

Contents

Preface

xiii

PART ONE INTRODUCTION AND GRAPHICAL TECHNIQUES

1

1	A First Look	3
1.1	Initial Screen	3
1.2	Entering Data	4
1.3	Saving Data: Worksheets and Projects	5
1.4	Data Operations: An Introduction	5
1.5	Deleting and Inserting Columns and Rows	7
1.6	First Statistical Analyses	8
1.7	Getting Help	10
1.8	Personal Configuration	12
1.9	Assistant	13
1.10	Any Difficulties?	14
2	Graphics for Univariate Data	15
2.1	File 'PULSE'	15
2.2	Histograms	16
2.3	Changing the Appearance of Histograms	17
2.4	Histograms for Various Data Sets	21
2.5	Dotplots	23
2.6	Boxplots	24
2.7	Bar Diagrams	25
2.8	Pie Charts	27
2.9	Updating Graphs Automatically	28
2.10	Adding Text or Figures to a Graph	29
3	Pareto Charts and Cause–Effect Diagrams	31
3.1	File 'DETERGENT'	31
3.2	Pareto Charts	32
3.4	Cause-and-Effect Diagrams	35

4	Scatterplots	37
4.1	File ‘pulse’	37
4.2	Stratification	38
4.3	Identifying Points on a Graph	39
4.4	Using the ‘Crosshairs’ Option	45
4.5	Scatterplots with Panels	46
4.6	Scatterplots with Marginal Graphs	48
4.7	Creating an Array of Scatterplots	50
5	Three Dimensional Plots	52
5.1	3D Scatterplots	52
5.2	3D Surface Plots	55
5.3	Contour Plots	58
6	Part One: Case Studies – Introduction and Graphical Techniques	62
6.1	Cork	62
6.2	Copper	68
6.3	Bread	73
6.4	Humidity	76
PART TWO HYPOTHESIS TESTING. COMPARISON OF TREATMENTS		79
7	Random Numbers and Numbers Following a Pattern	81
7.1	Introducing Values Following a Pattern	81
7.2	Sampling Random Data from a Column	83
7.3	Random Number Generation	83
7.4	Example: Solving a Problem Using Random Numbers	85
8	Computing Probabilities	87
8.1	Probability Distributions	87
8.2	Option ‘Probability Density’ or ‘Probability’	88
8.3	Option ‘Cumulative Probability’	89
8.4	Option ‘Inverse Cumulative Probability’	89
8.5	Viewing the Shape of the Distributions	92
8.6	Equivalence between Sigmas of the Process and Defects per Million Parts Using ‘ <i>Cumulative Probability</i> ’	92
9	Hypothesis Testing for Means and Proportions. Normality Test	95
9.1	Hypothesis Testing for One Mean	95
9.2	Hypothesis Testing and Confidence Interval for a Proportion	99
9.3	Normality Test	100

10	Comparison of Two Means, Two Variances or Two Proportions	103
10.1	Comparison of Two Means	103
10.2	Comparison of Two Variances	107
10.3	Comparison of Two Proportions	109
11	Comparison of More than Two Means: Analysis of Variance	110
11.1	ANOVA (Analysis of Variance)	110
11.2	ANOVA with a Single Factor	110
11.3	ANOVA with Two Factors	114
11.4	Test for Homogeneity of Variances	119
12	Part Two: Case Studies – Hypothesis Testing. Comparison of Treatments	120
12.1	Welding	120
12.2	Rivets	124
12.3	Almonds	126
12.4	Arrow	127
12.5	U Piece	131
12.6	Pores	133
	PART THREE MEASUREMENT SYSTEMS STUDIES AND CAPABILITY STUDIES	137
13	Measurement System Study	139
13.1	Crossed Designs and Nested Designs	139
13.2	File 'RR_CROSSED'	140
13.3	Graphical Analysis	140
13.4	R&R Study for the Data in File 'RR_CROSSED'	141
13.5	File 'RR_NESTED'	147
13.6	Gage R&R Study for the Data in File 'RR_NESTED'	147
13.7	File 'GAGELIN'	148
13.8	Calibration and Linearity Study of the Measurement System	148
14	Capability Studies	151
14.1	Capability Analysis: Available Options	151
14.2	File 'VITA_C'	152
14.3	Capability Analysis (Normal Distribution)	152
14.4	Interpreting the Obtained Information	152
14.5	Customizing the Study	154
14.6	'Within' Variability and 'Overall' Variability	155
14.7	Capability Study when the Sample Size Is Equal to One	158
14.8	A More Detailed Data Analysis (Capability Sixpack)	161

15	Capability Studies for Attributes	163
15.1	File 'BANK'	163
15.2	Capability Study for Variables that Follow a Binomial Distribution	163
15.3	File 'OVEN_PAINTED'	166
15.4	Capability Study for Variables that Follow a Poisson Distribution	166
16	Part Three: Case Studies – R&R Studies and Capability Studies	168
16.1	Diameter_measure	168
16.2	Diameter_capability_1	173
16.3	Diameter_capability_2	174
16.4	Web_visits	176
 PART FOUR MULTI-VARI CHARTS AND STATISTICAL PROCESS CONTROL		 181
17	Multi-Vari Charts	183
17.1	File 'MUFFIN'	183
17.2	Multi-Vari Chart with Three Sources of Variation	184
17.3	Multi-Vari Chart with Four Sources of Variation	186
18	Control Charts I: Individual Observations	188
18.1	File 'CHLORINE'	188
18.2	Graph of Individual Observations	188
18.3	Customizing the Graph	191
18.4	I Chart Options	192
18.5	Graphs of Moving Ranges	196
18.6	Graph of Individual Observations – Moving Ranges	197
19	Control Charts II: Means and Ranges	198
19.1	File 'VITA_C'	198
19.2	Means Chart	199
19.3	Graphs of Ranges and Standard Deviations	200
19.4	Graphs of Means-Ranges	201
19.5	Some Ideas on How to Use Minitab as a Simulator of Processes for Didactic Reasons	201
20	Control Charts for Attributes	204
20.1	File 'MOTORS'	204
20.2	Plotting the Proportion of Defective Units (P)	204
20.3	File 'CATHETER'	205
20.4	Plotting the Number of Defective Units (NP)	206

20.5	Plotting the Number of Defects per Constant Unit of Measurement (C)	208
20.6	File 'FABRIC'	210
20.7	Plotting the Number of Defects per Variable Unit of Measurement (U)	210
21	Part Four: Case Studies – Multi-Vari Charts and Statistical Process Control	212
21.1	Bottles	212
21.2	Mattresses (1st Part)	217
21.3	Mattresses (2nd Part)	221
21.4	Plastic (1st Part)	223
21.5	Plastic (2nd Part)	224
PART FIVE	REGRESSION AND MULTIVARIATE ANALYSIS	231
22	Correlation and Simple Regression	235
22.1	Correlation Coefficient	235
22.2	Simple Regression	238
22.3	Simple Regression with 'Fitted Line Plot'	239
22.4	Simple Regression with 'Regression'	244
23	Multiple Regression	247
23.1	File 'CARS2'	247
23.2	Exploratory Analysis	247
23.3	Multiple Regression	249
23.4	Option Buttons	250
23.5	Selection of the Best Equation: Best Subsets	252
23.6	Selection of the Best Equation: Stepwise	254
24	Multivariate Analysis	256
24.1	File 'LATIN_AMERICA'	256
24.2	Principal Components	257
24.3	Cluster Analysis for Observations	263
24.4	Cluster Analysis for Variables	266
24.5	Discriminant Analysis	267
25	Part Five: Case Studies – Regression and Multivariate Analysis	272
25.1	Tree	272
25.2	Power Plant	278
25.3	Wear	285
25.4	TV Failure	290

PART SIX	EXPERIMENTAL DESIGN AND RELIABILITY	293
26	Factorial Designs: Creation	295
	26.1 Creation of the Design Matrix	295
	26.2 Design Matrix with Data Already in the Worksheet	301
27	Factorial Designs: Analysis	303
	27.1 Calculating the Effects and Determining the Significant Ones	303
	27.2 Interpretation of Results	308
	27.3 A Recap with a Fractional Factorial Design	310
28	Response Surface Methodology	313
	28.1 Matrix Design Creation and Data Collection	313
	28.2 Analysis of the Results	317
	28.3 Contour Plots and Response Surface Plots	322
29	Reliability	325
	29.1 File	325
	29.2 Nonparametric Analysis	326
	29.3 Identification of the Best Model for the Data	329
	29.4 Parametric Analysis	330
	29.5 General Graphical Display of Reliability Data	333
30	Part Six: Case Studies – Design of Experiments and Reliability	335
	30.1 Cardigan	335
	30.2 Steering wheel – 1	340
	30.3 Steering Wheel – 2	343
	30.4 Paper Helicopters	345
	30.5 Microorganisms	349
	30.6 Jam	359
	30.7 Photocopies	365
APPENDICES		371
A1	Appendix 1: Answers to Questions that Arise at the Beginning	373
A2	Appendix 2: Managing Data	377
	A2.1 Copy Columns with Restrictions (File: ‘PULSE’)	377
	A2.2 Selection of Data when Plotting a Graph	381
	A2.3 Stacking and Unstacking of Columns (File ‘BREAD’)	382
	A2.4 Coding and Sorting Data	386

A3 Appendix 3: Customization of Minitab	390
A3.1 Configuration Options	390
A3.2 Use of Toolbars	392
A3.3 Add Elements to an Existing Toolbar	392
A3.4 Create Custom Toolbars	393
Index	397