

# Preface

This book is about *systems*. It concentrates on the *engineering* of human-made systems and on systems *analysis*. In the first case, emphasis is on the process of bringing systems into being, beginning with the identification of a problem or need and extending through requirements determination, functional analysis and allocation, design synthesis and evaluation, design validation, operation and support, sustainment, and disposal. In the second case, focus is on the improvement of systems already in being. Systems analysis models and methods are embedded within the *systems engineering process*, which remains the overarching theme for this book.

Systems may be classified as either *natural* or *human-made*. Natural systems came into existence by natural processes. Human-made, or technical systems, come into being by human intervention in the natural order utilizing pervasive technologies through system components, attributes, and relationships. The types and variety of technical systems are numerous and encompass the human activity domains of communication, defense, education, health care, manufacturing, transportation, and others. Through the iterative steps of analysis, evaluation, modification, and feedback most systems now in existence can be improved in their operational effectiveness, product quality, affordability, sustainability, and stakeholder satisfaction.

The experience of recent decades indicates that a properly coordinated and functioning technical system, with a minimum of undesirable side effects, requires the application of an integrated life cycle-oriented “systems” approach. Accordingly, the main objective of this textbook is to provide design engineers, systems analysts, and technical managers with the essential system thinking, concepts, methodologies, models, and tools needed to understand, tailor, and apply *systems engineering* to most types of human-made systems.

The topics presented in this book are organized into six parts, encompassing 19 chapters and 8 appendices. Part I provides an introduction to systems and systems engineering in the context of system science and good engineering practice for bringing systems into being. Part II presents the system design process characterized by a series of evolutionary steps, progressing from the identification of a need through conceptual design, preliminary design, detail design and development, to test and evaluation. Part III derives and explains many useful mathematical models and methods for systems analysis, with emphasis on the integration of modeling and systems analysis as an integral part of the systems engineering process. Part IV addresses design for operational

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feasibility by examining those design characteristics found to be most significant for successful system operation and user satisfaction. Chapters are devoted to reliability, maintainability, usability (human factors), supportability, producibility, disposability, and sustainability, and affordability (life-cycle costing). Part V provides an overview of systems engineering management, with planning and organization concentrated in one chapter and program management and control in another. Part VI contains a comprehensive set of appendices providing special topics, checklists, tables, and references to the literature and relevant websites.

The primary utilization of this textbook is intended to be in the classroom at either the advanced undergraduate or graduate level. But, it has also become a standard text for continuing education and for personal reference by practicing systems professionals in business, industry, or government. The book includes more than 300 illustrations, about 450 problem exercises, and over 200 bibliographical and website references categorized to map on the systems engineering process. Many of the examples and applications have been developed from industrial and research experience in systems engineering and analysis by the authors over several decades.

Other Prentice Hall books by the authors provide background and some of the raw material from which this textbook was fashioned. These books cover the subject areas of applied operations research and management science, economic decision analysis, engineering economy, engineering organization and management, life-cycle cost and economic analysis, logistics engineering and management, and procurement and inventory systems analysis. But, more important to our teaching and authorship is the invaluable motivation, guidance, and critique generously provided by hundreds of students and practicing professionals down through the years. We thank each and every individual who has encouraged our authorship endeavors, but also acknowledge and accept full responsibility for the usefulness of the published products.

BENJAMIN S. BLANCHARD  
WOLTER J. FABRYCKY

## INSTRUCTOR MATERIALS

An Instructor's Guide to Problem Solutions and PowerPoint slides of the 300 figures in this book are available to professors who adopt this book for classroom use. These materials can be downloaded electronically from the Pearson Instructor's Resource Center at <http://www.pearsonhighered.com>. Material in the Resource Center is provided solely for the use of instructors to support their teaching.

## WHAT IS NEW IN THIS EDITION

### SYSTEMS ENGINEERING AND ANALYSIS

#### *New Thirtieth Anniversary Edition*

- **Incorporates strategic systems thinking** – Focused on designing, delivering, and sustaining *functionality, a capability, or a solution*. In contrast to offering systems or system elements and products per se, this strategic thinking is now being adopted by forward-looking enterprises in both the private and public sectors.
- **Develops a generic system life-cycle process** – Derived from four fundamental life-cycles of the system, the generic life-cycle process considers “the end before the beginning” with emphasis on *what the entities are intended to do* before determining *what the entities are*.
- **Harmonizes synthesis and analysis** – Organized to enable “process” by the logical development of material for utilization in both the classroom and to provide guidance for system design, operational support, and management personnel in commercial and governmental organizations.
- **Utilizes a design dependent parameter approach** – Oriented to the design and continuous improvement of most types of human-made systems encompassing the pervasive human activity domains of communication, defense, education, healthcare, manufacturing, transportation, and others.
- **Incorporates case-study applications** – Presents hypothetical and/or abstracted examples of “real-world” applications. Includes different types and categories of systems, various applications of analytical methods, checklists and related material from actual experience, some supported by problem exercises.
- **Provides up-to-date content** – Includes contemporary topics such as systems-of-systems, green engineering, supply chain management, and design for supportability and sustainability. Offers a comprehensive set of references and selected web sites for further study. Guidance for further study is provided by a summary and extensions section at the end of each chapter.
- **Includes extensive end-of-chapter exercises** – Provides several different problem types and thought-provoking exercises for solution and subsequent discussion. An Instructor's Guide to Problem Solutions and related material is available from the Pearson Instructor's Resource Center at <http://www.pearsonhighered.com>.