

Preface

This book explains and discusses broad areas concerning product manufacturing technologies from the standpoint of optimization. Manufacturing products of one kind or another is one of the most important and fundamental activities that people do, and the various processes involved directly, or indirectly, affect the daily life and economic wellbeing of countless people around the world. Product manufacturing methods have undergone dramatic development and change during the past 100 years. Now, successful manufacturing requires that a host of factors be taken into account when products are designed and developed, not just to match or surpass keen competition concerning product functions, performances, qualities, and manufacturing costs, but also to meet increasingly stringent requirements concerning product safety, reduced impact upon natural environments, recycling of resources, and satisfaction of subjective factors that are important to the people who use the products. Product manufacturing under these circumstances requires skillful decision-making in scenarios that are more complex and demanding than ever before. Unsophisticated methods that rely on conventional improvements and optimization within specific narrow regions must give way to more preferable and speedy decision-making based on logically precise methods capable of considering a broad range of related factors. To achieve this, the use of optimum system technologies is essential.

Optimization concepts and methodologies are often explained by means of mathematical descriptions, but in engineering research and practical use in industries, mathematically strict descriptions are less important than grasping fundamental ways of thinking about complex optimization problems, and employing useful methodologies. The term “optimization” is often easily used despite a lack of clarity in its meaning, such as when a more preferable result is obtained or selected from a range of choices, but the true optimality of the result may be doubtful. However, when fundamental concepts and descriptions of optimization are adopted in practical scenarios, optimized results that are truly optimal are more likely to be achieved. I have often heard from graduates who are active in industrial or economic sectors that the optimization concepts they learned at our labora-

tory are very useful in their daily work, and that their basic understanding of optimization is in fact more useful than specific optimization tools.

As explained above, to generate more preferable designs and freshly attractive products, a harmonious balance must be attained while considering numerous factors, and this requires mastery of optimization concepts and technologies. Furthermore, new product manufacturing technologies are being steadily developed, so a manufacturer that wishes to maintain a competitive advantage must be thoroughly skilled in the use of optimization technologies, and thus able to understand improvement trends and anticipate future directions for development and practical application. In this book, important technologies pertaining to future product manufacturing techniques are included as much as possible.

In the first chapter, the product manufacturing paradigm changes that have occurred during the past 100 years or so are explained. These discussions also indicate promising directions for future development of product manufacturing features, particularly the concepts, methodologies, and technologies that enable more preferable product manufacturing. Chapter 2 explains key optimization technologies and the criteria for judging the aptness and quality of the factors being considered. The relationships between criteria and optimization processes are then discussed. The problem of related criteria that often have complex conflicting interrelationships is explained, as is the use of multiobjective Pareto optimum solutions as a tool to cope with the multitude of product optimization details that must be dealt with. In Chap. 3, fundamental concepts and strategies for innovating product manufacturing are described, namely (1) generation from the conceptual design stages, (2) concurrent engineering, and (3) collaboration. The roles that people play are especially important when product manufacturing innovation is a goal, and Chap. 4 describes the relationships between product manufacturing and characteristics of special importance to people. To support decision-making personnel as they grapple with various aspects of product manufacturing, supporting technologies and systems are indispensable, and Chap. 5 clarifies these and explains specific key technologies, such as the important roles that information network systems play. To carry out the best possible decision-making when using a supporting system, suitable optimization methodologies must be chosen. Chapter 6 explains the present state of optimization technologies for product designs, and presents the fundamental methodologies and strategies, including system design optimizations. Achieving more preferable product manufacturing depends on obtaining more preferable decision-making results. In Chap. 7, the basic methodologies for decision-making in product design and manufacturing are explained. Effective collaborative optimization in product design and manufacturing is one of the most promising methodologies for obtaining preferable product design solutions. The details of product manufacturing directly affect the success and sustainability of a broad range of industries, industries which have considerable cultural impact in countries across the world. Chapter 8 discusses advanced product design optimization methodologies that aim to maximize the benefits of creative and collaborative optimization in product design while addressing important and pressing

social and environmental issues, as well as the cultural impact of product manufacturing.

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