时代教育·国外高校优秀教材精选

Mc Graw Hill Education

英文版·原书第5版

工程设计

[美] George E. Dieter (乔治 E.迪特尔)
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Engineering Design

机械工业出版社
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本书系统介绍了工程设计领域的相关知识，主要内容不仅包括其他同类书籍涵盖的产品开发过程、概念生成、实体设计、详细设计等知识，也包括本书独有的面向可持续性与环境的设计、材料选用、面向制造的设计，以及成本评估、决策学等知识。本书内容丰富，论述清楚，逻辑性强，具有：系统性，系统讲述了设计过程的相关知识以及设计相关的经济性、环境性等问题；实时性，引入了设计研究的最新成果；实践性，提供了贯穿多个章节的循序渐进的案例。

本书不仅是本科生学习设计知识的优选教材，对研究人员以及企业的产品设计者也具有极高的参考价值。

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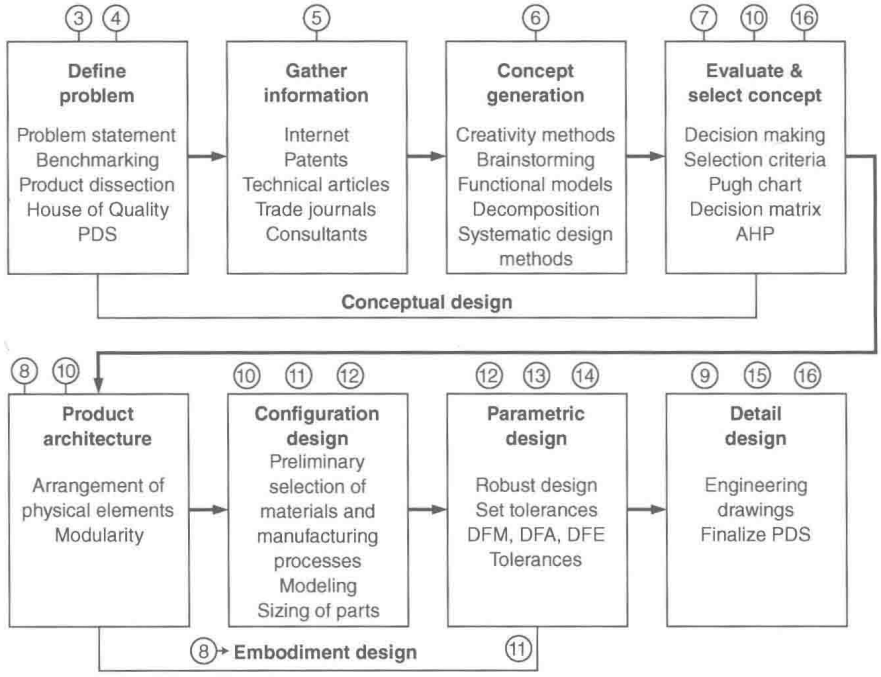
ROADMAP to ENGINEERING DESIGN



序

我国正在实施创新驱动战略，走中国特色的自主创新之路。创新的本质是设计，因此制造业竞争的本质是设计的竞争，竞争的焦点是用最短的开发周期和最小的开发成本实现最大的附加价值。设计是为了实现特定要求，对与产品相关的信息逐渐详细化的决策过程。该过程包括设计自身相关的知识和设计对象的相关知识。本书涵盖了与设计自身相关的知识，包括设计方法论、设计原理、设计方法和设计学等内容。尽管作为设计活动主体的设计者（人）天生具有设计的能力，但由于设计对象和设计活动自身的复杂性，不经过系统的学习和训练是难以完成复杂的设计任务的。而一本兼具系统性、实时性和实践性的设计著作无疑将有助于加速获取设计知识和缩短设计训练周期。

本书是美国马里兰大学机械工程系教授George E.Dieter（乔治E.迪特尔）一生从事设计研究和教学工作的结晶。他获得了美国机械工程师学会矿物、金属和材料分会教育家奖，美国工程教育学会最高奖兰姆金质奖章。他是美国工程院院士，并在2004年获得总统奖章。他在Drexel（德雷塞尔）大学获得学士学位，在卡内基梅隆大学获得科学博士学位。在结束杜邦工程研究实验室的工作后，他先后成为Drexel大学冶金工程系负责人和工程系主任。Dieter教授后来调入卡内基梅隆大学，担任工程学教授和工艺研究所所长。1977年他到马里兰大学工作，担任机械工程学教授和系主任。

Linda C. Schmidt（琳达C. 施密特）博士是马里兰大学机械工程系副教授。她的研究领域包括机械设计理论和方法学、概念设计和设计知识的获取，以及工程项目设计团队的高效学习等。她在爱荷华州立大学获得工业工程学士和硕士学位，在卡内基梅隆大学获得机械工程博士学位。Schmidt博士在工程设计研究、机械工程专业高年级本科生和研究生的工程设计教学方面表现活跃。她是一本工程决策教材和关于产品研发教材的合著者，还是美国机械工程师学会《Journal of Mechanical Design》（机械设计杂志）的副主编、《Journal of Engineering Valuation & Cost Analysis》（工程评估和成本分析杂志）的特邀编辑，以及美国机械工程师学会和美国工程教育学会会员。

本书在第4版的基础上根据设计学研究的最新进展增加了新的内容，并进行了修改。如对第3、6、7章进行了修改并增加了新的内容，包括贯穿这

些章节的一个循序渐进的案例；增加了第10章，面向可持续性和环境的设计；第15章把经济决策的内容从网站移到了本书内；在第16章增加了成本评估；对引用的各类设计手册的内容进行了更新。

本书在保留教材特色的基础上，对部分内容进行了删减。在删减时保留了新术语和概念中的一些词汇等。

本书既可作为低年级（第1～9章）和高年级本科生（第10～16章）学习设计知识的优选教材，也可供研究人员以及企业的产品设计者参考。

于随然

于上海交通大学

ABOUT THE AUTHORS

GEORGE E. DIETER is Glenn L. Martin Institute Professor of Engineering at the University of Maryland. The author received his B.S. Met.E. degree from Drexel University and his D.Sc. degree from Carnegie Mellon University. After a stint in industry with the DuPont Engineering Research Laboratory, he became head of the Metallurgical Engineering Department at Drexel University, where he later became Dean of Engineering. Professor Dieter later joined the faculty of Carnegie Mellon University as Professor of Engineering and Director of the Processing Research Institute. He moved to the University of Maryland in 1977 as professor of Mechanical Engineering and Dean of Engineering, serving as dean until 1994.

Professor Dieter is a fellow of ASM International, TMS, AAAS, and ASEE. He has received the education award from ASM, TMS, and SME, as well as the Lamme Medal, the highest award of ASEE. He has been chair of the Engineering Deans Council, and president of ASEE. He is a member of the National Academy of Engineering. He also is the author of *Mechanical Metallurgy,* published by McGraw-Hill, now in its third edition.

LINDA C. SCHMIDT is an Associate Professor in the Department of Mechanical Engineering at the University of Maryland. Dr. Schmidt's general research interests and publications are in the areas of mechanical design theory and methodology, design generation systems for use during conceptual design, design rationale capture, and effective student learning on engineering project design teams.

Dr. Schmidt completed her doctorate in Mechanical Engineering at Carnegie Mellon University with research in grammar-based generative design. She holds B.S. and M.S. degrees from Iowa State University for work in Industrial Engineering. Dr. Schmidt is a recipient of the 1998 U.S. National Science Foundation *Faculty Early Career Award* for generative conceptual design. She co-founded RISE, a summer research experience that won the 2003 Exemplary Program Award from the American College Personnel Association's Commission for Academic Support in Higher Education. Dr. Schmidt was

awarded the American Society of Engineering Education's 2008 Merryfield Design Award.

Dr. Schmidt is active in engineering design theory research and teaching engineering design to third- and fourth-year undergraduates and graduate students in mechanical engineering. She has coauthored a text on engineering decision-making, two editions of a text on product development, and a team-training curriculum for faculty using engineering student project teams. Dr. Schmidt was the guest editor of the *Journal of Engineering Valuation & Cost Analysis* and has served as an Associate Editor of the ASME *Journal of Mechanical Design*. Dr. Schmidt is a member of ASME, SME, and ASEE.

PREFACE TO FIFTH EDITION

THE FIFTH EDITION of *Engineering Design* continues the reorganization and expansion of topics introduced in the fourth edition. Major reorganization of topics to improve flow of information and increase learning have been made in Chapter 3, Problem and Need Identification; Chapter 6, Concept Generation; and Chapter 7, Decision Making and Concept Selection. A new, progressive example has been introduced and is continued through these three chapters. A new Chapter 10, Design for Sustainability and the Environment, has been added. The book continues its tradition of being more oriented to material selection, design for manufacturing, and design for quality than other broad-based design texts.

The text is intended to be used in either a junior or senior engineering design course with an integrated hands-on design project. At the University of Maryland we present the design process material, Chapters 1 through 9, to junior students in a course introducing the design process. The whole text is used in the senior capstone design course that includes a complete design project, starting from selecting a market to creating a working prototype. Students move quickly through the first nine chapters and emphasize Chapters 10 through 17 in making embodiment design decisions.

The authors hope that students will consider this book to be a valuable part of their professional library. Toward this end we have continued and expanded the practice of giving key literature references and referrals to useful websites. Many new references have been added and all websites have been verified as of June 2011. References to many of the design handbooks and design monographs available at knovel.com have been added to this edition. We have also used the extensive series of *ASM Handbooks* to extend topics in Chapters 11, 12, 13, and 14. These are also available at knovel.com.

New to This Edition

- Reorganization and new material in Chapters 3, 6, and 7, including a progressive example throughout these chapters
- New Chapter 10, Design for Sustainability and the Environment

- Chapter 15, Economic Decision Making, brought into the book from text website
- Section on Cost of Quality added to Chapter 16, Cost Evaluation
- Many additional connections to useful design information on the Internet
- Updated and new references including links to handbooks available through knovel.com
- PowerPoint lecture slides available to instructors through McGraw-Hill Higher Education

We want to acknowledge the willingness of students from our senior design course for permission to use material from their report in some of our examples. The JSR Design Team members are: Josiah Davis, Jamil Decker, James Maresco, Seth McBee, Stephen Phillips, and Ryan Quinn.

Special thanks to Peter Sandborn, Chandra Thamire, and Guangming Zhang, our colleagues in the Mechanical Engineering Department, University of Maryland, for their willingness to share their knowledge with us. Thanks also to Greg Moores of the DeWalt Division of Stanley Black and Decker, Inc. for his willingness to share his industrial viewpoint on several topics. We also thank the following reviewers for their helpful comments and suggestions: Bruce Floersheim, United States Military Academy; Mark A. Johnson, Michigan Tech University; Jesa Kreiner, California State University at Fullerton; David N. Kunz, University of Wisconsin, Platteville; Marybeth Lima, Louisiana State University; Bahram Nassersharif, University of Rhode Island; Ibrahim Nisanci, University of Arkansas at Little Rock; Keith E. Rouch, University of Kentucky; Paul Steranka, West Virginia University Institute of Technology; M. A. Wahab, Louisiana State University, John-David Yoder, Ohio Northern University; D. A. Zumbrunnen, Clemson University.

George E. Dieter and Linda C. Schmidt
College Park, MD
2012

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ENGINEERING DESIGN

1.1
INTRODUCTION

What is design? If you search the literature for an answer to that question, you will find about as many definitions as there are designs. Perhaps the reason is that the process of design is such a common human experience. Webster's dictionary says that to design is "to fashion after a plan," but that leaves out the essential fact that to design is to create something that has never been. Certainly an engineering designer practices design by that definition, but so does an artist, a sculptor, a composer, a playwright, or any another creative member of our society.

Thus, although engineers are not the only people who design things, it is true that the professional practice of engineering is largely concerned with design; it is often said that design is the essence of engineering. *To design is to pull together something new or to arrange existing things in a new way to satisfy a recognized need of society.* An elegant word for "pulling together" is *synthesis.* We shall adopt the following formal definition of design: "Design establishes and defines solutions to and pertinent structures for problems not solved before, or new solutions to problems which have previously been solved in a different way."[1] The ability to design is both a science and an art. The science can be learned through techniques and methods to be covered in this text, but the art is best learned by doing design. It is for this reason that your design experience must involve some realistic project experience.

The emphasis that we have given to the creation of new things in our introduction to design should not unduly alarm you. To become proficient in design is a perfectly attainable goal for an engineering student, but its attainment requires the guided experience that we intend this text to provide. Design should not be confused with discovery. Discovery is getting the first sight of, or the first knowledge of something, as

1. J. F. Blumrich, *Science,* vol. 168, pp. 1551–1554, 1970.