

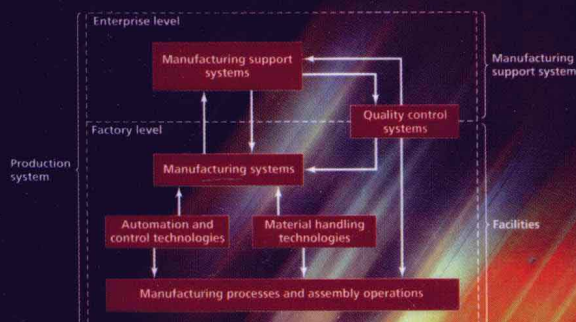
国外大学优秀教材——工业工程系列（影印版）

Mikell P. Groover

自动化、生产系统与 计算机集成制造(第3版)

Automation,
Production Systems,
and Computer-Integrated
Manufacturing

Third Edition



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2010年12月

Foreword

This textbook series is published at a very opportunity time when the discipline of industrial engineering is experiencing a phenomenal growth in China academia and with its increased interests in the utilization of the concepts, methods and tools of industrial engineering in the workplace. Effective utilization of these industrial engineering approaches in the workplace should result in increased productivity, quality of work, satisfaction and profitability to the cooperation.

The books in this series should be most suitable to junior and senior undergraduate students and first year graduate students, and to those in industry who need to solve problems on the design, operation and management of industrial systems.


Gavriel Salvendy

Department of Industrial Engineering, Tsinghua University

School of Industrial Engineering, Purdue University

April, 2002

序 言

本教材系列的出版正值中国学术界工业工程学科经历巨大发展，实际工作中对工业工程的概念、方法和工具的使用兴趣日渐浓厚之时。在实际工作中有效地应用工业工程的手段将无疑会提高生产率、工作质量、合作的满意度和效果。

该系列中的书籍对工业工程的本科生、研究生和工业界中需要解决工程系统设计、运作和管理诸方面问题的人士最为适用。

加弗瑞尔·沙尔文迪
清华大学工业工程系
普渡大学工业工程学院（美国）
2002年4月

Preface

This book was originally published in 1980 as *Automation, Production Systems, and Computer-Aided Manufacturing*. It contained 19 chapters and 601 pages. Topics included automated flow lines, assembly line balancing, numerical control, CAD/CAM, control theory, process control, production planning, group technology, and flexible manufacturing systems. A revised edition was published in 1986 with a change in title to *Automation, Production Systems, and Computer Integrated Manufacturing*. Additional topics included industrial robotics, programmable logic controllers, automated assembly systems, material handling and storage, automatic identification techniques, shop floor control, and the future automated factory. These additions increased the chapter count to 27 and the page count to 808. The second edition of this title was released in 2000 with a 2001 copyright. Although many of the topics remained the same as in the 1986 edition, the book was reorganized substantially, and most of the chapters were rewritten, bringing the technical subject matter up to date. The page count was increased to 856, even though much of the material on industrial process control was eliminated or reduced.

In this new edition of the current title (which is the fourth edition of the original textbook), I have consolidated and reorganized some of the topics and eliminated material that I felt is no longer relevant. At the same time, I have added or expanded coverage in several chapters on new and emerging technologies (e.g., radio frequency identification, Six Sigma, lean production, enterprise resource planning). A number of changes in the book were motivated by responses to a user survey that was conducted by the publisher. The names of the survey participants are included in the acknowledgements section below. Some very worthwhile suggestions were offered by these reviewers, and I have attempted to respond to them where feasible. In any case, I appreciate the thoughtful and serious efforts that they contributed to the project, and I am sure that the book is better as a result of those efforts. Finally, I have added review questions at the end of every chapter and revised some of the end-of-chapter problem sets.

The principle objective of the book remains the same as in the previous editions. It is a textbook designed primarily for engineering students at the advanced undergraduate or beginning graduate levels in industrial, mechanical, and manufacturing engineering. It has all the features of an engineering textbook: equations, example problems, diagrams, quantitative end-of-chapter exercises, and obscure technical descriptions.

The book should also be useful for practicing engineers and managers who wish to learn about automation and production systems technologies in modern manufacturing. In several chapters, application guidelines are presented to help readers decide whether the particular technology may be appropriate for their operations.

SUPPORT MATERIALS FOR INSTRUCTORS

For instructors who adopt the book for their courses, the following support materials are available:

- A *Solutions Manual* covering all review questions and problems.
- A complete set of Powerpoint slides for all chapters.

These support materials may be found at the website www.prenhall.com/college/groover. Evidence that the book has been adopted as the main textbook for the course must be verified. Individual questions or comments may be directed to the author personally at Mikell.Groover@Lehigh.edu or mpg0@Lehigh.edu.

MIKELL P. GROOVER

Acknowledgments

Participants in the previously-mentioned survey of faculty who reviewed the book are Amarnath Banerjee of Texas A&M University, Joe Chow of Florida International University, Joseph Domblesky of Marquette University, and Frank Peters of Iowa State University. Their suggestions were very helpful in shaping the book's final contents and organization. Several other people should be mentioned for their suggestions and advice regarding this new edition: Kalyan Ghosh, Department of Mathematics and Industrial Engineering at Ecole Polytechnique in Montreal, Quebec, Canada, for being a long-time user of this book in his courses and for his suggestions on this new edition; Jack Feng, Manufacturing Engineering Department at Bradley University, for his valuable feedback on this and other textbooks I have authored; George Wilson, my colleague in the Department of Industrial and Systems Engineering at Lehigh, for his advice on the production planning and control chapter (Chapter 25); and Marcia Hamm Groover, for being my wife, Powerpoint slide expert, and computer specialist (I write books about computer-related technologies, but she is the one who solves my own computer problems).

I also thank the following editors at Pearson Prentice Hall: Holly Stark, Senior Editor, Dee Bernhard, Associate Editor, Scott Disanno, Senior Managing Editor for this edition and Production Editor for the previous edition, and James Buckley, freelance production editor for Pearson Prentice Hall. In addition, I appreciate the fine copy-editing job on the manuscript done by WriteWith Inc. Finally, I am grateful to all of the faculty who adopted the previous editions of the book for their courses, thus making those projects commercially successful for Pearson Prentice Hall so that I would be allowed to prepare this new edition.

About the Author

Mikell P. Groover is Professor of Industrial and Systems Engineering at Lehigh University, where he also serves as Director of the George E. Kane Manufacturing Technology Laboratory and faculty member in the Manufacturing Systems Engineering Program. He received his B.A. in Arts and Science (1961), B.S. in Mechanical Engineering (1962), M.S. in Industrial Engineering (1966), and Ph.D. (1969), all from Lehigh. He is a Registered Professional Engineer in Pennsylvania. His industrial experience includes several years as a manufacturing engineer with Eastman Kodak Company. Since joining Lehigh, he has done consulting, research, and project work for a number of industrial companies.

His teaching and research areas include manufacturing processes, production systems, automation, material handling, facilities planning, and work systems. He has received a number of teaching awards at Lehigh University, as well as the *Albert G. Holzman Outstanding Educator Award* from the Institute of Industrial Engineers (1995) and the *SME Education Award* from the Society of Manufacturing Engineers (2001). His publications include over 75 technical articles and nine books (listed below). His books are used throughout the world and have been translated into French, German, Spanish, Portuguese, Russian, Japanese, Korean, and Chinese. The first edition of *Fundamentals of Modern Manufacturing* received the *IIE Joint Publishers Award* (1996) and the *M. Eugene Merchant Manufacturing Textbook Award* from the Society of Manufacturing Engineers (1996).

Dr. Groover is a member of the Institute of Industrial Engineers, American Society of Mechanical Engineers (ASME), the Society of Manufacturing Engineers (SME), the North American Manufacturing Research Institute (NAMRI), and ASM International. He is a Fellow of IIE and SME.

PREVIOUS BOOKS BY THE AUTHOR:

Automation, Production Systems, and Computer-Aided Manufacturing, Prentice Hall, 1980.

CAD/CAM: Computer-Aided Design and Manufacturing, Prentice Hall, 1984 (co-authored with E. W. Zimmers, Jr.).

Industrial Robotics: Technology, Programming, and Applications, McGraw-Hill Book Company, 1986 (co-authored with M. Weiss, R. Nagel, and N. Odrey).

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Automation, Production Systems, and Computer Integrated Manufacturing, Second Edition, Prentice Hall, 2001.

Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Second Edition, John Wiley & Sons, Inc., 2002.

Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Third Edition, John Wiley & Sons, Inc., 2007.

Work Systems and the Methods, Measurement, and Management of Work, Pearson Prentice Hall, 2007.

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Chapter 1

Introduction

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The systems aspects of manufacturing are more important than ever today. The word manufacturing was originally derived from two Latin words, *manus* (hand) and *factus* (make), so that the combination means *made by hand*. This was the way manufacturing was accomplished when the word first appeared in the English language around 1567. Commercial goods of those times were made by hand. The methods were handicraft, accomplished in small shops, and the goods were relatively simple, at least by today's standards. As many years passed, factories were developed, with many workers at a single site,