Multivariate Statistical Process Control Process Monitoring Methods And Applications Advances In Industrial Control

Quality control is a major concern and the best method for ensuring proper quality is to establish process adjustments. This text presents statistical methods for process adjustment and their relation to the classical methods of process monitoring.

Increase your odds of learning statistical process control (SPC) and identify and reduce variation in business processes using SPC--the powerful analysis tool for process evaluation and improvement. Statistical Process Control Demystified shows you how to use SPC to enable data-driven decision making and gain a competitive advantage in the marketplace. Written in a step-by-step format, this practical guide explains how to analyze process data, collect data, and determine the suitability of a process in meeting requirements. Attribute and X-bar control charts are discussed, as are charts for individuals data. You'll also get details on process improvement and measurement systems analysis. Detailed examples, calculations, and statistical assumptions make it easy to understand the material, and end-of-chapter quizzes and a final exam help reinforce key concepts. It's a no-brainer! You'll learn about: Control chart interpretation, overcoming common errors in the use of SPC, and general statistical analysis tools. Sampling requirements are analyzed, using Excel Estimating process variation, designed experiments, measurement systems analysis, including R&R studies. Continuous process improvement strategies are simple enough for a beginner, but challenging enough for an advanced student. Statistical Process Control Demystified is your shortcut to this powerful analysis solution.

Univariate and multivariate quality control charts are important tools for process/product monitoring and improvement. This monograph offers the developments and analyses of univariate and multivariate control charts, which are based on a generalized likelihood ratio (GLR) approach. It is commonly assumed that a process fault may shift the mean of a monitored statistic persistently to an unknown but constant value. However, there are situations such that a mean change is not constant but time varying. Incorporating a priori knowledge of a fault signature, a univariate GLR control chart is investigated for monitoring fault signatures. The GLR methodology can also be used in developing multivariate process control charts. Here, the GLR methodology is used to unify the development of various multivariate extensions to the CUSUM control charts. In addition to the GLR control charts under a normal distribution model, another GLR control chart is also proposed for monitoring a non-homogenous Markovian queuing system.

Process Monitoring Methods and Applications
Handbook of Multivariate Process Capability Indices
Statistical Methods for Quality Assurance
Multivariate Statistical Methods in Quality Management
Bayesian Process Monitoring, Control and Optimization

The intensive use of automatic data acquisition systems and the use of cloud computing for process monitoring have led to an increased occurrence of industrial processes that utilize statistical process control and capability analysis. These analyses are performed almost exclusively with multivariate methodologies. The aim of this Brief is to present the most important MSQC techniques developed in R language. The book is divided into two parts. The first part contains the basic R elements, an introduction to statistical procedures, and the main aspects related to Statistical Quality Control (SQC). The second part covers the construction of multivariate control charts, the calculation of Multivariate Capability Indices.

Providing a single-valued assessment of the performance of a process is often one of the greatest challenges for a quality professional. Process Capability Indices (PCIs) precisely do this job. For processes having a single measurable quality characteristic, there is an ample number of PCIs, defined in literature. The situation worsens for multivariate processes, i.e., where there is more than one correlated quality characteristic. Since in most situations quality professionals face multiple quality characteristics to be controlled through a process, Multivariate Process Capability Indices (MPCIs) become the order of the day. However, there is no book which addresses and explains different MPCIs and their properties. The literature of Multivariate Process Capability Indices (MPCIs) is not well organized, in the sense that a thorough and systematic discussion on the various MPCIs is hardly available in the literature. Handbook of Multivariate Process Capability Indices provides an extensive study of the MPCIs defined for various types of specification regions. This book is intended to help quality professionals to understand which PCI should be used and in what situation. For researchers in this field, the book provides a thorough discussion about each of the MPCIs developed to date, along with their statistical and analytical properties. Also, real life examples are provided for almost all the MPCIs discussed in the book. This helps both the researchers and the quality professionals alike to...
have a better understanding of the MPCIs, which otherwise become difficult to understand, since there is more than one quality characteristic to be controlled at a time. Features: A complete guide for quality professionals on the usage of different MPCIs. A step by step discussion on multivariate process capability analysis, starting from a brief discussion on univariate indices. A single source for all kinds of MPCIs developed so far. Comprehensive analysis of the MPCIs, including analysis of real-life data. References provided at the end of each chapter encompass the entire literature available on the respective topic. Interpretation of the MPCIs and development of threshold values of many MPCIs are also included. This reference book is aimed at the post graduate students in Industrial Statistics. It will also serve researchers working in the field of Industrial Statistics, as well as practitioners requiring thorough guidance regarding selection of an appropriate MPCI suitable for the problem at hand.

Process Control, Intensification, and Digitalisation in Continuous Biomanufacturing Explore new trends in continuous biomanufacturing with contributions from leading practitioners in the field. With the increasingly widespread acceptance and investment in the technology, the last decade has demonstrated the utility of continuous processing in the pharmaceutical industry. In Process Control, Intensification, and Digitalisation in Continuous Biomanufacturing, distinguished biotechnologist Dr. Ganapathy Subramanian delivers a comprehensive exploration of the potential of the continuous processing of biological products and discussions of future directions in advancing continuous processing to meet new challenges and demands in the manufacture of therapeutic products. A stand-alone follow-up to the editor's Continuous Biomanufacturing: Innovative Technologies and Methods published in 2017, this new edited volume focuses on critical aspects of process intensification, process control, and the digital transformation of biopharmaceutical processes. In addition to topics like the use of multivariate data analysis, regulatory concerns, and automation processes, the book also includes: Thorough introductions to capacitance sensors to control feeding strategies and the continuous production of viral vaccines Comprehensive explorations of strategies for the continuous upstream processing of induced microbial systems Practical discussions of preparative hydrophobic interaction chromatography and the design of modern protein-A-resins for continuous biomanufacturing In-depth examinations of bioprocess intensification approaches and the benefits of single use for process intensification Perfect for biotechnologists, bioengineers, pharmaceutical engineers, and process engineers, Process Control, Intensification, and Digitalisation in Continuous Biomanufacturing is also an indispensable resource for chemical engineers seeking a one-stop reference on continuous biomanufacturing.

Multivariate Statistical Process Control for Manufacturing Discrete Parts

Multivariate Quality Control

Douglas Montgomery's Introduction to Statistical Quality Control

Statistical Process Control Demystified

Data Depth

The book is a collection of some of the research presented at the workshop of the same name held in May 2003 at Rutgers University. The workshop brought together researchers from two different communities: statisticians and specialists in computational geometry. The main idea unifying these two research areas turned out to be the notion of data depth, which is an important notion both in statistics and in the study of efficiency of algorithms used in computational geometry. Many of the articles in the book lay down the foundations for further collaboration and interdisciplinary research. This undergraduate statistical quality assurance textbook clearly shows with real projects, cases and data sets how statistical quality control tools are used in practice. Among the topics covered is a practical evaluation of measurement effectiveness for both continuous and discrete data. Gauge Reproducibility and Repeatability methodology (including confidence intervals for Repeatability, Reproducibility and the Gauge Capability Ratio) is thoroughly developed. Process capability indices and corresponding confidence intervals are also explained. In addition to process monitoring techniques, experimental design and analysis for process improvement are carefully presented. Factorial and Fractional Factorial arrangements of treatments and Response Surface methods are covered. Integrated throughout the book are rich sets of examples and problems that help readers gain a better understanding of where and how to apply statistical quality control tools. These large and realistic problem sets in combination with the streamlined approach of the text and extensive supporting material facilitate reader understanding. Second Edition Improvements Extensive coverage of measurement quality evaluation (in addition to ANOVA Gauge R&R methodologies) New end-of-section exercises and revised-end-of-chapter exercises Two full sets of slides, one with audio to assist student preparation outside-of-class and another appropriate for professors' lectures Substantial supporting material Supporting Material Seven R programs that support variables and attributes control chart construction and analyses, Gauge R&R methods, analyses of Fractional Factorial studies, Propagation of Error analyses and Response Surface analyses Documentation for the R programs Excel data files associated with the end-of-chapter problem sets, most from real engineering settings The conference aims to provide a premier platform for Engineers, researchers, scientists and academicians to present their work in the emerging areas such as Renewable Energy, Energy storage, Power Electronics & drives, Smart devices and communication systems, Artificial Intelligence, Robotics, Networks an IoT, Control and automation etc.

Intelligent Electrical Systems:

A Short Overview and Some Applications in Industry
Multivariate Statistical Process Control of Batch Processes
Multivariate Statistical Process Control with Industrial Applications
Multivariate Statistical Process Control

Woodall and Montgomery in a discussion paper, state that multivariate process control is one of the most rapidly developing sections of statistical process control. Nowadays, in industry, there are many situations in which the simultaneous monitoring or control, of two or more related quality-process characteristics is necessary. Process monitoring problems in which several related variables are of interest are collectively known as Multivariate Statistical Process Control (MSPC). This article has three parts. In the first part, we discuss in brief the basic procedures for the implementation of multivariate statistical process control via control charting. In the second part we present the most useful procedures for interpreting the out-of-control variable when a control charting procedure gives an out-of-control signal in a multivariate process. Finally, in the third, we present applications of multivariate statistical process control in the area of industrial process control, informatics, and business.

Detailed coverage of the practical aspects of multivariate statistical process control (MVSPC) based on the application of Hotelling's T2 statistic. MVSPC is the application of multivariate statistical techniques to improve the quality and productivity of an industrial process. Provides valuable insight into the T2 statistic.

Master Statistical Quality Control using JMP! Using examples from the popular textbook by Douglas Montgomery, Douglas Montgomery's Introduction to Statistical Quality Control: A JMP Companion demonstrates the powerful Statistical Quality Control (SQC) tools found in JMP. Geared toward students and practitioners of SQC who are using these techniques to monitor and improve products and processes, this companion provides step-by-step instructions on how to use JMP to generate the output and solutions found in Montgomery's book. The authors combine their many years of experience as passionate practitioners of SQC and their expertise using JMP to highlight the recent advances in JMP's Analyze menu, and in particular, Quality and Process. Key JMP platforms include: Control Chart Builder CUSUM Control Chart Control Chart (XBar, IR, P, NP, C, U, UWMA, EWMA, CUSUM) Process Screening Process Capability Measurement System Analysis Time Series Multivariate Control Chart Multivariate and Principal Components Distribution For anyone who wants to learn how to use JMP to more easily explore data using tools associated with Statistical Process Control, Process Capability Analysis, Measurement System Analysis, Advanced Statistical Process Control, and Process Health Assessment, this book is a must!

Statistical Process Control in Automated Manufacturing
Multivariate Analysis in the Pharmaceutical Industry
Univariate and Multivariate Statistical Process Control

Proceedings of International Conference on Intelligent Manufacturing and Automation

Provides a theoretical foundation as well as practical tools for the analysis of multivariate data, using case studies and MINITAB computer macros to illustrate basic and advanced quality control methods. This work offers an approach to quality control that relies on statistical tolerance regions, and discusses computer graphic analysis highlights.

Written by experts from all over the world, the book comprises the latest applications of mathematical and models in food engineering and fermentation. It provides the fundamentals on statistical methods to solve standard problems associated with food engineering and fermentation technology. Combining theory with a practical, hands-on approach, this book covers key aspects of food engineering. Presenting cutting-edge information, the book is an essential reference on the fundamental concepts associated with food engineering.

Ideal for non-math majors, Advanced and Multivariate Statistical Methods teaches students to interpret, present, and write up results for each statistical technique without overemphasizing advanced math. This highly applied approach covers the why, what, when and how of advanced and multivariate statistics in a way that is neither too technical nor too mathematical. Students also learn how to compute each technique using SPSS software. New to the Sixth Edition Instructor ancillaries are now available with the sixth edition. All SPSS directions and screenshots have been updated to Version 23 of the software. Student learning objectives have been added as a means for students to target their learning and for instructors to focus their instruction. Key words are reviewed and reinforced in the end of chapter material to ensure that students understand the vocabulary of advanced and multivariate statistics.

Mathematical and Statistical Applications in Food Engineering

Theory and Applications ICIMA 2018

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A Step towards Smarter Earth
Robust Statistics Under Non-normality

Given their key position in the process control industry, process monitoring techniques have been extensively investigated by industrial practitioners and academic control researchers. Multivariate statistical process control (MSPC) is one of the most popular data-based methods for process monitoring and is widely used in various industrial areas. Effective routines for process monitoring can help operators run industrial processes efficiently at the same time as maintaining high product quality. Multivariate Statistical Process Control reviews the developments and improvements that have been made to MSPC over the last decade, and goes on to propose a series of new MSPC-based approaches for complex process monitoring. These new methods are demonstrated in several case studies from the chemical, biological, and semiconductor industrial areas. Control and process engineers, and academic researchers in the process monitoring, process control and fault detection and isolation (FDI) disciplines will be interested in this book. It can also be used to provide supplementary material and industrial insight for graduate and advanced undergraduate students, and graduate engineers. Advances in Industrial Control aims to report and encourage the transfer of technology in control engineering. The rapid development of control technology has an impact on all areas of the control discipline. The series offers an opportunity for researchers to present an extended exposition of new work in all aspects of industrial control.

Although there are many Bayesian statistical books that focus on biostatistics and economics, there are few that address the problems faced by engineers. Bayesian Process Monitoring, Control and Optimization solves this need, showing you how to oversee, adjust, and optimize industrial processes. Bridging the gap between application and development, this reference adopts Bayesian approaches for actual industrial practices. Divided into four parts, it begins with an introduction that discusses inferential problems and presents modern methods in Bayesian computation. The next part explains statistical process control (SPC) and examines both univariate and multivariate process monitoring techniques. Subsequent chapters present Bayesian approaches that can be used for time series data analysis and process control. The contributors include material on the Kalman filter, radar detection, and discrete part manufacturing. The last part focuses on process optimization and illustrates the application of Bayesian regression to sequential optimization, the use of Bayesian techniques for the analysis of saturated designs, and the function of predictive distributions for optimization. Written by international contributors from academia and industry, Bayesian Process Monitoring, Control and Optimization provides up-to-date applications of Bayesian processes for industrial, mechanical, electrical, and quality engineers as well as applied statisticians.

Multivariate Statistical Process Control with Industrial Applications

Methods of Multivariate Analysis

An Introduction to the Fundamentals and History of Control Charts, Applications, and Guidelines for Implementation

INTRODUCTION TO STATISTICAL QUALITY CONTROL

A JMP Companion

Process Control, Intensification, and Digitalisation in Continuous Biomanufacturing

This book presents the outcomes of the International Conference on Intelligent Manufacturing and Automation (ICIMA 2018) organized by the Departments of Mechanical Engineering and Production Engineering at Dwarkadas J. Sanghvi College of Engineering, Mumbai, and the Indian Society of Manufacturing Engineers. It includes original research and the latest advances in the field, focusing on automation, mechatronics and robotics; CAD/CAM/CAE/CIM/FMS in manufacturing; product design and development; DFM/DFA/FMEA; MEMS and Nanotechnology; rapid prototyping; computational techniques; industrial engineering; manufacturing process management; modelling and optimization techniques; CRM, MRP and ERP; green, lean, agile and sustainable manufacturing; logistics and supply chain management; quality assurance and environment protection; advanced material processing and characterization; and composite and smart materials.

Statistical Process Adjustment for Quality Control

The Mahalanobis-Taguchi System

A Practical Approach

Pharmaceutical Quality by Design

Robust Multivariate Analysis, Computational Geometry, and Applications

To understand the world around us, as well as ourselves, we need to measure many things, many variables, many properties of the systems and processes we investigate. Hence, data collected in science, technology, and almost everywhere else are multivariate, a data table with multiple variables measured on multiple observations (cases, samples, items, process time points, experiments). This book describes a remarkably simple minimalistic and practical approach to the analysis of data tables (multivariate data). The approach is based on projection methods, which are PCA (principal components analysis), and PLS (projection to latent
structures) and the book shows how this works in science and technology for a wide variety of applications. In particular, it is shown how the great information content in well collected multivariate data can be expressed in terms of simple but illuminating plots, facilitating the understanding and interpretation of the data.

The projection approach applies to a variety of data-analytical objectives, i.e., (i) summarizing and visualizing a data set, (ii) multivariate classification and discriminant analysis, and (iii) finding quantitative relationships among the variables. This works with any shape of data table, with many or few variables (columns), many or few observations (rows), and complete or incomplete data tables (missing data). In particular, projections handle data matrices with more variables than observations very well, and the data can be noisy and highly collinear.

Authors: The five authors are all connected to the Umetrics company (www.umetrics.com) which has developed and sold software for multivariate analysis since 1987, as well as supports customers with training and consultations. Umetrics’ customers include most large and medium sized companies in the pharmaceutical, biopharm, chemical, and semiconductor sectors.

A practical guide to Quality by Design for pharmaceutical product development

**Pharmaceutical Quality by Design: A Practical Approach** outlines a new and proven approach to pharmaceutical product development which is now being rolled out across the pharmaceutical industry internationally. Written by experts in the field, the text explores the QbD approach to product development. This innovative approach is based on the application of product and process understanding underpinned by a systematic methodology which can enable pharmaceutical companies to ensure that quality is built into the product. Familiarity with Quality by Design is essential for scientists working in the pharmaceutical industry. The authors take a practical approach and put the focus on the industrial aspects of the new QbD approach to pharmaceutical product development and manufacturing.

The text covers quality risk management tools and analysis, applications of QbD to analytical methods, regulatory aspects, quality systems and knowledge management. In addition, the book explores the development and manufacture of drug substance and product, design of experiments, the role of excipients, multivariate analysis, and include several examples of applications of QbD in actual practice. This important resource:

- *Covers the essential information about Quality by Design (QbD) that is at the heart of modern pharmaceutical development*
- *Puts the focus on the industrial aspects of the new QbD approach*
- *Includes several illustrative examples of applications of QbD in practice*
- *Offers advanced specialist topics that can be systematically applied to industry*
- *Pharmaceutical Quality by Design offers a guide to the principles and application of Quality by Design (QbD), the holistic approach to manufacturing that offers a complete understanding of the manufacturing processes involved, in order to yield consistent and high quality products.*

A major tool for quality control and management, statistical process control (SPC) monitors sequential processes, such as production lines and Internet traffic, to ensure that they work stably and satisfactorily. Along with covering traditional methods, *Introduction to Statistical Process Control* describes many recent SPC methods that improve upon:

- **Basics, Measurement, Control, Capability, and Improvement**
- **Multivariate Statistical Process Control of Chemical Processes**
- **Evolution-traced Multivariate Statistical Process Control for Batch Processes**
- **Multi- and Megavariate Data Analysis Basic Principles and Applications**
- **Contributors to a Multivariate Statistical Process Control Chart Signal**

**The MAHALANOBIS-TAGUCHI SYSTEM (MTS)** is a groundbreaking new philosophy that has been reshaping Japanese industry since its inception. Developed by award-winning quality engineering expert Dr. Genichi Taguchi - acknowledged as one of the most innovative thinkers in the field and based on the work of Indian Statistics giant Dr. P. C. Mahalanobis, the system provides a powerful process for recognizing patterns and forecasting results. MTS goes beyond theory - it shows you exactly how international business giants have successfully put the system to work for them. The book includes 15 fascinating case studies that provide an inside look at how organizations such as Fuji, Nissan, Sharp, Xerox and others have utilized the system effectively. MTS can be applied in patient monitoring, medical diagnosis, software, manufacturing, weather forecasting, automotive collision prevention system, and fire detection. Doctors, researchers, engineers, insurance experts, financial analysts, programmers, and anyone else with an interest in pattern recognition and forecasting will find this book to a blueprint to improved decision-making.

"Japan's Taguchi is America's new quality hero." --Fortune Magazine November 23, 1998 "Subir Chowdhury: V oices of quality for the 21st Century." --Quality Progress (January 2000) American Society for Quality "There is no question that the Mahalanobis-Taguchi System is a profoundly important giant step in improving the productivity of evaluating and improving diagnostic and other systems based on pattern recognition. Potential application of this method abound in many industries." --John King, Ford Motor Company "JAPAN’S POWERFUL, NEW PATTERN-RECOGNITION METHODS NOW AVAILABLE TO AMERICAN BUSINESS AND INDUSTRY And here is the FIRST book on the subject Learn how you can harness the power of an amazing new pattern-recognition and forecasting method from Dr. Genichi Taguchi, a world-renowned quality genius. 15 case studies from around the U.S. and Japan show how industry giants used the MTS effectively in their organizations. With this important and authoritative book, you can achieve the same success. This book provides an introduction to statistical process control in automated manufacturing and suggests implementation strategies. It focuses on time series applications in statistical process control and explores the role of knowledge-based systems in process control."

A mstat News asked three review editors to rate their top five favorite books in the September 2003 issue. Methods of multivariate analysis was among those chosen.
When measuring several variables on a complex experimental unit, it is often necessary to analyze the variables simultaneously, rather than isolate them and consider them individually. Multivariate analysis enables researchers to explore the joint performance of such variables and to determine the effect of each variable in the presence of the others. The Second Edition of Alvin Rencher's Methods of Multivariate Analysis provides students of all statistical backgrounds with both the fundamental and more sophisticated skills necessary to master the discipline. To illustrate multivariate applications, the author provides examples and exercises based on fifty-nine real data sets from a wide variety of scientific fields. Rencher takes a "methods" approach to his subject, with an emphasis on how students and practitioners can employ multivariate analysis in real-life situations. The Second Edition contains revised and updated chapters from the critically acclaimed First Edition as well as new chapters on: Cluster analysis, multidimensional scaling, correspondence analysis, and biplots. Each chapter contains exercises, with corresponding answers and hints in the appendix, providing students the opportunity to test and extend their understanding of the subject. Methods of Multivariate Analysis provides an authoritative reference for statistics students as well as for practicing scientists and clinicians.

A Contribution to Multivariate Statistical Process Control
Multivariate Statistical Quality Control Using R

Introduction to Statistical Process Control

This applied, self-contained text provides detailed coverage of the practical aspects of multivariate statistical process control (MVSPC), based on the application of Hotelling's T² statistic. MVSPC is the application of multivariate statistical techniques to improve the quality and productivity of an industrial process. The authors, leading researchers in this area who have developed major software for this type of charting procedure, provide valuable insight into the T² statistic. Intentionally including only a minimal amount of theory, they lead readers through the construction and monitoring phases of the T² control statistic using numerous industrial examples taken primarily from the chemical and power industries. These examples are applied to the construction of historical data sets to serve as a point of reference for the control procedure and are also applied to the monitoring phase, where emphasis is placed on signal location and interpretation in terms of the process variables.

Multivariate Analysis in the Pharmaceutical Industry provides industry practitioners with guidance on multivariate data methods and their applications over the lifecycle of a pharmaceutical product, from process development, to routine manufacturing, focusing on the challenges specific to each step. It includes an overview of regulatory guidance specific to the use of these methods, along with perspectives on the applications of these methods that allow for testing, monitoring and controlling products and processes. The book seeks to put multivariate analysis into a pharmaceutical context for the benefit of pharmaceutical practitioners, potential practitioners, managers and regulators. Users will find a resource that addresses an unmet need on how pharmaceutical industry professionals can extract value from data that is routinely collected on products and processes, especially as these techniques become more widely used, and ultimately, expected by regulators. Targets pharmaceutical industry practitioners and regulatory staff by addressing industry specific challenges. Includes case studies from different pharmaceutical companies and across product lifecycle of to introduce readers to the breadth of applications. Contains information on the current regulatory framework which will shape how multivariate analysis (MVA) is used in years to come.

An Introduction to Acceptance Sampling and SPC with R

An Introduction to Acceptance Sampling and SPC with R is an introduction to statistical methods used in monitoring, controlling and improving quality. Topics covered include acceptance sampling, Shewhart control charts for Phase I studies; graphical and statistical tools for discovering and eliminating the cause of out-of-control conditions; Cusum and EWMA control charts for Phase II process monitoring; and the design and analysis of experiments for process troubleshooting and discovering ways to improve process output. Origins of statistical quality control and the technical topics presented in the remainder of the book are those recommended in the ANSI/ASQ/ISO guidelines and standards for industry. The final chapter ties everything together by discussing modern management philosophies that encourage the use of the technical methods presented earlier. In the modern world sampling plans and the statistical calculations used in statistical quality control are done with the help of computers. As an open source high-level programming language with flexible graphical output options, R runs on Windows, Mac and Linux operating systems, and has add-on packages that equal or exceed the capability of commercial software for statistical methods used in quality control. In this book, we will focus on several R packages. In addition to demonstrating how to use R for acceptance sampling and control charts, this book will concentrate on how the use of these specific tools can lead to quality improvements both within a company and within their supplier companies. This would be a suitable book for a one-semester undergraduate course emphasizing statistical quality control for engineering majors (such as manufacturing engineering or industrial engineering), or a supplemental text for a graduate engineering course that included quality control topics.

Advanced and Multivariate Statistical Methods