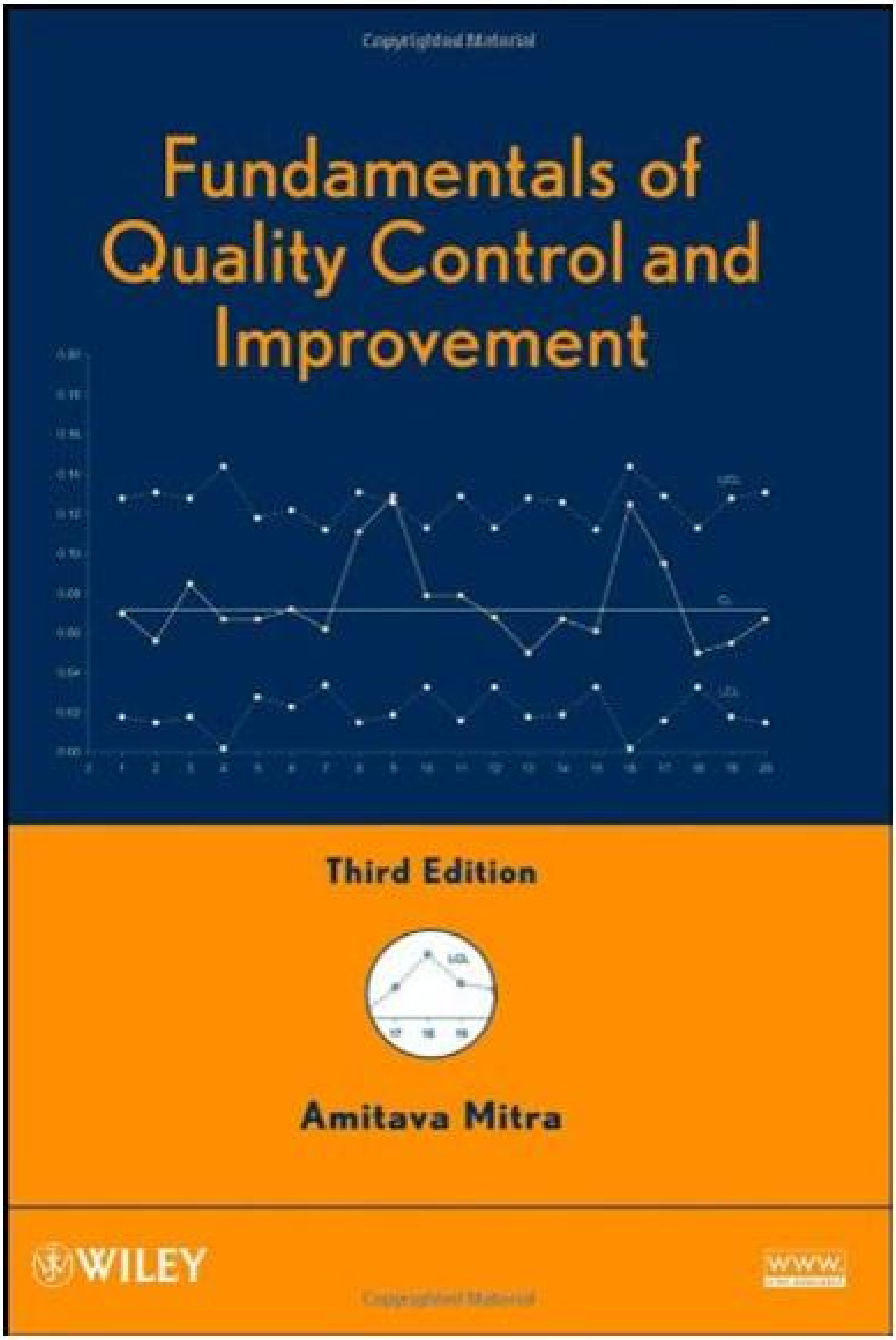
Solutions Manual

Fundamentals of Quality Control and Improvement

3rd Edition

Amitava Mitra



Solutions Manual to Accompany

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PREFACE

This solutions manual is designed to accompany the text, "Fundamentals of Quality Control and Improvement." To assist the student and the instructor in the teaching of the material, this manual includes solutions to the end-of-the chapter problems. The answers to the discussions questions are included too. Detailed explanation on the discussion questions may be found in the text and references. Associated figures and graphs on solutions to the problems are kept to a minimal. Most of the computations may be conducted using the Minitab software.

CHAPTER 1

INTRODUCTION TO QUALITY CONTROL AND THE TOTAL QUALITY SYSTEM

1-1. a) Call center that sells computers – possible definitions of quality that involve different variables/attributes could be as follows:

i) Time to process customer order for computers – Time measured in hours.
ii) Total turn over time (starting with customer placement of order to customer receipt of computer) – Time measured in hours.
iii) Proportion of delivered orders that do not match customer requirements exactly.
iv) Proportion of orders that are fulfilled later than promised date.

Integration of the various measures to one measure is not easily attainable. Individual measures, as proposed, should not be difficult to measure.

b) Emergency services for a city or municipality:

i) Time to respond to an emergency – Time measured in minutes.
ii) Time to process an emergency call – Measured in minutes and seconds.

Proposed measures readily obtainable.

c) Company making semiconductor chips:

i) Total manufacturing costs/10,000 chips.
ii) Parts per million of defective chips.
iii) Equipment and overhead costs/10,000 chips.

Measure iii) can be integrated into measure i). Measure ii) will influence manufacturing costs per conforming product. All of the measures should be easily obtainable.

d) A hospital: Variety of measures exist based on patient satisfaction, effectiveness of services, efficiency of operations, rate of return to investors, and employee/staff/nurse/physician satisfaction.

i) Proportion of in-patients satisfied with services.
ii) Length of stay of patients, by specified diagnosis related groups – Measured in days.
iii) Turn around time for laboratory tests, by type of test – Measured in hours/minutes.
iv) Annual or quarterly rate or return.

Most of the measures can be readily obtained. It may be difficult to integrate all such measures. However, some of these measures, such as annual rate of return, may serve as an integrated measure.

e) Deliver mail/packages on a rapid basis:

$$Z_1 = \frac{21-17.50}{2} = 1.75; \; Z_2 = \frac{9-17.50}{2} = -4.25.$$

Using the standard normal distribution, the area above the UCL is 0.0401, while the area below the LCL is 0.0000. The area between the control limits is 0.9599, which is the probability of non-detection of the shift on a given sample.

The probability of detecting the shift by the second sample
= 0.0401 + (0.9599)(0.0401) = 0.0401 + 0.0385 = 0.0786.

d) ARL = 1/0.0401 = 24.94.

acceptance and rejection lines are found based on a chosen level of producer's risk and acceptable mean life, and a chosen level of consumer's risk and a minimum mean life.

11-5. Reliability = exp (-0.00006)(4000) = 0.7866. MTTF = $1/\lambda$ = 1/0.00006 = 16666.667 hrs.

$$\text{Availability} = \frac{\mu}{\lambda + \mu}$$

$$= \frac{0.004}{0.00406} = 0.985.$$

11-6. R(t) = exp (- λ(6000)) = 0.92. This yields λ = 0.13896 x 10^{-4}/hour, or MTTF = $1/\lambda$ = 71958.314.

11-7. It is given that α = 300 and β = 0.5. R(t) = exp [-$(500/300)^{0.5}$] = 0.275. MTTF = 300 x Γ(1/0.5 + 1) = 600.

11-8. Reliability of the remote control unit = $(0.9994)^{40}$ = 0.9763. Reliability of redesigned unit = $(0.9994)^{25}$ = 0.9851.

11-9. We have, 0.996 = exp [- λ_s(3000)], which yields λ_s = 0.1336 x 10^{-5}/hour. The failure rate for each component is $\lambda = \lambda_s/25$ = 0.1336 x 10^{-5}/25 = 0.53 x 10^{-7}/hour or 5.3/10^8 hours. MTTF for each component is $1/\lambda$ = 18.7125 x 10^6 hours.

11-10. System reliability is R_s = 1 – (1 – 0.93)(1 – 0.88)(1 – 0.95)(1 – 0.92) = 0.9999664.

11-11. For each component, MTTF = 3000 hours, yielding an individual failure rate λ = 1/3000 = 3.333 x 10^{-4}/hour. Reliability of the subassembly is R_s = 1 – [1 – exp (-(1/3000)2500)]^4 = 0.8978. For the subassembly, MTTF = 3000 [1 + 1/2 + 1/3 + 1/4] = 6250 hours. If the MTTF of the subassembly were to be 6600, we have 6600 = ($1/\lambda$)[1 + 1/2 + 1/3 + 1/4], yielding λ = 3.156 x 10^{-4}/hour. So, for each component, MTTF = 3168 hours.

11-12. The reliability of the subsystem with components A and B is R_1 = 1 – (1 – 0.96)(1 – 0.92) = 0.9968. The reliability of the subsystem with components E, F, and G is R_2 = 1 – (1 – (0.95)(0.88))(1 – 0.90) = 0.9836. So, the system reliability is R_s = (0.9968)(0.94)(0.89) (0.9836) = 0.8202. To improve system reliability, try to improve the reliabilities of C and D.

11-13. For the subsystem with components A and B, MTTF = (1/0.0005)(1 + 1/2) = 3000. For the subsystem with components E, F, and G, MTTF = (1/0.0064)(1 + 1/2) = 234.375. Note that the failure rate of the subsystem with components E and F in series is 0.0004 + 0.006 = 0.0064. Now, the system failure rate is:

λ_s = 1/3000 + 0.0003 + 0.0008 + 1/234.375 = 0.0057/hour,

TABLE 12-18. Experimental Layout and Calculations

Outer array (L_8)				E	1	1	1	1	2	2	2	2		
				F	1	1	2	2	1	1	2	2		
				ExF	1	1	2	2	2	2	1	1		
				G	1	2	1	2	1	2	1	2		
				ExG	1	2	1	2	2	1	2	1		
Inner array (L_9)														
Run	A	B	C	D	Response Variable								$\bar{y}$	S/N
1	1	1	1	1	19.3	20.2	19.1	18.4	21.1	20.6	19.5	18.7	19.612	26.372
2	1	2	2	2	20.6	18.5	20.2	19.4	20.1	16.3	17.2	19.4	18.962	21.887
3	1	3	3	3	18.3	20.7	19.4	17.6	20.4	17.3	18.2	19.2	18.887	23.589
4	2	1	2	3	20.8	21.2	20.2	19.9	21.7	22.2	20.4	20.6	20.875	28.554
5	2	2	3	1	18.7	19.8	19.4	17.2	18.5	19.7	18.8	18.4	18.812	26.960
6	2	3	1	2	21.1	20.2	22.4	20.5	18.7	21.4	21.8	20.6	20.837	25.335
7	3	1	3	2	17.5	18.3	20.0	18.8	20.2	17.7	17.9	18.2	18.575	25.187
8	3	2	1	3	20.4	21.2	22.4	21.9	21.5	20.8	22.5	21.7	21.550	29.345
9	3	3	2	1	18.0	20.2	17.6	22.4	17.2	21.6	18.5	19.2	19.337	20.141

<u>Factor A – Average S/N</u>

Level 1: (26.372 + 21.887 + 23.589)/3 = 23.949

Level 2: (28.554 + 26.960 + 25.335)/3 = 26.950

Level 3: (25.187 + 29.345 + 20.141)/3 = 24.891

<u>Factor A – Average response</u>

Level 1: (19.612 + 18.962 + 18.887)/3 = 19.154

Level 2: (20.875 + 18.812 + 20.837)/3 = 20.175

Level 3: (18.575 + 21.550 + 19.337)/3 = 19.821

<u>Factor B – Average S/N</u>

Level 1: (26.372 + 28.554 + 25.187)/3 = 26.704

Level 2: (21.887 + 26.960 + 29.345)/3 = 26.064

Level 3: (23.589 + 25.335 + 20.141)/3 = 23.088

<u>Factor B – Average response</u>

Level 1: (19.612 + 20.875 + 18.575)/3 = 19.687