Preface

Technology in the manufacturing industry is progressing at a pace that has not been seen before. As the manufacturing industry grows and previous generations of workers continue to retire, companies are experiencing difficulties filling skilled positions. This is a great time to be entering the field of manufacturing!

In the past, manufacturing facilities were filled with manually operated mills and lathes, a skilled machinist crafting parts at each machine. Today, manufacturing facilities are filled with computer numerical control (CNC) machines, and CNC programmers and operators use these machines to produce parts at a higher level of quality, a higher rate of production, and a higher level of consistency than was attainable in the past.

CNC programmers are highly skilled professionals. They have a fundamental understanding of machine technology, machining operations, cutting tools, and part workholding methods. Along with this knowledge, CNC programmers possess a detailed understanding of programming commands and functions used to control the machine. CNC programmers are also able to work efficiently with machining personnel in today's fast-paced production environment.

Advancing technology in the manufacturing industry requires a new educational approach to prepare tomorrow's workforce. Students must be able to develop the relevant skills needed for career success. **CNC Programmer's Guide** has been designed to meet these needs. This text will help students prepare for a career in the exciting field of CNC machining.

The content of this text is organized into three sections. The first section, *CNC Mill Programming*, covers the commands, functions, and programming techniques used in CNC milling operations. The second section, *CNC Lathe Programming*, covers the commands, functions, and programming techniques used in CNC lathe operations. The third section, *Subprogramming, Probe Programming, and Macros*, covers subprogramming applications, probe programming, macro programming, and advanced topics. This content organization is designed for different course structures and flexibility in training programs. The three sections contain comprehensive coverage focused on specific machine processes and programming applications.

CNC Programmer's Guide features an extensive number of programs throughout the text to illustrate examples of how CNC operations are programmed. These are practical examples with detailed explanations to help students understand how codes work and when they are used. Depending on the CNC machine and controller type, programming commands and functions can vary significantly. This text explains different programming formats where appropriate, with an emphasis on Haas and Fanuc controllers.

CNC Programmer's Guide employs a building-block approach to present fundamental concepts before progressing to more advanced topics. Programming commands and formats are introduced before specific types of operations are covered. Coverage includes processes involved in program planning, machine setup, and part verification.

The primary focus of **CNC Programmer's Guide** is CNC programming techniques and practices. For more in-depth coverage of CNC manufacturing, including CNC machining technology, machine types, tooling, and advanced topics, refer to **CNC Manufacturing Technology**, also published by Goodheart-Willcox.

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About the Author

Rick Calverley is the Assistant Academic Dean at Lincoln College of Technology in Grand Prairie, Texas, where he designed and implemented Lincoln's first program in CNC Machining and Manufacturing Technology. As a third-generation machinist, trained mold maker, tool and die maker, and CNC multiaxis programmer, Mr. Calverley has seen this industry go through radical changes. He started his career in 1982, running manual machinery in his father's shop. During his 30 plus years of making parts, he has produced parts used to make turbochargers, transmissions, plastic injection molds, aircraft parts, and even parts for the International Space Station. Before joining Lincoln, Mr. Calverley worked as a CNC programmer for several manufacturing firms, including Solidiform, Inc., a defense contractor in the aerospace industry.

Mr. Calverley is the author of **CNC Manufacturing Technology**. He holds an AS degree in marine technology from the College of Oceaneering and has completed additional college-level industry and academic programs. He holds all 12 NIMS Machining Level 1 certifications, as well as three Mastercam Associate Level certifications.

Mr. Calverley has served on the national councils for the Fabricators and Manufacturers Association, the Mastercam Educators Alliance, and the Haas Technical Education Community. He also established the first National Tooling and Machining Association student chapter.

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New to This Edition

The second edition of **CNC Programmer's Guide** contains numerous enhancements to help you succeed. It has been carefully vetted by a panel of experts in the field of manufacturing education to make sure the material is technically accurate, up to date, and presented in the most logical and effective manner.

Updates include the following:

- Final projects have been added at the end of *Section 1, CNC Mill Programming*, and *Section 2, CNC Lathe Programming*. These projects provide opportunities for students to apply what they have learned throughout their course of study. Each project consists of a part to be programmed, machined, and detailed in setup sheet documentation.
- Content has been expanded to cover newer technologies. Emerging use of artificial intelligence (AI) in CNC machining and programming is covered in Chapter 31, *Additional Tips and Tricks*.
- Instructional design improvements include the use of modular numbered heads and corresponding learning outcomes. New bulleted summaries corresponding to each numbered learning outcome help students review key concepts.
- Additional questions are provided for student evaluation in the end-of-chapter review sections. The questions are correlated to learning outcomes and major sections in the chapter.

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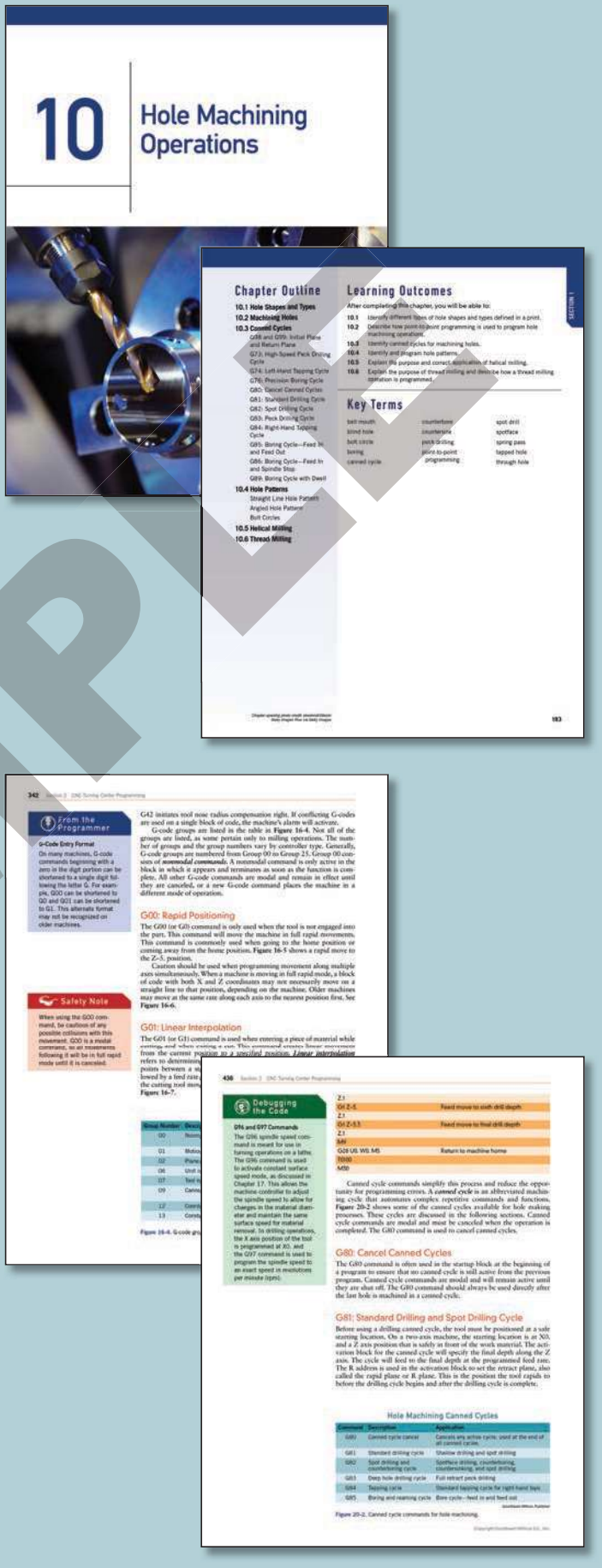
The instructional design of this textbook includes student-focused learning tools to help you succeed. This visual guide highlights these features.

Chapter Opening Materials

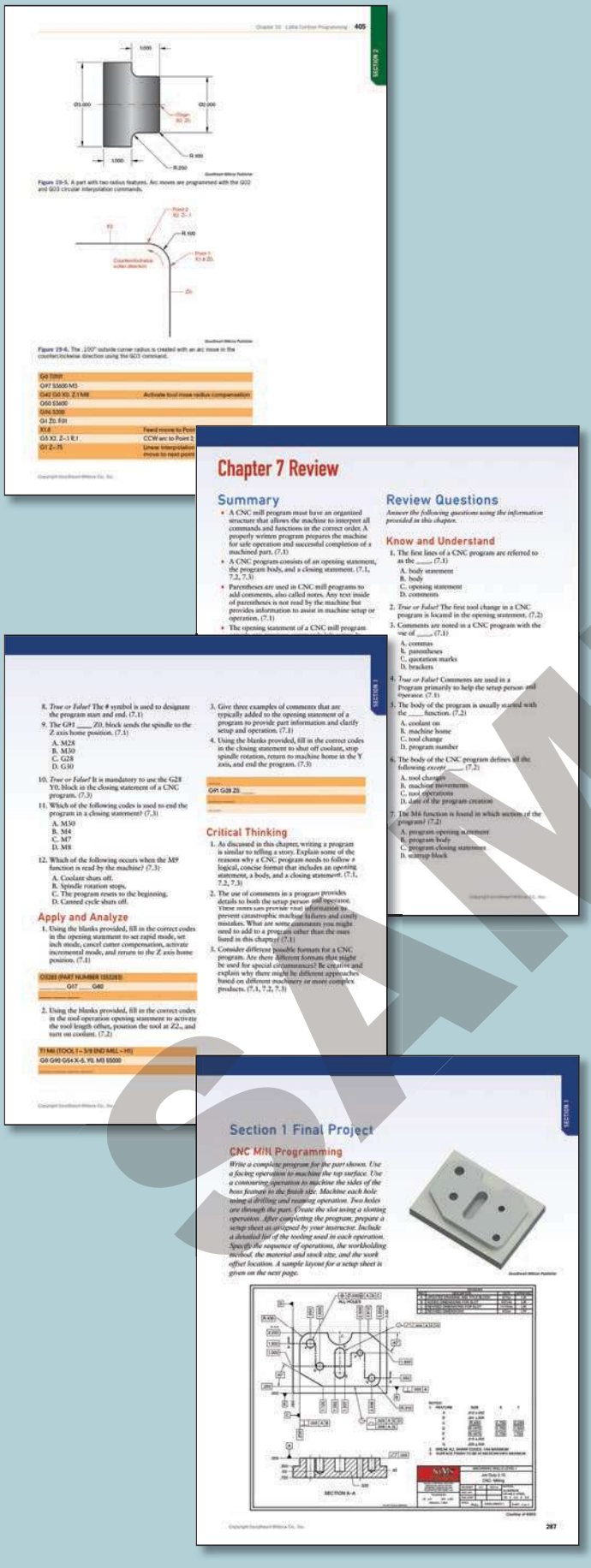
Each chapter opener contains a chapter outline, a list of learning outcomes, and a list of key technical terms. The **Chapter Outline** summarizes the topics that will be covered in the chapter. **Learning Outcomes** clearly identify the knowledge and skills to be gained when the chapter is completed. These outcomes are labeled and correlated to related assessment elements to facilitate reporting and remediation. **Key Terms** list the key words to be learned in the chapter. When key terms are introduced, they are highlighted in bold italic type.

Additional Features

Additional features are used throughout the body of each chapter to further learning and knowledge. **Safety Notes** alert you to potentially dangerous materials and practices. **From the Programmer** features provide practical advice and guidance that is especially applicable on the job. **Debugging the Code** features explain proper use of programming commands and help you develop troubleshooting skills.



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Illustrations

Illustrations have been designed to clearly and simply communicate the specific topic. The text makes extensive use of detailed illustrations and photographs to support explanations of concepts.

Program Examples

Numerous **Program Examples** show students the programmed code corresponding to discussions in the text. These examples are set off from the main text with color highlighting. Explanations of specific codes appear to the right of the lines in the program.

End-of-Chapter Content

End-of-chapter material provides an opportunity for review and application of concepts. A concise **Summary** provides an additional review tool and reinforces key learning outcomes. This helps you focus on important concepts presented in the text. **Know and Understand** questions enable you to demonstrate knowledge, identification, and comprehension of chapter material. **Apply and Analyze** questions extend learning and allow you to apply knowledge and skills. **Critical Thinking** questions help you develop higher-order thinking and problem-solving skills. **Final Projects** enable you to apply CNC mill and lathe programming skills.

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