

Preface

This book started in 2005 as a discussion on modeling and simulation (M&S) education. That discussion led to the development of an M&S certificate program through the Georgia Tech School of Professional Education. The certificate program, geared toward working professionals, was designed to have two required courses (on fundamental M&S topics) and four electives (on the domain topics important to the student). In the context of professional education, the need was to introduce working professionals to the broad landscape of M&S science, process, architecture, and standards. Around the same time, discussions started in the Georgia Tech Research Institute (GTRI) on creating a Professional Masters in Applied Systems Engineering (PMASE). The need to include M&S as one of the core courses in this program was identified early on. In the context of PMASE, the need was to introduce systems engineering students to the broad landscape of M&S they will encounter throughout their careers. Through these two efforts, the vision for a survey-type M&S course came about.

One of the fundamental ideas I based the course on is that M&S is a broad discipline, and systems engineers need to understand the breadth of technologies, methodologies, and uses of M&S to be effective in their jobs. There are many academic M&S courses available at Georgia Tech (and other universities), but they focus on a specific slice of the discipline. For example, Industrial and Systems Engineering teaches discrete event simulation, College of Computing teaches parallel and distributed simulation, Mechanical Engineering teaches model based design, Electrical and Computer Engineering teaches continuous simulation, and Aerospace Engineering teaches surrogate modeling. All of these methodologies are important to understand, and each has a different purpose in the systems engineering life cycle. I own many books on M&S, but none cover the breadth of M&S used in systems engineering. This was the motivation for creating a book based on my PMASE course—to put all this information in one place.

Since 2007 I have taught hundreds of students, both professionals desiring new or enhanced knowledge of modeling and simulation, and masters' students, pursuing formal academic credentials in systems engineering. The students' educational pursuits are quite different, but a common thread seems to connect them—limited time. In an era when we are juggling our careers, staying abreast of technology

changes, as well as making time for family and friends, a formal academic educational approach is not the right choice for everyone. In some situations, the need to learn the formal theory behind the technology is less important than the need to understand the core concepts, and how to apply those concepts to solve real world problems. The format of this book is one solution to this need.

This book provides an introduction to the fundamental concepts of M&S and systems engineering, and how M&S is used in the systems engineering life cycle. This is captured through a series of short lectures (represented here as chapters), intended to provide an introduction to core concepts. The chapters are relatively short as compared to traditional books. The goal is to give readers foundational knowledge about a topic in 7–12 pages (although some chapters are a little longer), with references to seminal work and additional publications so the reader can dive deeper as desired. These concepts are grouped into five Parts that cover: foundational elements and processes, methods and methodologies, experimentation and execution, systems engineering fundamentals, and M&S in systems engineering case studies. Each Part contains a number of lectures (chapters), covering core concepts in M&S or systems engineering. Georgia Tech is unique in that M&S is fundamental to most every college, school, and research laboratory. I highlight that expertise by leveraging many of the research and teaching faculty from across campus to contribute chapters on their area of specialization.

My hope is this book will be useful for professional education, undergraduate education, and even high school introduction to the discipline of modeling and simulation. There are many excellent M&S books available that provide a deep dive into specific areas of M&S; this book should be viewed more as a handbook that introduces the reader to the broad discipline of M&S that systems engineers need to understand to be effective in their jobs.

Modeling and Simulation in the Systems Engineering
Life Cycle

Core Concepts and Accompanying Lectures

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