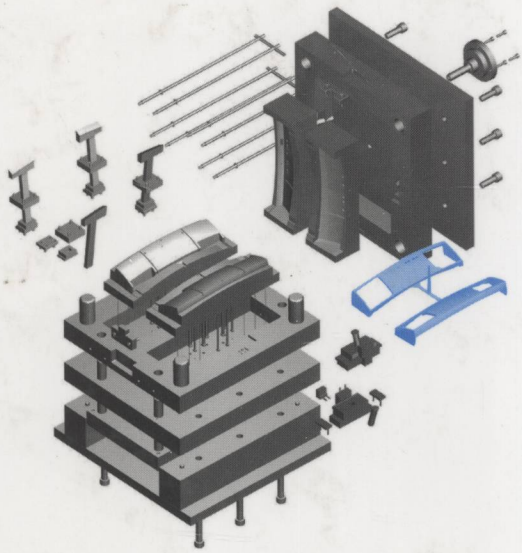
COMPUTER-AIDED INJECTION MOLD DESIGN AND MANUFACTURE



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To our families

for their kind understanding and unfailing support during
the long hours we have spent on this book

Preface

Mold making is an important sector in the precision engineering industry since molded parts represent more than 70% of the consumer products, ranging from computers, home appliances, medical devices, to automobiles, etc. The high demand for shorter design and manufacturing lead-time, good dimensional accuracy, overall quality and rapid design changes have become the main bottlenecks to the mold-making industry. To maintain the competitive edge, there is an urgent need to shorten the lead-time and reduce manufacturing costs by automating the design process. Computer-aided design and computer-aided manufacturing (CAD/CAM) technologies, which emerged during the past two decades, have helped to increase engineering productivity significantly. They have provided the total integration of design, analysis and manufacturing functions and have had a large impact on the engineering practices.

While CAD/CAM has found a wide range of engineering applications, its applications to mold design and manufacturing have been relatively limited. Most of the mold-making companies now use 3-D CAD software to design tooling for increasing their productivity; however, the lack of a semi-auto- or fully auto-design system makes the design tasks manual, daunting, time-consuming and error-prone. Thus, the development of computer-aided injection mold design systems (CADIMDS) has become a must and a research focus in both industry and academia since the 1990s.

This book aims to report the latest research and development achieved in automating plastic injection mold (for plastic) and die casting mold (for metal) design and manufacture. It hopes to promote the use of CADIMDS and stimu-

late greater R&D efforts in this critical area. While most of the major CAD/CAM vendors are actively developing mold application modules, there are still many technical issues which need to be addressed. Based on the authors' past eight years of research on intelligent mold design technologies at the National University of Singapore, many important findings are summarized and concluded in this book. In particular, the development and commercialization of an Intelligent Mold Design and Assembly System (IMOLD®) are thoroughly presented. The system architectures and detailed technologies described will be very useful for the development of applicable CADIMDS in the CAD/CAM markets.

Chapter 1 introduces the historical background of CAD/CAM technology for tooling design such as fixtures and injection molds, highlighting the importance of its R&D efforts and impact on industry. The bottlenecks and technical issues are described in detail. The main concepts of plastic injection mold and molding design, based on report literature, are described in Chapter 2. The design flow from the creation of a containing box, parting generation, runner and gating design, mold base selection, ejector design, cooling layout, etc., is presented. The issues of slider and lifter design for undercut features are also highlighted. The approaches to intelligent mold design and assembly that can lead to future fully automated systems are presented in Chapter 3. The algorithms for optimal parting directions, parting lines, and parting surfaces are given with illustrative examples. The undercut features recognition for sliders and lifters design and core and cavity generation are also covered. Several examples are used to illustrate the methodology. Chapter 4 describes a semi-automated die casting die (mold) design methodology that is similar to the plastic injection mold design approach but is applied to the injection of metals, e.g., aluminum, magnesium, etc. A unique method for a parametric and feature-based design approach is presented.

Detailed discussions on computer-aided engineering (CAE) and analyses for mold design are given in Chapter 5. This chapter fills the gap between the design and manufacturing of injection molds and thus brings up the possibility of future integrated CAD/CAE/CAM systems for mold design applications. In Chapter 6, mold manufacturing and machining (cavity and core, in particular) are discussed. The key topics of cutter selection to ensure gouge-free 3-axis machining as well as automated EDM electrode design are comprehensively described. These issues are useful for CAM users in programming and planning the NC tool paths for the machining of complex injection molds. Chapter 7 reports on a computer-aided process planning (CAPP) approach specially developed for the manufacture of mold components. The approach, implementation, and prototype system are reported. Early cost estimation of mold making, a critical activity in mold manufacture, is presented in Chapter 8. One of the promising cost estimation approaches based on neural-network modeling is introduced. The case studies on both Unix-based and Windows-based intelligent mold design systems (i.e., IMOLD® and IMOLDWorks) are given in Chapter 9.

The prototypes of Windows-based mold design system and parametric die casting die design system are used to demonstrate the previously presented methodologies. The implementation details are shown together with many industrial example parts.

The mold design and molding technologies are important to the material processing of metals and plastics that constitute most of the engineering materials used today. This book is intended to give the most comprehensive descriptions and thorough study on CAD/CAM and CAE of injection molds for researchers and developers in the industry, R&D organizations and universities, with particular focuses on the algorithms, implementations and system architecture that can eventually lead to a fully automated or semi-automated CADIMDS. It also provides valuable information to the designers and developers in this challenging research field and can be used as either a design handbook or a reference/text for a graduate course in understanding intelligent mold design technologies. We sincerely hope that through this publication, greater R&D efforts can be generated from both academia and the industry in critical CAD/CAM and CAE technologies that eventually will benefit the precision engineering industry as a whole.

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