To my current and former graduate students whose dedication and hard work not only have made modern coal mining safer and more productive, but also made my life-long career in coal shine all over the world.
Preface

The first edition of *Longwall Mining*, coauthored with Professor Han Shing Chiang, was published in 1984. At that time, longwall mining was a new technology to the U.S. coal industry, so the content of the book was more of a review of the practice as it was then in the U.S. and elsewhere up until that time. Since then, many changes have occurred in longwall mining. Most notably, the U.S. coal industry has advanced itself from being a pure import country in the 1970s, in terms of longwall mining technology, to an export country since the late 1980s and early 1990s. The growth of U.S. longwall mining in the past three decades can be considered miraculous, especially considering the fact that this explosive growth came about during a period of an extremely depressed coal market.

In the 1970s and early 1980s, federal funding for mining research and development (R&D) was plentiful and several longwall demonstration projects for various mining conditions were sponsored, such as thin seam, inclined seam, and thick seam longwalls and many other production and safety related projects. Following the mid 1980s, federal funding dried up and funding for mining R & D practically stopped, even though the U.S. Bureau of Mines carried on. Since the U.S. coal industry traditionally relied on the U.S. Bureau of Mines for technology development, when the funding stopped, the burden of technology development fell upon the original equipment manufacturers (OEMs). From the mid 1980s to mid 1990s, the coal industry demanded improvements and development of new products every time a new order of equipment was placed. The OEMs responded well. As a result, there were many new developments and improvements on existing equipment, making it the golden age of longwall technology development. It was during this period that U.S. longwalls established the first world production record and became the leader in modern longwall mining.

I was fortunate that West Virginia University was located at the heart of Appalachian coalfield where nearly two-thirds of U.S. longwall were, and still are, located. In addition to traditional ground control research such as entry stability, panel design, and underground rock mechanics instrumentation, I began my longwall research on shield design and surface subsidence in the mid 1970s. We conducted research in coal mines in the north and central Appalachian coalfields, monitoring shield leg pressures for powered support design and selection. From these data, we found that two-leg shields with active horizontal force are the best among all types of powered supports. Today, two-leg shields are the industry standard. At one point during the 1980s, I was involved in the design and selection of more than one-third of the longwall powered supports in the U.S.

Our research team has also developed a computer software program, **CISPM** (Comprehensive and Integrated Subsidence Prediction Model), that can accurately predict surface subsidence and mitigate surface structural damage. The program is used routinely by coal companies in the northern Appalachian coalfields where citizens against longwalling began because of surface subsidence and dewatering problems. It has been used to support many subsidence issues and kept many longwalls operating. We later expanded our longwall mining research to respirable dust, drum cutting, and automation. Throughout the past three decades, I have visited and/or performed research and consulting work in more than 300 underground coal mines in all coal producing states in the U.S. and 15 foreign countries. Therefore, I have intimate knowledge, especially including my personal observation, in the practical operation and management aspects of coal mining. I have personally observed, and in some cases, I was deeply involved in the development of longwall technology. In coal mining, there are many ways to achieve the same goals, in production and safety, even if exactly the same equipment is used. In the U.S., for example, different coalfields and different mines (even within the same region of the same company) may practice differently in some respects, due in parts to geological conditions, local practice, or crew preference. In international scale, this is even more the case. So any typical method/technique described may not be completely inclusive. Based on this background, personal observation, research, and
consulting service all over the world throughout the past three decades, I have written the 2nd edition of *Longwall Mining*. This book covers what I call the U.S. longwall mining technology that was developed and practiced in the U.S. for the past 30 years. It covers all phases of longwall technology in 14 chapters. Each chapter is devoted to a subsystem of equipment or engineering technology. Each chapter begins with a brief introduction on the historical trends of development of the subsystem equipment or engineering technology, followed by a detailed description of the subsystem and engineering technology as they are practiced in the U.S. today.

The book begins with a description of U.S. longwall mining technology in which special features about U.S. longwalls and their requirements and constraints are detailed (Chapter one). Annual statistics are presented from 1976 onward to show the historical trends of development for all major subsystems. A preliminary evaluation of longwall feasibility of a coal reserve is discussed in Chapter two, in which the factors that have proven to be critical to longwall production during the past 30 years are identified and discussed. In longwall mining ground control, understanding and control of the abutment pressures associated with the retreating face and their effect on roof stability and control is the key to successful longwall mining. The rock mechanics characteristics, e.g., cavability, of the near-seam stratigraphic sequence define the nature of the abutment pressures and feasibility of longwalling. These and measured data are discussed in Chapter three. Modern longwalls demand rapid gateroad development in order to keep up with the fast-advancing face. Chapter four describes the various methods for multiple entry development. Examples of rapid development systems are illustrated. Chapters five and six are devoted to all elements of the two-leg shield support, including structural and hydraulic components and their functions, the hydraulic supply system, design, selection and testing of shield supports, support working principles, and their analysis. Two coal cutting machines, the shearer and plow, are covered in this book although the plow is no longer popular. But I believe as good reserves deplete, the plow will regain favor for thin seam longwalling.

The shearer system is covered in Chapter seven, including major components and their functions, types of haulage systems, methods and examples of production cutting methods, automation, and the drum and its cutting mechanisms. In Chapter eight, after identifying the applicable seam conditions between the plow and shearer systems, the fully automated plow system is described, including horizon, travel, and shield controls. The coal transportation system is covered in Chapter 9. It includes the armored face conveyer (AFC), stage loader, outby belt conveyors, bunker and skip hoist. The elements and their function of AFC and the stage loader are explained in detail. Chapter 10 cites several important issues and problems and gives practical examples of how to deal with them, including roof falls, hard faces, soft bottom, hard-to-cave rocks, faults, gas/oil wells, etc.

Ventilation requirements and practices are covered in Chapter 11, which also includes methane and dust control. The methods employed by U.S. longwalls for methane and dust controls are highly effective, because the practice enables many highly gaseous coal seams to be mined with clean environments and in a highly productive manner. Face move involves removal and transport of heavy and large pieces of equipment. The goals, planning, methods, and equipment required for a face move are described in Chapter 12. Chapter 13 includes a brief introduction to mine power distribution and system control, including the logics and factors to be considered in system automation. Finally, in Chapter 14, surface subsidence and dewatering are introduced by using a practical example to illustrate that subsidence in longwalling is predictable and “controlled,” including subsidence features, prediction and mitigation of subsidence damages, and dewatering. New chapters or sections have been added, including panel development, ventilation, system control, and power distribution.
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During my writing of this book, I was gratified that many friends in the industry, upon a phone call, either spent hours with me discussing the current operational practices and equipment characteristics or graciously provided me with valuable information that makes this book the most comprehensive and up-to-date on the subject. Among them, in alphabetical order:

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