ECONOMIC SYSTEMS ANALYSIS AND ASSESSMENT

Cost, Value, and Competition in Information and Knowledge Intensive Systems, Organizations, and Enterprises

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PREFACE

The purpose of this book is to provide a background in the fundamentals of economic systems analysis and assessment that is appropriate for engineers and managers concerned with the systems engineering and management of systems that are generally information technology intensive. It is assumed that readers of this book will have previously studied mathematics through calculus and differential equations, and that they have some background in linear algebra. No prior background in mathematical programming or economics is assumed, although a modest exposure to undergraduate microeconomics will be very helpful. The objectives of this book include a salient discussion of engineering economic systems that will be relevant for those who need or desire to use the subject matter in their professional practice. This book will also support those who must communicate and broker the results of engineering economic systems analyses and assessments between the many professionals having a stake in definition, development, and deployment of information technology intensive systems. Finally, this book provides a thorough grounding in investment analysis and assessment, particularly for technology portfolios, capacity improvement and expansion, and mergers and acquisitions to acquire technologies and/or capacity.

The book itself is comprised of five major parts as follows:

1. ***Microeconomics.*** We provide a concise overview of classic microeconomics including production and the theory of the firm; theory of the consumer; market equilibria and market imperfections; and normative or welfare economics, including imperfect competition effects and consumer and producer surplus. Chapters 2 to 5 contain this presentation. We also discuss some behavioral economics issues in this part, particularly in Chapter 5. These chapters are as follows:
   - **Chapter 1:** Introduction to Economic Systems Analysis and Assessment
   - **Chapter 2:** Production and the Theory of the Firm
   - **Chapter 3:** The Theory of the Consumer
   - **Chapter 4:** Supply–Demand Equilibria and Microeconomic Systems Analysis and Assessment Models
   - **Chapter 5:** Normative or Welfare Economics, Decisions and Games, and Behavioral Economics
2. ***Program Management Economics.*** We discuss economic valuation of programs and projects including investment rates of return,

cost–benefit and cost–effectiveness analysis, earned value management, cost structures and estimation of program costs and schedules, strategic and tactical pricing issues, and capital investment and options. There is one lengthy chapter in this part:

- **Chapter 6:** Cost–Benefit and Cost–Effectiveness Analyses and Assessments

3. ***Cost Estimation.*** Cost estimation technologies involve precedented and unprecedented development, commercial off-the-shelf (COTS) software, software reuse, application generators, and fourth-generation languages. Contemporary cost estimation methods are evaluated in terms of openness of underlying models, platform requirements, data required as inputs, output, and accuracy of estimates provided by the models. COCOMO I and II, and COSYSMO are examples of a cost model, function point cost estimation models. Cost is estimated for systems of systems engineering. There is a single chapter in this part:
   - **Chapter 7:** Cost Assessment
4. ***Strategic Investments in an Uncertain World.*** The final part of our economic systems analysis and assessment efforts is concerned with valuation of major investments such as technology portfolios and large-scale capacity expansions, as well as mergers and acquisitions. Here we provide a chapter that addresses alternative methods for valuation of firms including Stern–Stewart's EVA, Holt's CFROI, and various competing methodologies. Chapter **9** considers option-based valuation models including classic real option models (Black–Scholes) and extensions for multistage options with more robust portfolio assumptions. Valuation of information technology intensive enterprises is also addressed. Overall, this part provides a discussion of valuation methods for managing strategic investments in an uncertain world:
   - **Chapter 8:** Approaches to Investment Valuation
   - **Chapter 9:** Real Options for Investment Valuation
5. ***Extensions to the Work.*** There are many extensions possible to economic systems analysis and assessment. There are needed extensions to the classic microeconomics of economic systems analysis and assessment to enable satisfactory treatment of the increasing returns to scale, network effects, and path-dependent issues generally associated with contemporary ultra-large-scale telecommunications and information networks. Investing in the training and education, safety and health, and work productivity of humans is another very important issue. In our concluding chapter of this work, we present a very brief discussion of these issues:
   - **Chapter 10:** Contemporary Perspectives

We sincerely hope that readers find our discussions of economic systems analysis and assessment of value to their work in systems and software engineering, systems and enterprise management, and related areas.

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CHAPTER 1

INTRODUCTION TO ECONOMIC SYSTEMS ANALYSIS AND ASSESSMENT: COST, VALUE, AND COMPETITION IN INFORMATION AND KNOWLEDGE INTENSIVE SYSTEMS, ORGANIZATIONS, AND ENTERPRISES

1.1 INTRODUCTION

This book is about one of the fundamental concerns in the engineering and management of systems of all types, and especially those with a major telecommunications and information network focus: the economic behavior of these systems. We discuss the very important role of economics in shaping our lives and designing our activities and institutions to achieve economic (and other) objectives. The purpose of this book is to present those fundamentals of classic and modern microeconomic systems analysis and assessment that are most necessary in the engineering and management of systems of machines, humans, and organizations that are effective and efficient, and equitable as well. We desire to equip ourselves to answer three fundamental questions:

1. What should be produced and how much of it should be produced?
2. How should the goods be produced?
3. Who should get the goods and services that are produced?

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by Andrew P. Sage and William B. Rouse