Capability Using Control Charts
Process Capability Using x-bar and R Chart
Process Capability SixPack
Process Capability Analysis of Multiple Variables Using Normal Distribution
Process Capability Analysis Using Attribute Charts
 Process Capability Using a p-Chart
 Process Capability Using a u-Chart
Notes on Implementation
Hands-on Exercises

Chapter 7—

Measurement System Analysis: Gage Repeatability & Reproducibility (Gage R &R) Study

Chapter Outline

Introduction
Terms Related to the Measurement Systems Analysis
 Systematic Errors
 Random Errors
 Metrology
 Gage
 Bias
 Resolution
Accuracy, Precision Repeatability, and Reproducibility
 Accuracy and Precision
 Gage Linearity
 Bias
 Stability
 Repeatability
 Reproducibility
Estimating Measurement Error: Some Measurement Models
 Classification of Measurement Errors
Graphical Analysis of Gage Study: Gage Run Chart

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Example 1

Example 2

Example 3

Example 4

Summary of Examples 1 through 4

Analytical Gage Study: Gage R & R

Case 1: Determining Gage Capability

Case 2: Determining Gage Capability

Case 3: Gage R & R Study (Crossed): X-bar and R Method:

Case 4: Gage R & R Study (Crossed): ANOVA Method Using Case 3 Data:

Case 5: Comparing the Results of Gage Run Chart, Gage R & R: X-bar and R Method, and Gage R & R: ANOVA Method

Case 6: Another Example on Comparing the Results of Gage Run Chart, Gage R & R: X-bar and R Method, and Gage R & R: ANOVA Method

Case 7: Gage R & R Study (Nested): ANOVA Method Determining the Bias and Linearity

Case 8: Gage Linearity and Accuracy (Bias) Study 1

Case 9: Gage Linearity and Accuracy (Bias) Study 2

Comparing Two Measuring Instruments for Precision and Accuracy

Case 10: Comparing the Precision and Accuracy of Two Measuring Instruments: 1

*Case 11: Comparing the Precision and Accuracy of Two Measuring Instruments: 2
Statistical Control of the Measurement Process*

Case 12: Use of Individuals Control Chart to Detect the Shift in Measuring

Instruments

Hands-on Exercises