Integrated Statistical and Automatic Process Control

Hybrid Process and Quality Control

G. Venkatesan

Alpha Science

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Alpha Science International Ltd.
Oxford, U.K.

Integrated Statistical and Automatic Process Control

248 pgs. | 31 figs. | 14 tbls.

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www.alphasci.com

ISBN 978-1-84265-881-9

Printed in India

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Preface

The material contained in this book is based on the author's academic and industrial experience in the context of process modelling and product quality control. The fields of 'Stochastic Control' and 'Control Engineering' are vast and broad subjects that span long periods of time. Situations that arise in the practice of process control have been attempted both by statistical and process control practitioners by applying the concepts of stochastic and engineering control theories. This book reviews some of the relevant and pertinent situations and includes some of those references published in the process control literature. It covers the application of Statistical Process Control (SPC) and Automatic Process Control (APC) principles, practices, tools and techniques for process and product quality control at the interface of the two disciplines.

The core contributions and the fundamental work on Time Series Analysis, Forecasting and Control by Professor George Box and Jenkins, K. J. Astrom and others working in the stochastic process control and control engineering areas will always be of immense value to process control practitioners.

This book can assist and guide process control and quality control practitioners to develop process control methodology for quality production by applying stochastic and mathematical modelling concepts, develop and simulate stochastic feedback control algorithm for analysis and interpretation of the results. For this purpose, the book uses the interface of the two different disciplines, which have the common objective of process and product quality control. The book explains use of the developed feedback control algorithm in simulation and interpretation of the simulation results to develop statistical process control procedures and process regulation schemes. It is expected that the parallel processing computer architectures described in this monograph and other computer architectures that are currently available can be used for incorporating the stochastic feedback control algorithm suitably in process control domain in order to achieve the purposes of efficient and cost effective process and product quality control.

It may be possible that some mistakes and errors might have crept in inspite of best efforts to make the book free of omissions, commissions, and repetition to maintain flow of text and continuity of discussion.

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Acknowledgement

I wish to thank my academic colleagues at Monash, RMIT and Victoria University for valuable guidance, suggestions and contributions that have appeared in international published papers and conference proceedings, for which references are provided in the relevant chapters.

I acknowledge the permission given by the publishers of journals and conference proceedings to reproduce the tables and figures.

I wish to thank Narosa Publishing House, management and the production department for the meticulous attention to detail efforts in making this publication possible.

G. Venkatesan

Contents

Chapter

1

Introduction to the Development of Process Control Methodologies

1.1 OBJECTIVES

Modern high-tech and sophisticated manufactured products should be of high quality with minimum variations to satisfy the needs and requirements of customers. Quality products with minimum variances are the outcomes of successful process control of production processes. Statistical Process Control (SPC) monitors and detects special cause variations. Automatic Process Control (APC) compensates for 'disturbances', adjusts a manufacturing process and reduces output product quality variations. APC, based on real-time feedback is popular as a process control tool in manufacturing applications. It is a challenge for process control practitioners to develop methodologies to integrate both SPC and APC to control processes with various unknown disturbances. The objective of this book is to describe from mathematical and statistical principles the development of a suitable feedback control algorithm, an integrated hybrid process control methodology for manufacturing processes that have both 'time delays' and unknown disturbances. The integrated process control methodology proposed and discussed in this book will assist in better process control and product quality control thus reducing manufacturing costs.

In engineering (machines, machine components and parts), and chemical processes (petroleum, oil refining, mining) manufacturing, more often than not, it is quite common to encounter problems that are associated with control of output product quality. Physical or chemical change of matter or conversion of energy is called process, for example, changes in pressure, temperature, speed, electrical potential etc. A process can be anything from a control valve in a length of pipe, (simple flow control), to an enormously comprehensive and complicated physical and/or chemical complex such as a system of distillation columns, or any complex process comprised of many process subsections. The outcome of a manufacturing

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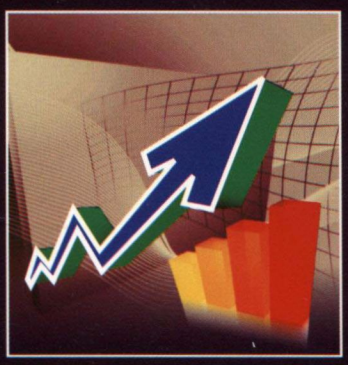

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This text book on **Integrated Statistical and Automatic Process Control** covers mathematical process and stochastic modelling, algorithm development, simulation principles, analysis of simulation results to develop process regulation schemes for cost effective and efficient process control and statistical control procedures for producing quality products.

Manufacturing processes, in order to provide good quality products that satisfy the needs of customers at affordable cost, need to be controlled during process operations. Different types of processes require different types of control that may be either simple or complex.

In this book, an integrated statistical and process model of Automatic Process Control (APC) and Statistical Process Control (SPC) is developed by using the tools and techniques of the two different process control disciplines when overlapping at their interface.

These regulation schemes and control procedures will be of practical use and value in industry through the hybrid process and quality control of the manufacturing processes and products.

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