

PRODUCT DESIGN AND DEVELOPMENT

Second Edition



Karl T. Ulrich

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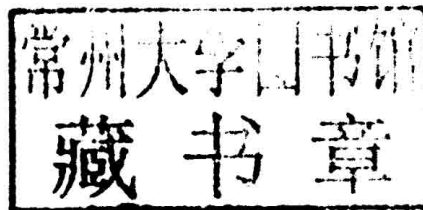
PRODUCT DESIGN AND DEVELOPMENT

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S E C O N D E D I T I O N

PRODUCT DESIGN AND DEVELOPMENT

To the professionals who shared their experiences with us and to the product development teams we hope will benefit from those experiences.

KARL T. ULRICH is an associate professor at the Wharton School at the University of Pennsylvania, and also holds a secondary appointment in the Department of Mechanical Engineering and Applied Mechanics. He received the S.B., S.M., and Sc.D. degrees in Mechanical Engineering from MIT. Professor Ulrich has led the development efforts for many products, including medical devices and sporting goods, and is a founder of two technology-based companies. As a result of this work, he has received 13 patents. His current research focuses on coordination of design, manufacturing, and marketing decisions in the product development process.

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This book contains material developed for use in the interdisciplinary courses on product development that we teach. Participants in these courses include graduate students in engineering, industrial design students, and MBA students. While we aimed the book at interdisciplinary graduate-level audiences such as this, many faculty teaching graduate and undergraduate courses in engineering design have also found the material useful. *Product Design and Development* is also for practicing professionals. Indeed, we could not avoid writing for a professional audience because most of our students are themselves professionals who have worked either in product development or in closely related functions.

This book blends the perspectives of marketing, design, and manufacturing into a single approach to product development. As a result, we provide students of all kinds with an appreciation for the realities of industrial practice and for the complex and essential roles played by the various members of product development teams. For industrial practitioners, in particular, we provide a set of product development methods that can be put into immediate practice on development projects.

A debate currently rages in the academic community as to whether design should be taught primarily by establishing a foundation of theory or by engaging students in loosely supervised practice. For the broader activity of product design and development, we reject both approaches when taken to their extremes. Theory without practice is ineffective because there are many nuances, exceptions, and subtleties to be learned in practical settings and because some necessary tasks simply lack sufficient theoretical underpinnings. Practice without guidance can too easily result in frustration and fails to exploit the knowledge that successful product development professionals and researchers have accumulated over time. Product development, in this respect, is like sailing: proficiency is gained through practice, but some theory of how sails work and some instruction in the mechanics (and even tricks) of operating the boat help tremendously.

We attempt to strike a balance between theory and practice through our emphasis on methods. The methods we present are typically step-by-step procedures for completing tasks, but rarely embody a clean and concise theory. In some cases, the methods are supported in part by a long tradition of research and practice, as in the chapter on product development economics. In other cases, the methods are a distillation of relatively recent and *ad hoc* techniques, as in the chapter on design for manufacturing. In all cases, the methods provide a concrete approach to solving a product development problem. In our experience, product development is best learned by applying structured methods to ongoing project work in either industrial or academic settings. Therefore, we intend this book to be used as a guide to completing development tasks either in the context of a course project or in industrial practice.

An industrial example or case study illustrates every method in the book. We chose to use different products as the examples for each chapter rather than carrying the same example through the entire book. We provide this variety because we think it makes the book more interesting and because we hope to illustrate that the methods can be applied to a wide range of products, from bowling equipment to syringes.

We designed the book to be extremely modular—it consists of 14 independent chapters. Each chapter presents a development method for a specific portion of the product development process. The primary benefit of the modular approach is that each chapter can be used independently of the rest of the book. This way, faculty, students, and practitioners can easily access only the material they find most useful.

This second edition of the book adds two new chapters: Product Planning and Concept Testing. Based on information gathered from users of the first edition, we discovered that these two were the most important topics for which existing educational materials were inadequate. In addition to developing these two new chapters, we made major revisions to the chapters on product architecture and industrial design. Throughout the rest of the book, we updated examples and data, clarified explanations, and added insights from recent research and innovations in practice.

To supplement this textbook, we have developed a web site on the Internet. This is intended to be a resource for instructors, students, and practitioners. We will keep the site current with additional references, examples, and links to available resources related to the product development topics in each chapter. Please make use of this information via the Internet at www.ulrich-eppinger.net.

The application of structured methods to product development also facilitates the study and improvement of development processes. We hope, in fact, that readers will use the ideas in this book as seeds for the creation of their own development methods, uniquely suited to their personalities, talents, and company environments. We encourage readers to share their experiences with us and to provide suggestions for improving this material. Please write to us with your ideas and comments at ulrich@wharton.upenn.edu and eppinger@mit.edu.

Hundreds of people contributed to this book in large and small ways. We are grateful to the many industrial practitioners who provided data, examples, and insights. We appreciate the assistance we have received from numerous academic colleagues, research assistants, and support staff, from our sponsors, and from the McGraw-Hill team. Indeed we could not have completed this project without the cooperation and collaboration of many professionals, colleagues, and friends. Thank you all.

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methods in product development projects have greatly helped us to refine the material.

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Karl T. Ulrich
Steven D. Eppinger

1	Introduction	1
2	Development Processes and Organizations	13
3	Product Planning	35
4	Identifying Customer Needs	59
5	Product Specifications	79
	Appendix Target Costing	104
6	Concept Generation	107
7	Concept Selection	137
	Appendix A Concept-Screening Matrix Example	158
	Appendix B Concept-Scoring Matrix Example	159
8	Concept Testing	161
	Appendix Estimating Market Sizes	179
9	Product Architecture	181
10	Industrial Design	209
11	Design for Manufacturing	235
	Appendix A Materials Costs	264
	Appendix B Component Manufacturing Costs	265
	Appendix C Assembly Costs	271
	Appendix D Cost Structures	272
12	Prototyping	273
13	Product Development Economics	295
	Appendix Time Value of Money and the Net Present Value Technique	316
14	Managing Projects	321
	Appendix Design Structure Matrix Example	348

1 Introduction 1

Characteristics of Successful Product Development	2
Who Designs and Develops Products?	3
Duration and Cost of Product Development	4
The Challenges of Product Development	5
Approach of This Book	7
Structured Methods	7
Industrial Examples	8
Organizational Realities	8
Road Map of the Book	9
References and Bibliography	10
Exercises	11
Thought Question	11

2 Development Processes and Organizations 13

A Generic Development Process	14
Concept Development: The Front-End Process	18
Adapting the Generic Product Development Process	20
Technology-Push Products	20
Platform Products	22
Process-Intensive Products	22
Customized Products	22
The AMF Development Process	23

Product Development Organizations	25
Organizations Are Formed by Establishing Links among Individuals	25
Organizational Links May Be Aligned with Functions, Projects, or Both	25
Choosing an Organizational Structure	28
The AMF Organization	30
Summary	31
References and Bibliography	31
Exercises	32
Thought Questions	33

3 Product Planning 35

The Product Planning Process	37
Four Types of Product Development Projects	38
The Process	38
Step 1: Identify Opportunities	39
Step 2: Evaluate and Prioritize Projects	41
Competitive Strategy	41
Market Segmentation	42
Technological Trajectories	42
Product Platform Planning	43
Evaluating Fundamentally New Product Opportunities	46
Balancing the Portfolio	46
Step 3: Allocate Resources and Plan Timing	47
Resource Allocation	48
Project Timing	48
The Product Plan	50
Step 4: Complete Pre-Project Planning	50
Mission Statements	51
Assumptions and Constraints	52
Staffing and Other Pre-Project Planning Activities	53
Step 5: Reflect on the Results and the Process	53
Summary	54
References and Bibliography	55
Exercises	56
Thought Questions	57

4 Identifying Customer Needs 59

Step 1: Gather Raw Data from Customers	63
Choosing Customers	64
The Art of Eliciting Customer Needs Data	66
Documenting Interactions with Customers	67

Step 2: Interpret Raw Data in Terms of Customer Needs	69
Step 3: Organize the Needs into a Hierarchy	70
Step 4: Establish the Relative Importance of the Needs	73
Step 5: Reflect on the Results and the Process	75
Summary	75
References and Bibliography	76
Exercises	77
Thought Questions	78

5 Product Specifications 79

What Are Specifications?	80
When Are Specifications Established?	82
Establishing Target Specifications	83
Step 1: Prepare the List of Metrics	83
Step 2: Collect the Competitive Benchmarking Information	88
Step 3: Set Ideal and Marginally Acceptable Target Values for Each Metric	90
Step 4: Reflect on the Results and the Process	92
Setting the Final Specifications	94
Step 1: Develop Technical Models of the Product	94
Step 2: Develop a Cost Model of the Product	96
Step 3: Refine the Specifications, Making Trade-Offs Where Necessary	97
Step 4: Flow Down the Specifications as Appropriate	100
Step 5: Reflect on the Results and the Process	101
Summary	101
References and Bibliography	102
Exercises	104
Thought Questions	104
Appendix Target Costing	104
Example	105

6 Concept Generation 107

The Activity of Concept Generation	108
Structured Approaches Reduce the Likelihood of Costly Problems	109
A Five-Step Method	109
Step 1: Clarify the Problem	111
Decompose a Complex Problem into Simpler Subproblems	112
Focus Initial Efforts on the Critical Subproblems	114
Step 2: Search Externally	115
Interview Lead Users	115
Consult Experts	116

Search Patents	116
Search Published Literature	118
Benchmark Related Products	118
Step 3: Search Internally	119
Both Individual and Group Sessions Can Be Useful	120
Hints for Generating Solution Concepts	121
Step 4: Explore Systematically	122
Concept Classification Tree	124
Concept Combination Table	126
Managing the Exploration Process	130
Step 5: Reflect on the Results and the Process	132
Summary	133
References and Bibliography	134
Exercises	135
Thought Questions	135

7 Concept Selection 137

Concept Selection Is an Integral Part of the Product Development Process	138
All Teams Use Some Method for Choosing a Concept	139
A Structured Method Offers Several Benefits	142
Overview of Methodology	143
Concept Screening	144
Step 1: Prepare the Selection Matrix	144
Step 2: Rate the Concepts	146
Step 3: Rank the Concepts	146
Step 4: Combine and Improve the Concepts	147
Step 5: Select One or More Concepts	147
Step 6: Reflect on the Results and the Process	147
Concept Scoring	148
Step 1: Prepare the Selection Matrix	149
Step 2: Rate the Concepts	150
Step 3: Rank the Concepts	151
Step 4: Combine and Improve the Concepts	151
Step 5: Select One or More Concepts	152
Step 6: Reflect on the Results and the Process	152
Caveats	153
Summary	154
References and Bibliography	155
Exercises	156
Thought Questions	157
Appendix A Concept-Screening Matrix Example	158
Appendix B Concept-Scoring Matrix Example	159

8 Concept Testing 161

- Step 1: Define the Purpose of the Concept Test 163
- Step 2: Choose a Survey Population 163
- Step 3: Choose a Survey Format 165
- Step 4: Communicate the Concept 166
 - Verbal Description 166
 - Sketch 166
 - Photos and Renderings 166
 - Storyboard 166
 - Video 166
 - Simulation 168
 - Interactive Multimedia 168
 - Physical Appearance Models 168
 - Working Prototypes 169
- Matching the Survey Format with the Means of Communicating the Concept 169
- Issues in Communicating the Concept 170
- Step 5: Measure Customer Response 171
- Step 6: Interpret the Results 172
- Step 7: Reflect on the Results and the Process 175
- Summary 176
- References and Bibliography 177
- Exercises 178
- Thought Questions 178
- Appendix** Estimating Market Sizes 179

9 Product Architecture 181

- What Is Product Architecture? 182
 - Types of Modularity 184
 - When Is the Product Architecture Defined? 185
- Implications of the Architecture 186
 - Product Change 186
 - Product Variety 187
 - Component Standardization 188
 - Product Performance 188
 - Manufacturability 188
 - Product Development Management 189
- Establishing the Architecture 190
 - Step 1: Create a Schematic of the Product 190
 - Step 2: Cluster the Elements of the Schematic 192
 - Step 3: Create a Rough Geometric Layout 194
 - Step 4: Identify the Fundamental and Incidental Interactions 195
- Variety and Supply Chain Considerations 197