

Preface

Another book on mathematical modeling? Yes! The topics in this book focus on a specific target – military applications. We have assembled articles that can be used in conjunction with undergraduate texts in assorted disciplines to teach modeling and problem solving. Our experience with many undergraduate mathematics texts has been that they are effective in covering theory, concepts, skills, and elementary problem solving, however, they are weak in more advanced problem solving and modeling applications. For students, it is important to recognize the relevance and application of their knowledge to practical applications (especially in their profession). This supplemental text bridges a gap between the student's abilities and advanced modeling, preparing the student to go forth on their own to solve complicated problems in their profession.

This volume begins with two introductory foundation articles that describe how mathematics (especially modeling) is used in the Army and how modeling is featured in the mathematics program at the United States Military Academy (USMA). The remaining articles focus on a specific problem (or set of problems) that involve mathematical modeling in a military setting. Each article contains problems to be solved and demonstrates the use of mathematical modeling to solve an advance application problem. These applications show a relation between mathematical modeling and solving complex problems in the military. Some articles use mathematics of one specific type; others utilize several categories of mathematics. Certain articles involve working with detailed military information; others contain material that is considered common knowledge. When an understanding of topics in the science and engineering disciplines is required, the authors try to provide enough detail for the student to succeed with understanding the problem and its solution. The exercises contained in the articles also provide the student with issues and questions to think about, discuss, and solve.

Our primary purpose in writing this text is to allow cadets at USMA to see the relevance of their mathematics education in a military context. We hope our scenarios reinforce the material covered in the students' texts and course work. Ultimately, mathematical modeling plays the key role in the Department of Mathematical Sciences' mission of developing cadets and faculty as competent, confident problem solvers. Of course, we believe this book is valuable to all students learning modeling (not just USMA cadets) who want to experience what military mathematical modeling is all about and develop as problem solvers.

The problems presented by the authors (current or former members of the Department of Mathematical Sciences at West Point, unless noted) come from experiences in their basic branch assignments in the field army or in their roles as operations research analysts. As analysts, the authors have worked on these types of interdisciplinary, military-related problems for the Department of the Army or the Department of Defense.

In particular, many mathematics faculty at West Point are supported by the Mathematical Sciences Center of Excellence to perform research and solve problems for the Army Research Laboratories (ARL).

The position of Operations Research Analyst is a functional area in the Army personnel management system that is available to officers who are qualified in their basic branch. Operations Research (OR) was specifically developed during World War II to blend the techniques of mathematics and mathematical modeling with information from other disciplines to serve military operations. It continues to be very important to the Army. OR is the discipline that provides Army decision-makers with a rigorous, quantitative, and objective basis to evaluate available military options. The rapid growth of new technologies presents great opportunities and challenges for the Army. Today's force planning and resource allocation problems are daunting—however—this is the environment in which the OR analyst thrives. OR analysts make tremendous contributions to the Army. Their capabilities include:

- Formulating problems, building mathematical models, and designing research methods.
- Conducting qualitative and quantitative analyses of complex military problems.
- Bringing objective, analytical, and orderly thinking to the analysis of complex operational and management problems.
- Involvement in the areas of evaluation of strategic and tactical systems; evaluation and testing of new weapons, vehicles, and aircraft; designing training simulations; and performing strategy and force assessment.

The editor thanks the authors for their contributions and hopes readers (especially USMA cadets) appreciate the value of mathematics to the military profession. We hope you find these problems interesting and motivational as you develop the valuable skill of military mathematical modeling.

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1 May 1998

Acknowledgements

Large projects are always done best through teamwork. This volume is no exception. It has been assembled by a superb team of authors, editors, reviewers, and computer graphics experts from the Department of Mathematical Sciences at West Point. The team experienced great enjoyment in this activity and hopes that the goals and objectives of this volume are realized. In particular, the following people, in addition to the authors, are recognized and thanked for their contributions: Kirk Benson, William Prokopyk, Dennis Day, Rodney Sturdivant, Bern d Schliemann, Andy Napoli, Donald Engen, James Gigrich, William Fox, Gary Krahn, and Frieda Clogston. In addition, we thank the Military Operations Research Society (MORS) for all the work they do promoting and supporting the use of mathematics and mathematical modeling in the military. We also thank the organizations of some of the co-authors of the articles: Department of Physics (USMA); Department of Civil and Mechanical Engineering (USMA); Department of Systems Engineering (USMA); Mathematics Department of the Naval Postgraduate School, and the ARDEC, Picatinny Arsenal, NJ. Many of the graphic images (photographs) were taken from the annual volume: *Weapons Systems: United States Army 1998*, Government Printing Office. Other photographs are courtesy of William Prokopyk and Jerry Kobylski. The clipart was obtained from CorelDRAW and Master Clips software. This has been a true team effort and the editor sincerely thanks the team for a job well done.

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