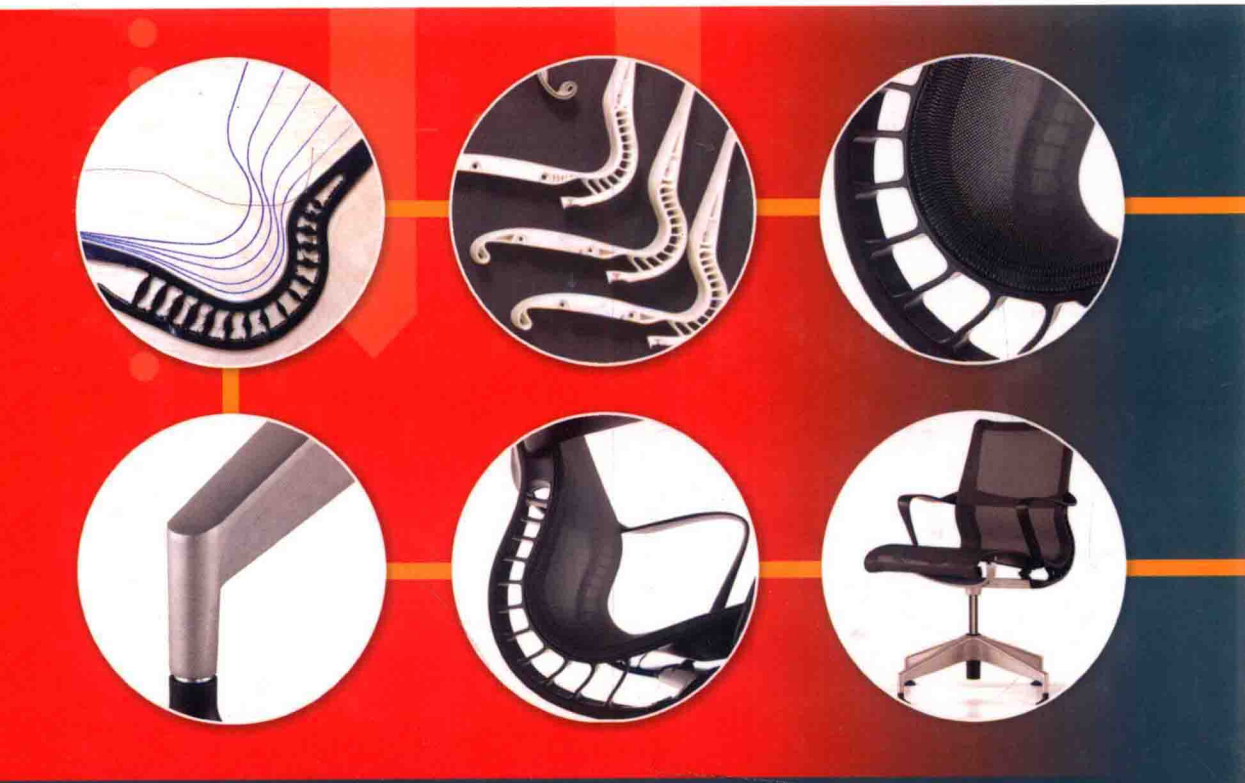
FIFTH EDITION

Product Design and Development



KARL T. ULRICH · STEVEN D. EPPINGER

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Fifth Edition

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

About the Authors

Karl T. Ulrich *University of Pennsylvania*
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Preface

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 often heard in the academic community relates 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 environment. 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 industrial equipment to consumer products.

We designed the book to be extremely modular—it consists of 18 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 the material they find most useful.

This fifth edition of the book includes new chapters on opportunity identification and design for environment, as well as updated examples and data, new insights from recent research and innovations in practice, and revisions throughout the book.

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.

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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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We have received tremendous assistance from our colleagues who have offered frequent encouragement and support for our somewhat unusual approach to teaching and research, some of which is reflected in this book. We are especially indebted to the MIT Leaders for Manufacturing (LFM) Program and to the MIT Center for Innovation in Product Development (CIPD), two exemplary partnerships involving major manufacturing firms and MIT's engineering and management schools. We have benefited from collaboration with the faculty and staff associated with these programs, especially Gabriel Bitran, Kent Bowen, Don Clausing, Tom Eagar, Charlie Fine, Woodie Flowers, Steve Graves, John Hauser, Rebecca Henderson, Maurice Holmes, Tom Magnanti, Kevin Otto, Don Rosenfield, Warren Seering, Shoji Shiba, Anna Thornton, Jim Utterback, Eric von Hippel, Dave Wallace, and Dan Whitney. We have received financial support from LFM, CIPD, and the Gordon Book Fund. Most important, LFM and CIPD partner companies have provided us with unparalleled access to industrial projects and research problems in product development and manufacturing.

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