UNDERSTANDING INDUSTRIAL EXPERIMENTATION

Second Edition

Donald J. Wheeler



Contents

		Glossary Preface to the Second Edition	ix
IN	TRODU	CTION	
		Uniqueness of Industrial Experimentation	. 2
		Strategy for Industrial Experimentation	
		Shewhart's Cycle for the Scientific Process	
		Elements of Effective Industrial Experimentation	6
1.	WORKIN	NG WITH VARIATION	
	1.1	Measures of Dispersion	10
	1.2	The Notion of a Distribution	
	1.3	Using Statistics to Estimate Parameters	18
	1.4	Some Estimates of Dispersion Parameters	23
	1.5	Three Ways to Estimate SD(X)	29
	1.6	Within-Subgroup Estimates of SD(X)	39
	1.7	Degrees of Freedom	43
	1.8	Time Series Data	
	1.9	Summary	52
2.	THE AN	NALYSIS OF MEANS	
	2.1	Comparing k Treatments	54
	2.2	Experimental Data vs. Production Data	56
	2.3	Decision Limits for ANOM	59
	2.4	The Role of the Range Chart With ANOM	63
	2.5	ANOM With Multifactor Studies	
	2.6	Interaction Effects and ANOM	72
	2.7	ANOM with Unequal Subgroup Sizes	75
	2.8	The Analysis of Mean Ranges	77
	2.9	Summary of Uses of ANOM	82
3.	THE A	NALYSIS OF VARIANCE	
	3.1	The Concept of Analysis of Variance	83
	3.2	The ANOVA Table	86
	3.3	The Computation of ANOVA Values	90
	3.4	Interpreting the F-Ratio	
	3.5	Making Sense of a One-Way ANOVA	
	3.6	The Difference Between ANOM and ANOVA	01

4.	CONTRASTS					
	4.1	Comparisons and Contrasts	111			
	4.2	Evaluating Contrasts	115			
	4.3	F-Ratios for Contrasts	115			
	4.4	Interpreting Contrasts	121			
	4.5	Working With Contrasts	122			
5.						
	5.1	Partitioning the Between Subgroup Sum of Squares	125			
	5.2	Orthogonal Contrasts				
	5.3	Sets of Mutually Orthogonal Contrasts				
	5.4	Maximal Mutually Orthogonal Contrasts	132			
	5.5	Factorial ANOVA				
	5.6	The Invariance of Factorial ANOVA				
	5.7	Multifactor Studies with Subgroups of Size One	142			
	5.8	A Priori Pooling	144			
	5.9	Post Hoc Pooling	146			
	5.10	Scree Plots	150			
	5.11	Normal Probability Plots	155			
	5.12	Interpreting the Results: Response Plots and ANOM Plots	161			
	5.13	Partially Crossed Multifactor Studies	164			
	5.14	Analyzing Messy Data	168			
	5.15	The Problem of Varying One Factor At A Time	174			
	5.16	Nested Factors	178			
	5.17	Using the Different Analysis Techniques	181			
6.	FRACTI	ONAL FACTORIAL DESIGNS				
	6.1	Redundancies of Full Factorial Designs	183			
	6.2	Some 2 ^{k-p} Fractional Factorial Designs	186			
	6.3	Using Fractional Factorial Designs	192			
	6.4	Working With 2 ^{k-p} Fractional Factorials	201			
7.	PLACKE	ETT-BURMAN SCREENING DESIGNS				
	7.1	Eight-Run Plackett-Burman Designs				
	7.2	Non-Saturated 8-Run Designs				
	7.3	16-Run Plackett-Burman Designs	223			
	7.4	Non-Geometric Two-Level Designs	228			
	7.5	Four-Level Factors in Two-Level Designs				
	7.6	The Randomization of Run Order				
	7.7	Two-Level Plackett Burman Designs With Added Points	237			
	7.8	Three-Level Plackett-Burman Designs				
	7.9	Critique of Three-Level Plackett-Burman Designs	246			
	7 10	Choice of Factor Levels and Other Cautions	247			

8.	THE PROB	LEM OF PRODUCT VARIATION	
	8.1 Th	ne Costs of Variation	252
	8.2 th	e Specification Approach to Variation	253
	8.3 Th	ne Taguchi Loss Function	255
	8.4 Th	ne Average Loss Per Unit of Production	257
	8.5 M	inimizing the Average Loss	259
	8.6 A	Strategy for Experimation	266
9.	THE TAGU	ICHI APPROACH TO INDUSTRIAL EXPERIMENTA	ΓΙΟΝ
	9.1 Th	ne Noise Matrix	270
	9.2 Si	gnal to Noise Ratios	280
		ımmary	
	DELIDICES.	•	
AI	PPENDICES		206
		Data Sets	
	Table A		
	Table B	Bias Correction Factors and Degrees of Freedom	
	Table C	Control Chart Factors	
	Table D		
		2 ANOMR Critical Values	
	Table E	O	
	Table F		
	Table G	Percentiles of Maximum F Ratio	.319
	Table H	Dispersion Estimators	335
Analysis o		s of Means Worksheet	338
	Analysis of Variance Worksheet		339
	Working	g With Contrasts	340
	Data Set Eleven		341
			342
			352
			355
	Bibliogr	aphy and References	362
	Answer	s to Exercises	364
	Topical	Index	375