Preface

Why are you reading this book?

Engineering design is the process of creating products to fill needs.

Beginning with the simple potter's wheel and evolving into complex consumer products, transportation systems, and spacecraft, humans have been designing objects for nearly 5,000 years. Each of these objects results from a long and often demanding design process. This book is about that process. Whether designing gearboxes, electric cars, satellites, code, or doorknobs, certain techniques are common during the design process to ensure successful results. Since this book is about the design process, it focuses on techniques that apply to the design of all kinds of objects and products, not on the design of any one type of object.

If people have been designing for 5,000 years and millions of objects work well, why study the design process? Because there are certain best practices that successful companies use to design new, cost-effective, high-quality products. Today's products are so complex they require teams of people from diverse areas of expertise to develop an idea into hardware. The more people involved in a project, the greater the need for assistance in communication and information structure. This is to ensure nothing important gets overlooked and that the customers will be satisfied.

In addition, the global marketplace demands new products at a rapid and accelerating pace. To compete, a company must be efficient in designing its products, and the processes studied here determine the level of efficiency. Furthermore, an estimated 85% of problems with new products not working as they should, taking too long to bring to market, or costing too much are the result of a flawed design process—the best practices in this book help avoid this 85%.

Most modern products combine mechanical, electronic, and software systems. The material here primarily focuses on the design of the hardware aspects of products, namely the mechanical and electrical. That said, design decisions must include software, as software may supply many product functions.

In this book, the term "product" is broadly used as it may be the final object, a system within it, a sub-system, a part, a PC board, an app, or a chunk of code because all evolve through the design process from the initial needs.

The design process may be static for mature products, but building, understanding, and developing the product are learning processes. For new products or new systems, the problem, product, and process coevolve as engineers learn more information. In other words, understanding the problem drives the tasks (the process) needed to develop the product.

The Book's Organization

The authors organized this book around product development best practices commonly used by successful organizations. A best practice is a professional method accepted as effective in product development. Not all organizations use all these best practices, but leading companies use many of them.

Each best practice has a chapter, and each chapter begins its title with "Successful

Product Development Organizations" + the title of the best practice. For example, Best Practice 4.3 is "Successful Product Development Organizations Work to Understand the Design Requirements."

Terms like "best practice" are defined in the glossary at the end of the book. The glossary contains almost three hundred terms commonly used during the product design process.

Most best practices stand alone, but not all. For example, Best Practice 2.3, "Successful Product Development Organizations Manage Information Uncertainty and Risk," references other best practices that accomplish what the title says. Each best practice has a section near its end titled "Related Best Practices." This section contains a table of terms from the Glossary that are used but are defined in another best practice. Each term has its definition and a best practice number for more details.

The last section of each best practice, "Sources," lists additional reading for more the topics.

The best practices are organized in ten sections, as illustrated in Fig. 1.

Worksheets

Most best practices have worksheets developed in Excel to support the material, and an example showing how an organization used the worksheet may be provided. Some worksheets are fill-in-the-blank, some are checklists, and others perform calculations. Fig. 2 is a worksheet of worksheets listing all that are available by which Best Practice they are in. The worksheets and other supporting material could form the nexus of a design report.

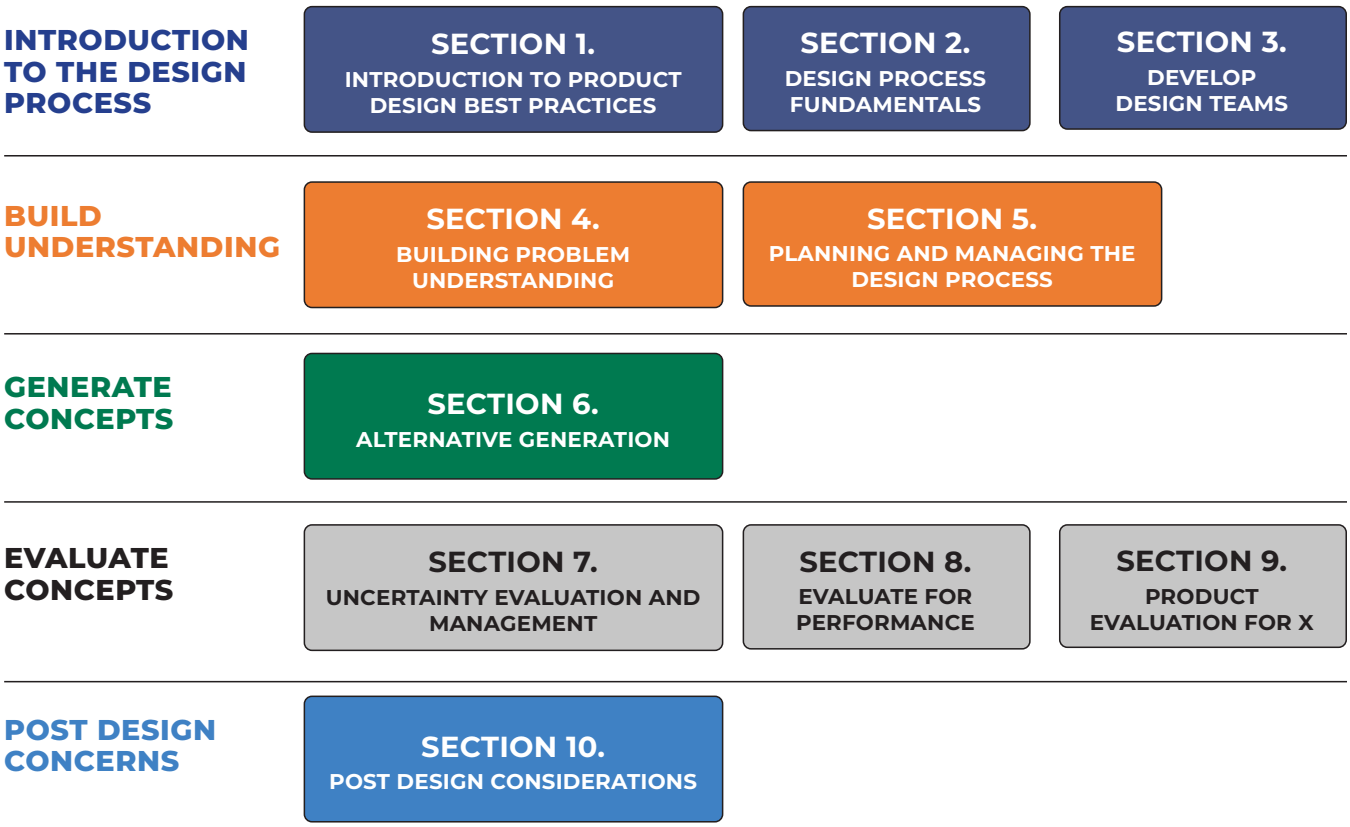

Figure 1. The sections of this book.

Product Design Best Practices
Worksheet of Worksheets

For instructions, hover here.

Purpose: Identify worksheets important for documenting the project

Project:

Date:

Team:

		BP
Section 2: Design Process Fundamentals		
Learning Debrief Worksheet	☐	2.1
VUCA+ Worksheet	☐	2.3
Pro/Con Worksheet	☐	2.4
Pairwise Comparison Worksheet	☐	2.4
Decision Matrix Worksheet	☐	2.4
Section 3: Design Teams		
Team Contract Worksheet	☐	3.1
Team Meeting Minutes Worksheet	☐	3.1
Personal Problem Solving Dimensions Worksheet	☐	3.2
Team Environment Worksheet	☐	3.3
Team Health Worksheet	☐	3.4
Section 4: Building Problem Understanding		
Product Proposal Worksheet	☐	4.1
Project Proposal Worksheet	☐	4.1
Stakeholder Worksheet	☐	4.2
Requirements Worksheet (Voice of the Customer)	☐	4.3
Requirement Worksheet	☐	4.4
Product Decomposition Worksheet: Function	☐	4.5
Product Decomposition Worksheet: Disassembly	☐	4.5
Product Decompostion Worksheet: Components	☐	4.5
Engineering Specifications Worksheet	☐	4.6
QFD Worksheet	☐	4.7
Section 5. Planning and Managing the Design Process		
Task Worksheet	☐	5.1
Task Short-Form Worksheet	☐	5.1
Prototype Proposal Worksheet	☐	5.1
Esitmation Worksheet	☐	5.2
Task Ranking Worksheet	☐	5.3
Gantt Chart Worksheet	☐	5.4
Kanban (Task) Board Worksheet	☐	5.4
Design Review Planning Worksheet	☐	5.5

		BP
Section 6. Alternative Generation		
Morphology Worksheet	☐	6.1
Morph Chart Integrated Solutions Worksheet	☐	6.2
Interfaces Worksheet	☐	6.3
Function Model Worksheet	☐	6.4
Bill of Materials (BOM) Worksheet	☐	6.5
Section 7. Evaluate for Uncertainity		
Design Technology Readiness Worksheet	☐	7.1
Hazard Assessment Worksheet	☐	7.2
Factor of Safety Worksheet	☐	7.3
Additive Tolerance Stack-up Worksheet	☐	7.4
Statistical Stack-up Worksheet	☐	7.4
Section 8. Evaluate for Performance		
Evaluation Selection Worksheet	☐	8.1
DOE Robust Design L4 Worksheet	☐	8.3
DOE Robust Design L8 Worksheet	☐	8.3
Section 9. Evaluate for X		
Cost of Machined Components Worksheet	☐	9.1
Cost of Plastic Injection Molded Part Worksheet	☐	9.1
Cost of PCBs Worksheet	☐	9.1
Design For Assembly Worksheet	☐	9.3
Design For Reliability Worksheet	☐	9.4
Design For Test and Maintainability Worksheet	☐	9.5
Product Lifecycle Evaluation Worksheet	☐	9.6
Section 10. Post Design Considerations		
Engineering Change Notice Worksheet	☐	10.1
Patent Specification Worksheet	☐	10.2

Product Design Best Practices

Figure 2. The Worksheet of Worksheets.