Preface

This textbook was developed to fill the need for an accessible but comprehensive presentation of the analytical approaches for modeling and analyzing models of manufacturing and production systems. It is an out growth of the efforts within the Industrial and Systems Engineering Department at Texas A&M to develop and teach an analytically based undergraduate course on probabilistic modeling of manufacturing type systems. The level of this textbook is directed at undergraduate and masters students in engineering and mathematical sciences. The only prerequisite for students using this textbook is a previous course covering calculus-based probability and statistics. The underlying methodology is queueing theory, and we shall develop the basic concepts in queueing theory in sufficient detail that the reader need not have previously covered it. Queueing theory is a well-established discipline dating back to the early 1900's work of A. K. Erlang, a Danish mathematician, on telephone traffic congestion. Although there are many textbooks on queueing theory, these texts are generally oriented to the methodological development of the field and exact results and not to the practical application of using approximations in realistic modeling situations. The application of queueing theory to manufacturing type systems started with the approximation based work of Ward Whitt in the 1980's. His paper on QNA (a queueing network analyzer) in 1983 is the base from which most applied modeling efforts have evolved.

There are several textbooks with titles similar to this book. Principle among these are: Modeling and Analysis of Manufacturing Systems by Askin and Standridge, Manufacturing Systems Engineering by Stanley Gershwin, Queueing Theory in Manufacturing Systems Analysis and Design by Papadopoulos, Heavey and Browne, Performance Analysis of Manufacturing Systems by Tayfur Altiok, Stochastic Modeling and Analysis of Manufacturing Systems, edited by David Yao, and Stochastic Models of Manufacturing Systems by Buzacott and Shanthikumar. Each of these texts, along with several others contributes greatly to the field. The book that most closely aligns with the motivation, level, and intent of this book is Factory Physics by Hopp and Spearman. Their approach and analysis is highly recommended reading, however, their book's scope is on the larger field of production and operations management. Thus, it does not provide the depth and breath of analytical modeling procedures that are presented in this text.

This text is about the development of analytical approximation models and their use in evaluating factory performance. The tools needed for the analytical approach are fully developed. One useful non-analytical tool that is not fully developed in this textbook is simulation modeling. In practice as well as in the development of the models in this text, simulation is extensively used as a verification tool. Even though the development of simulation models is only modestly addressed, we would encourage instructors who use this book in their curriculum after a simulation course to ask students to simulate some of the homework problems so that a comparison can be made of the analysis using the models presented here with simulation models. By developing simulation models students will have a better understanding of the modeling assumptions and the accuracy of the analytical approximations. In addition several chapters include an appendix that contains instructions in the use of Microsoft Excel as an aid in modeling or in building simple simulation models.

For this second edition, suggestions from various instructors who have used the textbook have been incorporated. Because of the importance of simulation modeling, this second edition also includes an introduction to event-driven simulations.

Two special sections are included to help the reader organize the many concepts contained in the text. Immediately after the Table of Contents, we have included a symbol table that contains most of the notation used throughout the text. Second, immediately after the final chapter a glossary of terms is included that summarizes the various definitions used. It is expected that these will prove valuable resources as the reader progresses through the text.

Many individuals have contributed to this book through our interactions in research efforts and discussions. Special thanks go to Professor Martin A. Wortman, Texas A&M University, who designed and taught the first presentation of the course for which this book was originally developed and Professor Bryan L. Deuermeyer, Texas A&M University, for his significant contributions to our joint research activities in this area and his continued interest and criticism. In addition several individuals have helped in improving the text by using a draft copy while teaching the material to undergraduates including Eylem Tekin at Texas A&M, Natarajan Gautam also at Texas A&M, and Kevin Gue at Auburn University. We also wish to acknowledge the contributions of Professors John A. Fowler, Arizona State University, and Mark L. Spearman, Factory Physics, Inc., for their continued interactions and discussions on modeling manufacturing systems. And we thank Ciriaco Valdez-Flores, a co-author of the first chapter covering basic probability for permission to include it as part of our book. Finally, we acknowledge our thanks through the words of the psalmist, "Give thanks to the Lord, for He is good; His love endures forever." (Psalms 107:1, NIV)

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