Preface

Today's market is characterized by intense competition in the global manufacturing environment. In order to succeed or even to survive, manufacturers must be able to deliver their products with speed, diversity, high quality, environment compliancy, and at low cost. Outstanding product design meeting the above-mentioned requirements will ultimately determine the final winner in this competition. In fact, there is a growing awareness of the vital role of product design for business success. Therefore, the desire for advanced design paradigms and powerful design tools has been persistent. On the design paradigm side, systematic product design and manufacturing principles are advancing, such as concurrent engineering (CE), Taguchi method, axiomatic design, theory of inventive problems solving (TRIZ), design for manufacturability and assembly (DFMA), mass customization, etc. On the practical design tool side, various computer-based systems and tools have been thriving, such as computer-aided design (CAD), computer-aided manufacturing (CAM), computer-aided engineering (CAE), product data management (PDM), expert systems, virtual reality (VR) and augmented reality (AR), etc. The last decade also witnessed the burgeoning of Internet technologies that facilitated a distributed, collaborative manufacturing environment.

Along with the flourishing methodologies and tools, comes information explosion such that the information base is too huge and volatile to be effectively managed. The dilemma faced by the designers in this information age is that a designer is "drown in data but thirsty for knowledge" [Rezayat, 2000]. There is an apparent appeal for more effective tools to manage the existing product information such that a

designer can be supported by the relevant knowledge, at the right time, and in the right form.

In such a context, many researchers have been advocating design reuse as an effective knowledge management methodology. Design reuse is not aimed at delivering fancy solutions that will excite the customers and the designers themselves. Instead, it is a methodology to make good use of existing good ideas. The bottom line is: *we do not reinvent the wheel*. In the past few years, the authors of this book have been studying the applicability and effectiveness of design reuse in product development. These efforts involve different stages of product development. Nevertheless, the authors paid more attention to the early stages of product development because it is during these stages that the value of a product is largely determined. Moreover, with the increasing interest in product family design, significant effort has been made on applying the design reuse methodology in product family design.

The efforts made in these areas can be summarized in three areas, namely modeling, analysis, and optimization. Design reuse starts from existing product designs. Thus, modeling is necessary to capture the essential information in a form that is suitable for reuse. Modeling also involves the building of design system infrastructure to organize the information. Analysis refers to the activities to explore the design domain, identify useful knowledge pieces, and assemble them into reusable forms. Optimization mainly focuses on the design-by-reuse process, where solutions for new design tasks can be generated, evaluated, and optimized based on the design targets. An effective reuse system must integrate these interrelated processes to achieve the best efficacy.

This book is organized as follows. Chapter 1 provides an overview of the design reuse methodology and its relevancy to product development. The requirements to apply design reuse in product design are proposed. Chapter 2 presents a literature review of the legacy design reuse system and the computational tools to support the reasoning in design reuse. Chapter 3 is devoted to the information modeling issue. In particular, it presents the information modeling techniques to support design reuse. It introduces what information should be reused and how the information should be represented. The analysis issues are dealt with in Chapter 4. A central question in this respect is how to support the establishment of

product platforms. A novel method based on neural networks is proposed. Chapters 5 ~ 7 present different aspects of the optimization issues. Chapter 5 presents a framework of optimization-based design synthesis approach for product configuration design. Chapter 6 summarizes the state-of-the-art techniques of cost estimation, where cost is an important criterion for optimization. Chapter 7 focuses on another optimization criterion, namely the product performance. A novel method based on axiomatic design is proposed to deal with this particular problem. Next, Chapter 8 presents an integrated design reuse system that amalgamates the technologies in design reuse and applies it to the design of product families. Finally, an online Web-based design reuse system is introduced in Chapter 9 to implement the embodiment and detailed design. In the book, various electro-mechanical products are used in the case studies to help the readers understand the methodologies.

This book covers topics in knowledge gathering, deployment, and utilization. It is intended to be useful for undergraduate and graduate students, and researchers in mechanical/industrial engineering and computer science to improve their understanding of the principles of product development. It can also be used as a reference book for practicing engineers and engineering managers to expand their visions of systematic product development and project management. The reader should have a basic understanding of mechanical products and systems. Fundamental knowledge of artificial intelligence is also helpful to understand the content of this book.

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