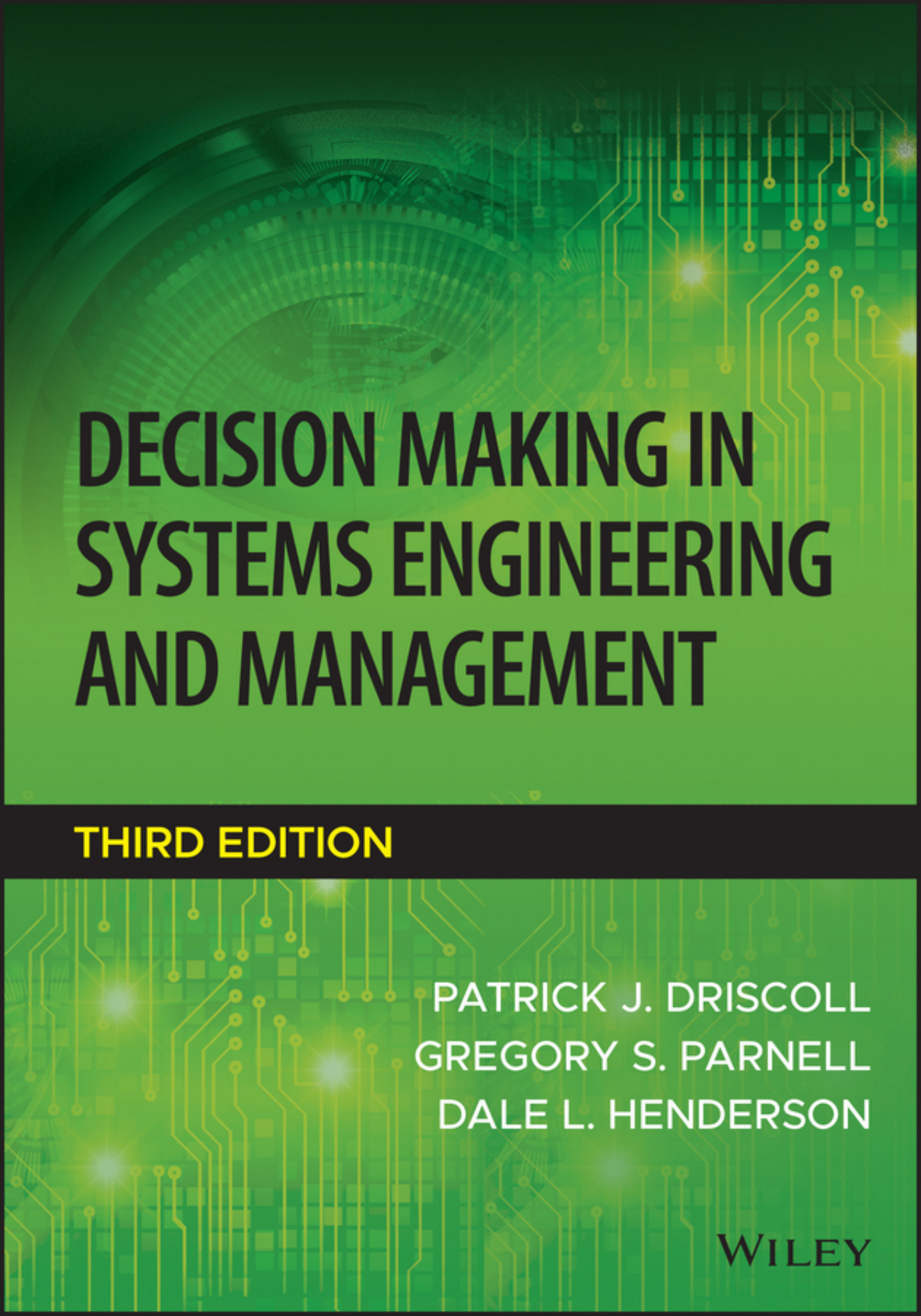
DECISION MAKING IN SYSTEMS ENGINEERING AND MANAGEMENT
THIRD EDITION
PATRICK J. DRISCOLL
GREGORY S. PARNELL
DALE L. HENDERSON
WILEY

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Co-authors

It is difficult to imagine how our systems engineering, engineering management, and systems design curriculum at West Point would have advanced to the quality level it is currently operating at without the many contributions from our entire department staff and faculty. The first edition was the epitome of a team effort involving many of the folks listed in the following, several of whom are currently making outstanding contributions at other academic institutions and industry. As editions progressed to this 3rd edition, many of their contributions to this text live on, perhaps reshaped into a different format with a different emphasis, but with the same core intent maintained: to help develop the next generation of systems thinkers. The primary chapters to which they deserve co-authorship are noted next to their names below. And for that, we thank them profusely.

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Preface

This third edition represents significant changes from the previous two. While the core material has been preserved, evolutionary changes in teaching and professional practice related to decision making in systems engineering and management had transformed both environments substantially, an effect only made more pronounced by the COVID-19 outbreak in 2020 and subsequent social interaction restrictions.

Ten years of teaching, applied systems decision support, and systems assessments have yielded valuable opportunities and insights. Project sponsors and clients expressed interest in understanding system modularity and integration levels as new and more network capable technologies were becoming part of Army operations, and recognizing advances that industry had already embraced. Deterministic modeling, while still useful, was universally recognized as needing extensions capable of addressing decision makers' personal risk, principally because of the high costs associated with system development and acquisition. In response, we developed a new technique called *realization analysis* that directly leverages Monte Carlo simulation to address this concern, providing decision support in a manner previously overlooked.

We continued our support for deployed or isolated analysts possessing limited access to specialty software, yet still needing to accomplish many of the tasks associated with systems discussed in previous editions. Open source and freely accessible software took on new importance in this light, motivating us to place a heavier emphasis on spreadsheets, programs like *SIPmath*, *Gephi*, *Vensim PLE*, and others both in practice and in our curriculum. Several examples in the third edition now illustrate their use.

The third edition material has been shaped with two reader groups in mind: students and faculty exploring effective decision support approaches and professional analysts engaged in systems projects and programs. Both groups require a book that enables them to quickly adopt new techniques and that will add value. Key chapter references have also been updated, but we also preserved those identifying earlier work that still shape current thinking.

Ideation techniques that leverage design concepts have taken on newfound importance in professional practice, echoed in part by efforts of the Stanford d.School which did not exist when the previous editions were being crafted. Several core elements associated with design thinking are now included in this edition.

This third edition makes several important refinements to our approach for supporting decisions since the second edition was published in 2010. Most notably, the book now includes techniques for including uncertainty modeling and analysis to augment the systems decision process (SDP), in particular to the major topics of value modeling, cost estimating, reliability, and risk analysis. No decision support is complete without such a treatment, especially when faced with the occasionally interesting and oftentimes frustrating challenges and complications that go hand-in-hand with systems design, acquisition, development, operation, and replacement. Regardless of whether these systems involve policy, organizations, technology, national security, law, politics, or the myriad of other interdependent entities that are now commonplace in our lives, it seemed a bit of injustice to leave the reader armed with only deterministic approaches when we were routinely applying a more expansive toolkit in practice and within our curriculum.

The book unabashedly advocates a philosophical systems thinking worldview that encourages "embrace and understand" approaches that recognize something important is lost when decomposition, component optimization, and reassembly activities are imposed on a system. One sees these holistic behaviors and characteristics when a system is assembled and operating, and observes them disappearing when attention shifts to individual system elements. Internet congestion, traffic jams, the "accordion effect" in traffic, queues at service windows, climate change, species adaptation, mechanical instabilities, market effects, restaurant failures, and so on are some of the plethora of system-level behaviors diagnosable from a holistic systems thinking viewpoint. Tools that support this engagement philosophy such as systemigrams, dependency structure matrices, system dynamics, and directional dependency diagrams are now included. And, when they are, they are connected to mathematics that reveal insights into system structure that supports actions within the SDP. Fourteen years of advising student team consulting efforts with outside organizations—called capstone design projects at West Point and other universities—have also informed changes to this edition.

Changes in the way that our faculty use textbook materials also affected the structure of the third edition. Whereas in the past, faculty would rely on book exercises for student assignments, that practice has largely disappeared. Custom assignments developed anew every semester by faculty has become the norm. So, chapter-end exercises have been removed, replaced in select locations with short checks on learning. Faculty textbook reliance persists, but only when methods and ideas are presented in a student-accessible manner they can build upon. Students continue to be encouraged to rely upon professional journal publications throughout our courses, motivating us to include an example addressing how to pursue these resources online.

We tried to make chapters more self-containing instead of asking readers to negotiate several chapters to piece together critical techniques associated with multi-criteria value models (MCVM) that we advocate. This also better positions the book for a digital edition should the publisher choose to do so.

While there are a handful of definitions endorsed by professional organizations mentioned in the book, it is difficult to pigeonhole systems engineering as an activity. In some cases, it is about tangible design and manufacturing. In others, it's focused on the activities that a disciplinary engineer is required to do once they have progressed beyond benchwork. In yet others, systems engineering leans toward product, systems, and services acquisition and, of course, decision support. This third edition recognizes this and provides methods that cross-cut all these interests.

It is customary to specify who this edition is intended to serve. For practicing professional, it is relatively easy to do: systems analysts of all types, acquisition professionals, systems engineers, and anyone engaged with systems decision support. For education, it fits well as a text for courses supporting systems engineering, operations research, decision analysis, and systems design and development, and especially well for courses intended to bridge these topics. The book's focus is on fundamental philosophies and techniques for supporting critical decisions throughout the life cycle