CAD/CAM THEORY AND PRACTICE

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PREFACE

Engineering design and manufacturing form the core of the engineering profession. The engineering curricula and the engineering educational process attempt to provide today's students, tomorrow's engineers, with a sufficient number of sciences and tools to perform, among other things, design and manufacturing. Engineering sciences are well established and most often include physics, engineering mechanics, mechanical behavior and processes of materials, and thermal fluids. Mathematics, computers and computational techniques, communication methods, and drafting skills are among the essential tools a designer needs. In contrast to engineering sciences some of these tools, in particular computers and drafting skills, have been changing quite often to reflect changes and advances in manufacturing and technology. Over the past thirty years, engineering has changed from using mathematical tables, to slide rules, to pocket calculators, to personal computers. In the past fifteen years the interactive computer graphics and CAD/CAM technology have been impacting the drafting, design, and manufacturing tools significantly. It is because of these important impacts that this book has been written.

In an attempt to write a meaningful book with enough subject depth and breadth in the area of CAD/CAM, a focus for the book must be defined. Among the many available choices, this book focuses on presenting a balanced mix on the theory and practice of the CAD/CAM concepts. Throughout the book, the influence of the theoretical and practical aspects of CAD on CAM is also presented. The late chapters of the book, such as Chapters 16 and 20, discuss the integration of CAD and CAM databases. It is believed that the true integration between CAD and CAM forms the bottleneck for achieving automation. It is hoped that the "A" in CAD/CAM will mean automated instead of aided.

The purpose of this book is to present CAD/CAM principles and tools in generic and basic forms with enough depth and breadth. These principles are supplemented with engineering and design applications as well as problems. The presentation of these principles and tools maintains a balance between both theory and practice. The book is concerned with developing the proper attitudes

and approaches to utilizing the existing CAD/CAM technology in engineering. It attempts to expand the reader's imagination beyond just creating interactive graphics. Therefore, Parts IV, V, and VI illustrate how geometric modeling and graphics concepts covered in previous parts can be applied to engineering and design applications. Whenever new tools and applications become available in the future, these three parts can be updated without affecting the book organization. This is important for those who adopt a book in a rapidly developing field such as CAD/CAM. Throughout the book, examples, applications, and computer algorithms are covered independently of any specific hardware or programming languages. However, it is assumed that the reader is familiar with computers and has a basic background in engineering and computer programming.

The book is targeted at students, engineers, and professionals who are interested in the CAD/CAM technology and its applications to design. Most often, this group utilizes, in one form or another, a CAD/CAM system. It may be a fully commercial system or a low-end PC-based system. In either case, the user is faced with understanding the same basic concepts and principles underlying the system. Failure of such understanding often results in user frustration and a significant decline in productivity and utilization of the system relative to manual procedures. Manuals and documentation which are typically provided with CAD/CAM systems tend to concentrate on the user interface and the syntax associated with it. They usually assume that the user has the proper theoretical background which this book attempts to provide. Such a background helps the user a great deal in understanding the various jargon and terminology encountered in the system documentation as well as enabling the user to deal with system errors more intelligently.

The material in the book can be used in various ways. As a textbook, it could be used at either the advanced undergraduate or first graduate level. A two quarter-long or a one semester-long undergraduate course is adequate to cover most of the material and allows time for a project which is a valuable experience for students. The book provides a complete menu of topics. The depth and choice of topic coverage and projects may vary based on a particular curriculum. A graduate course should be designed to cover all the book material and allow for a comprehensive project. A course with an interactive computer graphics focus may cover Chapters 2, 3, 5, 6, 9, 10, 13, and 15. A course with a geometric modeling focus may cover Chapters 2, 3, 5, 6, 7, 9, and 15. A course with a CAD/CAE focus may cover Chapters 1 to 9, 11 to 15, and 17 to 19. A course with a CAM focus may cover Chapters 1 to 9, 11 to 15, 16, and 20 (supplemental material to these chapters may be provided by the instructor). Courses with other foci can easily be designed in a similar fashion. Many instructors may prefer to supplement Parts IV, V, and VI of the book with their own experience and/or their applications. If an engineering curriculum does not offer separate CAD/CAM courses, this book is then ideal as a reference for outside reading by the students. The book can also serve as a reference for the CAD/CAM industry. Training courses typically offered by CAD/CAM vendors to engineers and professionals concentrate on system syntax and documentation.

To write a book in the very rapidly changing CAD/CAM field is perhaps the most challenging endeavor an individual can undertake. The book design and organization has taken this observation into consideration. The book has been divided into six integrated parts which can be updated in the future to reflect new trends, tools, and applications when they evolve without changing the book organization. For example, if a new application subject becomes available in the future, it can be added as a new chapter in Part V or VI. Future updates will always be made taking into consideration the book size. The author has tried to collect as much material from the literature as possible into this book with a unified notation. This represents a major task. The author would be grateful to receive any suggestions, opinions, ideas, and advice regarding the book. The author would also appreciate receiving any errors which went undetected in this edition, and will acknowledge them by name and institution in subsequent editions.

A final word regarding the book organization and style. The book is organized and written in such a way to be suitable for self-study. There are enough details about each subject. Instructors using the book do not have to cover all these details in class. Instead, they can assign some of these details as out-of-class reading exercises. In this way the class time can be utilized effectively by both students and instructors to discuss design projects and applications or issues related to using a particular CAD/CAM system. With this style, engineers and professionals should also find the book material handy to use and easy to understand.

The author is indebted to all the people who helped directly or indirectly to make this book idea a reality. Without their assistance this project would never have been completed. The author would like to thank the following reviewers for their valuable comments, suggestions, encouragement, and sound advice throughout the project: Abdu' imad Ata, University of Detroit; Samir B. Billatos, University of Connecticu., Richard G. Budynas, Rochester Institute of Technology; Jan Evans, University of Tennessee at Chattanooga; Herbert Freeman, Rutgers University; Gary A. Gabriele, Rennselear Polytechnic Institute; Gary L. Kinzel, Ohio State University; Michael B. McGrath, Colorado School of Mines; Charles Mischke, Iowa State University; John J. Moskwa, University of Wisconsin-Madison; Albert P. Pisano, University of California, Berkeley; Donald R. Riley, University of Minnesota; Eric Teicholz, Graphics Systems, Inc.; and Robert O. Warrington, Jr., Louisiana Tech University. The author has made every possible effort to take advantage of their suggestions. The author is also indebted to the many CAD/CAM vendors and their personnel who provided photographs and slides for the book.

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Ibrahim Zeid

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