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Additional Volumes in Preparation
HIGH-QUALITY STEEL ROLLING
THEORY AND PRACTICE

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Preface

In each stage of the development of steel rolling technology, there have been specific challenges to be met by both steel producers and designers of rolling mill equipment. In the past three decades, the most important challenges have included increasing production rates, conserving energy, increasing coil weights, and reducing the finishing gauge.

Whereas these goals have been gradually achieved by the majority of steel producers, the two main challenges that remain for steel producers today are improving product quality and reducing production costs. Although these goals have always been considered in the past, they are now looked at in a completely new perspective because of the following three factors:

- Excessive capacity for production of flat rolled products.
- Entry of developing nations into the marketplace.
- Entry of mini-mills into flat rolled production.

The excessive capacity for the production of flat rolled steel products has created an extremely competitive environment among the world’s leading steel producers. The producers who meet the customer’s high quality standards and at the same time maintain low production costs have a distinct advantage over their competitors. However, current competition is not just between the steel producers of the major industrial countries.

The competition is continuously intensifying as a growing number of developing countries enter into the steel producing market. The impact of these developing nations on the world steel marketplace is not just in capacity alone, but in improved product quality and lower production costs. These developments can be directly attributed to the huge investments that the developing nations have made in modern rolling mill technology for their steel producing plants.

The most recent and possibly most influential development is the transfer of the flat rolled steel production process from integrated steel mills that use iron ore and coal as the prime sources of their steelmaking process to mini-mills that utilize steel scrap and direct reduced iron. The rate of this transfer will depend on the capability of the integrated steel producers to defend their market position by further improving product quality and reducing production costs.
There are several distinct differences in the ways that steel producers can reduce their production costs. The developing countries can usually take advantage of low labor costs in their entire steelmaking plant. The mini-mills can lower their production costs by utilizing electric arc furnaces and steel scrap in their steelmaking operations. Meanwhile, the integrated steel producers of the major industrial countries solely rely on modernization and automation of their existing steelmaking and rolling facilities to lower labor and production costs.

Contrary to cost reduction, all steel producers are generally faced with very similar problems regarding improvement in the quality of flat rolled products. Until a completely new steel strip production process (such as strip casting) becomes commercially viable, the technology for improving product quality will remain virtually universal and applicable to all rolling mills, regardless of their location and type of plant.

In general, the successful improvement of product quality depends to a large degree on a clear understanding of the following key subjects:

- Definitions of quality parameters.
- Quality requirements of present and future markets.
- Measurement of quality parameters.
- Factors affecting product quality.
- Performance characteristics of quality improvement technology.
- Selection of optimum technology for each particular application.

*High-Quality Steel Rolling: Theory and Practice* examines these subjects with respect to the following topics:

**Part I, Geometry of Flat Rolled Products** summarizes the definitions of the geometrical parameters of flat rolled products based on both current industrial standards and the conventional terminology used in the industry's technical literature. A comparison of the tolerances specified by the standards of the major industrial countries shows that the existing standards do not always reflect the specific features of the rolling process. The examination of these standards also shows that the statistical character of the information that is related to the quality of the finished product is practically ignored. An analysis of the quality requirements that are being demanded by users of flat rolled products is discussed along with various ideas regarding future quality standards.

**Part II, Principles of Measurement** provides the definitions of basic metrological terms along with a classification of various types of transducers and sensors. The principles of signal treatment in application to contemporary rolling mills is also discussed. The effectiveness of sophisticated signal treatment systems is illustrated, but the need for careful evaluation of the additional errors of measurement that are contributed by these systems is emphasized.

**Part III, Gauge Control in Rolling Mills** investigates the causes of gauge variation and describes various automatic gauge control systems including the transducers and actuators as principal parts of these systems. Special attention is given to the methods of compensation of both static and dynamic gauge errors that are caused by various disturbance factors.
Part IV, **Width Control in Rolling Mills** outlines the basic theory of width change, provides analytical descriptions of both cross-sectional and plan view product geometry, and describes the various methods of width change by casting, rolling, and pressing. Definitions of the parameters that describe the efficiency of the width change process are provided to assist in objectively comparing these methods. New technological developments in automatic width and plan view control systems are also reviewed.

Part V, **Theory of Strip Profile and Flatness** examines both theoretical and practical aspects of strip profile and flatness control. Various mathematical models are presented that describe the effects of roll deformation along with thermal expansion and wear on strip profile. A detailed description the ROLL-FLEX™ Off-line Computer Model that was developed jointly by United Engineering and International Rolling Mill Consultants is also provided. This model is used to illustrate the relationships between strip profile, strip flatness, and various other rolling parameters.

Part VI, **Strip Profile and Flatness Control** describes the various types of actuators that are designed to provide on-line corrections of strip profile and flatness, including roll bending, roll shifting, and roll crossing systems. Rolls with specific profiles along with flexible edge rolls are also examined. Part VI concludes with a detailed review of strip profile and flatness sensors along with various types of automatic strip profile and flatness control systems.

The need for improvements in the quality of flat rolled products has triggered a multitude of developments in sophisticated rolling mill technology. The problem is no longer in the lack of technological developments, but rather in selecting the appropriate technology for each particular rolling mill. My hope is that *High-Quality Steel Rolling: Theory and Practice* can provide some direction and guidance to both steel producers and equipment suppliers in objectively evaluating and selecting the technology that will provide the maximum benefit (improvement versus cost) for their rolling mills.

This book was made possible with the support of United Engineering, Inc., Pittsburgh, Pa. A special thanks to David Rosburg, Fred Bakhtar, Mario Azzam, and Keith Watson, all of United Engineering, who participated in the research and development of some of the new technologies that are described in this book. Also thanks to Eugene Ginzburg of International Rolling Mill Consultants, who assisted in numerous computer presentations of these new technologies. My gratitude to Marilyn Deskins for the seemingly endless amount of word processing and to Robert Ballas, who took on the formidable task of editing the manuscript and preparing it for publication.

My special thanks and gratitude goes to Tatyana Ginzburg, my colleague, friend, and wife whose support makes all my efforts worthwhile.

*Vladimir B. Ginzburg*
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Fitted straight


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