

Contents

Preface

xi

Part 1 Process Understanding

1 Quality, processes and control	3
Objectives	3
1.1 The basic concepts	3
1.2 Design, conformance and costs	8
1.3 TQM, processes and the SPC system	14
1.4 Some basic tools	17
Chapter highlights	18
References	20
Discussion questions	21
	✓
2 Understanding the process	23
Objectives	23
2.1 Improving customer satisfaction through process management	23
2.2 Information about the process	26
2.3 Process mapping and flowcharting	29
2.4 Process analysis	35
2.5 Statistical process control and process understanding	37
Chapter highlights	40
References	41
Discussion questions	41
	✓
3 Process data collection and presentation	42
Objectives	42
3.1 The systematic approach	42
3.2 Data collection	44
3.3 Bar charts and histograms	46
	✓

3.4	Graphs, run charts and other pictures	54
3.5	Conclusions	57
	Chapter highlights	57
	References	58
	Discussion questions	58

Part 2 Process Variability

4	Variation and its management	63
	Objectives	63
4.1	The way managers look at data	63
4.2	Interpretation of data	64
4.3	Causes of variation	68
4.4	Accuracy and precision	72
4.5	Variation and management	77
	Chapter highlights	80
	References	81
	Discussion questions	81
5	Variables and process variation	82
	Objectives	82
5.1	Measures of accuracy or centring	82
5.2	Measures of precision or spread	85
5.3	The normal distribution	88
5.4	Sampling and averages	89
	Chapter highlights	95
	References	96
	Discussion questions	96
	Worked examples using the normal distribution	98

Part 3 Process Control

6	Process control using variables	105
	Objectives	105
6.1	Means, ranges and charts	105
6.2	Are we in control?	118
6.3	Do we continue to be in control?	120
6.4	Choice of sample size and frequency, and control limits	123
6.5	Short-, medium- and long-term variation – a change in the standard practice	126
6.6	Summary of SPC for variables using \bar{X} and R charts	130
	Chapter highlights	131

References	132
Discussion questions	133
Worked examples	141
7 Other types of control charts for variables	153
Objectives	153
7.1 Life beyond the mean and range chart	153
7.2 Charts for individuals or run charts	155
7.3 Median, mid-range and multi-vari charts	161
7.4 Moving mean, moving range, and exponentially weighted moving average (EWMA) charts	165
7.5 Control charts for standard deviation (σ)	176
7.6 Techniques for short run SPC	182
7.7 Summarizing control charts for variables	184
Chapter highlights	184
References	186
Discussion questions	186
Worked example	193
8 Process control by attributes	195
Objectives	195
8.1 Underlying concepts	195
8.2 np -charts for number of defectives or non-conforming units	198
8.3 p -charts for proportion defective or non-conforming units	206
8.4 c -charts for number of defects/non-conformities	210
8.5 u -charts for number of defects/non-conformities per unit	214
8.6 Attribute data in non-manufacturing	215
Chapter highlights	219
References	220
Discussion questions	221
Worked examples	224
9 Cumulative sum (cusum) charts	227
Objectives	227
9.1 Introduction to cusum charts	227
9.2 Interpretation of simple cusum charts	231
9.3 Product screening and pre-selection	236
9.4 Cusum decision procedures	237
Chapter highlights	242
References	243
Discussion questions	244
Worked examples	251

Part 4 Process Capability

10	Process capability for variables and its measurement	259
	Objectives	259
10.1	Will it meet the requirements?	259
10.2	Process capability indices	261
10.3	Interpreting capability indices	266
10.4	The use of control chart and process capability data	267
10.5	A service industry example – process capability analysis in a bank	270
	Chapter highlights	271
	References	272
	Discussion questions	273
	Worked examples	273

Part 5 Process Improvement

11	Process problem solving and improvement	277
	Objectives	277
11.1	Introduction	277
11.2	Pareto analysis	280
11.3	Cause and effect analysis	289
11.4	Scatter diagrams	296
11.5	Stratification	298
11.6	Summarizing problem solving and improvement	300
	Chapter highlights	301
	References	302
	Discussion questions	303
	Worked examples	307
12	Managing out-of-control processes	315
	Objectives	315
12.1	Introduction	315
12.2	Process improvement strategy	316
12.3	Use of control charts for trouble-shooting	318
12.4	Assignable or special causes of variation	329
	Chapter highlights	331
	References	332
	Discussion questions	332

13	Designing the statistical process control system	334
	Objectives	334
13.1	SPC and the management system	334
13.2	Teamwork and process control/improvement	338
13.3	Improvements in the process	340
13.4	Taguchi methods	347
13.5	Summarizing improvement	353
	Chapter highlights	353
	References	354
	Discussion questions	355
14	Six-sigma process quality	356
	Objectives	356
14.1	Introduction	356
14.2	The six-sigma improvement model	359
14.3	Six-sigma and the role of Design of Experiments	360
14.4	Building a six-sigma organization and culture	364
14.5	Ensuring the financial success of six-sigma projects	366
14.6	Concluding observations and links with Excellence	373
	Chapter highlights	375
	References	376
	Discussion questions	376
15	The implementation of statistical process control	378
	Objectives	378
15.1	Introduction	378
15.2	Successful users of SPC and the benefits derived	379
15.3	The implementation of SPC	380
	A final comment	384
	Chapter highlights	385
Appendices		
A	The normal distribution and non-normality	386
B	Constants used in the design of control charts for mean	396
C	Constants used in the design of control charts for range	397
D	Constants used in the design of control charts for median and range	398
E	Constants used in the design of control charts for standard deviation	399
F	Cumulative Poisson probability tables	400

G	Confidence limits and tests of significance	411
H	OC curves and ARL curves for \bar{X} and R charts	421
I	Autocorrelation	426
J	Approximations to assist in process control of attributes	428
K	Glossary of terms and symbols	433
	<i>Index</i>	441