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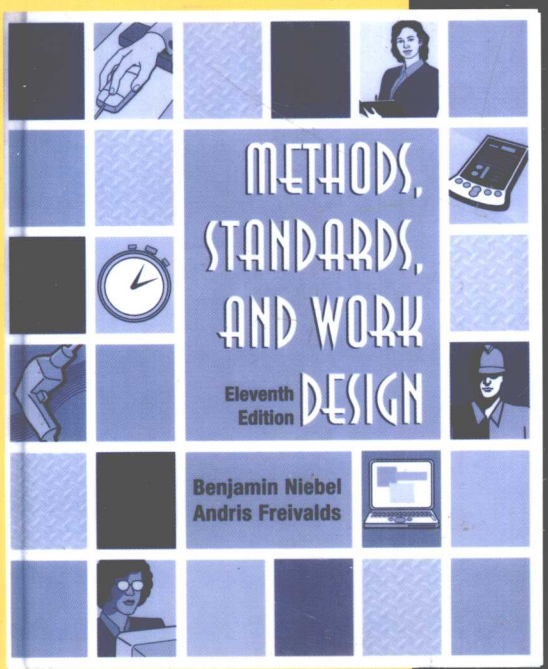
Benjamin Niebel, Andris Freivalds

方法、标准与作业设计

（第11版）



清华大学出版社

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Methods, Standards, and Work Design

ELEVENTH EDITION

方法、标准与作业设计

（第11版）

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PREFACE

BACKGROUND

Faced with increasing competition from all parts of the world, almost every industry, business, and service organization is restructuring itself to operate more effectively. Downsizing is becoming a trend. Each segment of these organizations must increase the intensity of its cost reduction and quality improvement efforts while working with a reduced labor force. Cost-effectiveness and product reliability without excess capacity are the keys to successful activity in all areas of business, industry, and government. And cost-effectiveness with improved quality under restricted plant capacity is the end result of methods engineering, equitable time standards, and improved employee motivation through the introduction of modern management reward systems.

Also, as machines and equipment grow increasingly complex and semi- if not fully automated, it is increasingly important to study both the manual components and the cognitive aspects of work. The operator must perceive and interpret large amounts of information, make critical decisions, and control these machines both quickly and accurately. In recent years, jobs have shifted gradually from manufacturing to the service sector. In both sectors, there is increasingly less emphasis on gross physical activity and a greater emphasis on information processing and decision making, especially via computers and associated modern technology. The same efficiency and work-design tools are the keys to productivity improvement in any industry, business, or service organization, whether in a bank, a hospital, a department store, a railroad, or the postal system. Furthermore, success in a given product line or service leads to new products and innovations. It is this accumulation of successes that drives hiring and the growth of an economy.

The reader should be careful not to be swayed or intimidated by some of the relatively new jargon offered as a cure-all for an enterprise's lack of competitiveness. Often these fads destroy sound engineering and management procedures that, when properly utilized, represent the key to continued success. Today we hear a good deal about re-engineering and use of cross-functional teams as business leaders reduce cost, inventory, cycle time, and nonvalue activities. However, experience in the past few years has proven that cutting people from the payroll just for the sake of automating their jobs is not always the wise procedure. The authors, with many years of experience in more than 100 industries, strongly recommend sound methods engineering, realistic standards, and equitable wage payment as the keys to success in both manufacturing and business.

WHY THIS BOOK WAS WRITTEN

The objectives of the eleventh edition have remained the same as for the tenth: to provide a practical, up-to-date college textbook describing engineering methods to measure, analyze, and design manual work. The importance of ergonomics and work design as part of methods engineering is emphasized, not only to increase productivity, but also to improve worker health and safety and, thus, company bottom-line costs. Far too often, industrial engineers have focused solely on increasing productivity through methods changes and job simplification, resulting in overly repetitive jobs for the operators and increased incidence rates of musculoskeletal injuries. Any cost reductions obtained are more than offset by the increased medical and Workers Compensation costs, especially considering today's ever-escalating health care costs.

WHAT'S NEW IN THE ELEVENTH EDITION

A new Chapter 7 on the cognitive aspects of work, information processing, and the human-computer interface have been included. The concepts in this chapter are increasingly important given the steady decline of manufacturing jobs in the United States and an increase in the importance of the service sector. Additional examples and case studies showing applications with the service industry (see Chapter 14) have been provided. Some topics of lesser importance or those that have been supplanted by technological changes have been reduced in scope. For example, Chapters 11 and 12 of the tenth edition, focusing on standard data and formula construction, have been combined in this edition, since these functions can now be accomplished using one of the many software packages available on the market today. Approximately 10–15 percent more examples, problems, and case studies have been added. The eleventh edition still provides a continued reliance on work sampling, time study, facilities layout and various flow process charts for students entering the industrial engineering profession and serves as a practical, up-to-date source of reference material for the practicing engineer and manager.

HOW THIS BOOK DIFFERS FROM OTHERS

Most textbooks on the market deal strictly either with the traditional elements of motion and time study or with human factors and ergonomics. Few textbooks integrate both topics into one book, or for that matter, one course. In this day and age, the industrial engineer needs to consider both productivity issues and their effects on the health and safety of the worker simultaneously. Few of the books on the market are formatted for use in the classroom setting. This text includes additional questions, problems, and sample laboratory exercises to assist the educator. Finally, no text provides the extensive amount of online student and instructor resources, electronic forms, current information, and changes as this edition does.

ORGANIZATION OF THE TEXT AND COURSE MATERIAL

The eleventh edition is laid out to provide roughly one chapter of material per week of a semester-long introductory course. Although there is a total of 18 chapters, Chapter 1 is short and introductory, much of Chapter 7 on cognitive work design may be covered in other human factors courses, and Chapter 15 on standards for indirect and expense work may not need to be covered in an introductory course, leaving only 15 chapters to be covered in the semester.

A typical semester plan, chapter by chapter, might be as follows:

Chapter	Lectures	Coverage
1	1	Quick introduction on the importance of productivity and work design, with a bit of historical perspective.
2	3	A few tools from each area (Pareto analysis, job analysis/worksite guide, flow process charts, worker–machine charts) with some quantitative analysis on worker–machine interactions. Line balancing may be covered in other courses.
3	3	Operation analysis with an example for each step.
4	4	Full, but can gloss over basic muscle physiology and energy expenditure.
5	4	Full.
6	4	Basics on illumination, noise, temperature, and, perhaps, two other topics as desired. Safety and OSHA may be covered in another course.
7	3	Coverage depends on instructor's interest.
8	3	Three tools: value engineering, cost-benefit analysis, and crossover charts; job analysis and evaluation, and interaction with workers. Other tools may be covered in other classes.
9	2–3	Basics of time study.
10	1	One form of rating.
11	2	First half of the allowances that are well established.
12	1–2	Coverage of standard data and formulas depends on instructor's interest.
13	3	Only one predetermined time system in depth.
14	2	Work sampling.
15	1	Coverage of indirect and expense labor standards depends on instructor's interest.
16	2	Overview and costing.
17	2	Day work and standard hour plan.
18	3	Learning curves, motivation, and people skills.

The recommended plan covers 44–46 lectures. Some instructors may wish to spend more time on any given chapter, for which additional material is supplied, for example, work design (Chapters 4–7), and less time on traditional work measurement (Chapters 8–16), or vice versa. The text allows for this flexibility.

SUPPLEMENTARY MATERIAL AND ON-LINE SUPPORT

The eleventh edition of this text continues to focus on the ubiquitous use of personal computers as well as the Internet to establish standards, conceptualize possibilities, evaluate costs, and disseminate information. A website, hosted by the publisher at http://www.mhhe.com/niebel-freivalds, furthers that objective by providing the educator with extensive on-line resources. The site includes an updated instructor's manual with electronic copies of necessary forms, additional practice problems, case studies, and suggested laboratory exercises. DesignTools version 3.0, a ready-to-use software program for time study, work sampling, standard data, costing, and so on, appears on the site as well. A special new feature of the website is the addition of QuikTS, a time study data collection program. The program may be downloaded via hot synch to a Palm device (m105 or higher) and used to collect time study data. The data are then uploaded directly to the time study form on DesignTools for easy and accurate calculation of standard time.

The book's website also links to a website hosted by the author at http://www.ie.psu.edu/courses/ie327, which provides instructors with on-line background material, including electronic versions of the forms available in the instructor's manual. Student resources include practice exams and solutions. Up-to-date information on any errors found or corrections needed in this new edition appear on this site as well. Suggestions received from individuals at the universities, colleges, technical institutes, industries, and labor organizations that regularly use this text have helped materially in the preparation of this eleventh edition. Further suggestions are welcome, especially if any errors are noticed. Please simply respond to the *OOPS!* button on the website or by e-mail to axf@psu.edu. As with any website, this one will continually evolve.

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Andris Freivalds

BRIEF CONTENTS

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CHAPTER 1

Methods, Standards, and Work Design: Introduction

KEY POINTS:

- Increasing productivity drives U.S. industry.
- Worker health and safety are just as important as productivity.
- Methods engineering simplifies work.
- Work design fits work to the operator.
- Time study measures work and sets standards.

PRODUCTIVITY IMPORTANCE

Certain changes continually taking place in the industrial and business environment must be considered both economically and practically. These include the globalization of both the market and the producer, the delayering of corporations in an effort to become more competitive without deteriorating quality, the growth of computerization in all facets of an enterprise, and the ever expanding applications of the information highway. The only way a business or enterprise can grow and increase its profitability is by increasing its productivity. Productivity improvement refers to the increase in output per work-hour or time expended. The United States has long enjoyed the world's highest productivity. Over the last 100 years, productivity in the United States has increased approximately 4 percent per year. However, in the last decade, the U.S. rate of productivity improvement has been exceeded by that of Japan, Korea, and Germany, and it has been challenged by Italy, France, and China.

The fundamental tools that result in increased productivity are: methods, time study standards (frequently referred to as work measurement), and work design. Of the total cost of the typical metal products manufacturing enterprise, 12 percent is direct labor, 45 percent is direct material, and 43 percent is overhead. All aspects of a business or industry—sales, finance, production, engineering, cost, maintenance, and management—provide fertile areas for the application of methods, standards, and work design. Too often, people consider only the production function when applying these tools. Important as the production function is, other aspects of the enterprise also contribute substantially to the cost of operation and are equally valid areas for the application of cost improvement techniques. In sales, for example, modern information retrieval methods usually result in more reliable information, leading to greater sales at less cost. Product quotas for specific territories provide a base or standard that individual salespeople endeavor to exceed, and payment for results always produces above-standard performance.

Today, most U.S. businesses and industries are, by necessity, restructuring themselves by downsizing, in order to operate more effectively in an increasingly competitive world. With more intensity than ever before, they are addressing cost reduction and quality improvement through productivity improvement. They are also critically examining all business components that do not contribute to their profitability.

Since the production area within manufacturing industries utilizes the greatest number of engineers in methods, standards, and work design efforts, this text will treat that field in more detail than any other. However, examples from other areas of the manufacturing industry, such as maintenance, transportation, sales, and management, as well as the service industry, will be provided.

The production areas of opportunity for students enrolled in engineering, industrial management, business administration, industrial psychology, and labor–management relations are: (1) work measurement, (2) work methods and design, (3) production engineering, (4) manufacturing analysis and control, (5) facilities planning, (6) wage administration, (7) ergonomics and safety, (8) production and inventory control, and (9) quality control. Other position areas, such as personnel or industrial relations, cost, and budgeting, are closely related to, and dependent on, the production group. These areas of opportunity are not confined to manufacturing industries. They exist, and are equally important, in such enterprises as department stores, hotels, educational institutions, hospitals, banks, airlines, insurance offices, military service centers, government agencies, and retirement complexes. Today, in the United States, only about 20 percent of the total labor force is employed in manufacturing industries. The remaining 80 percent is engaged in service industries or staff-related positions. As the United States becomes more service-industry oriented, the philosophies and techniques of methods, standards, and work design must be utilized in the service sector. Wherever people, materials, and facilities interact to obtain some objective, productivity can be improved through the intelligent application of methods, standards, and work design.

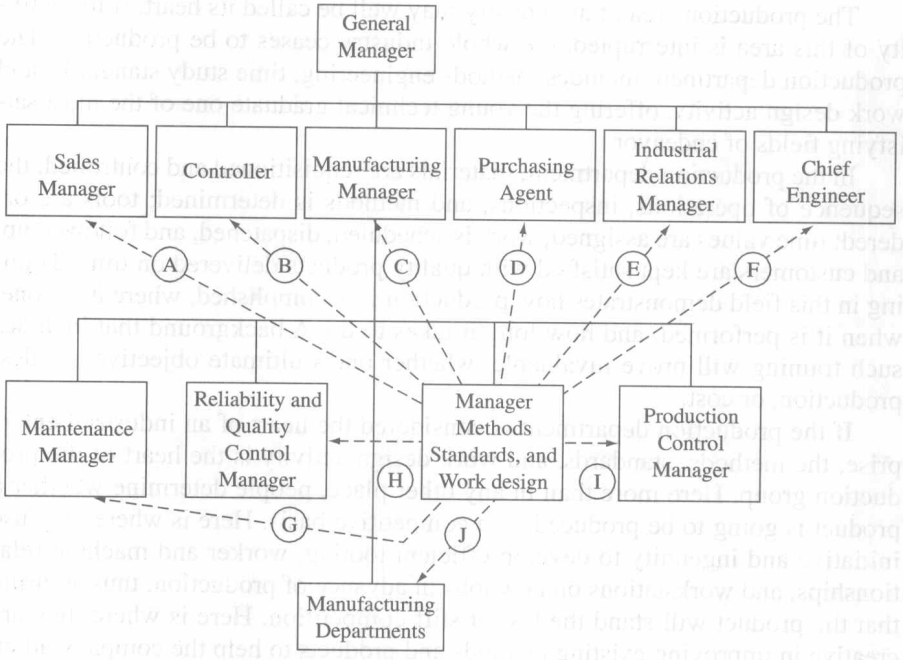
The production area of an industry may well be called its heart; if the activity of this area is interrupted, the whole industry ceases to be productive. The production department includes methods engineering, time study standards, and work design activity, offering the young technical graduate one of the most satisfying fields of endeavor.

In the production department, materials are requisitioned and controlled; the sequence of operations, inspections, and methods is determined; tools are ordered; time values are assigned; work is scheduled, dispatched, and followed up; and customers are kept satisfied with quality products delivered on time. Training in this field demonstrates how production is accomplished, where it is done, when it is performed, and how long it takes to do. A background that includes such training will prove invaluable, whether one's ultimate objective is sales, production, or cost.

If the production department is considered the heart of an industrial enterprise, the methods, standards, and work design activity is the heart of the production group. Here more than in any other place, people determine whether a product is going to be produced on a competitive basis. Here is where they use initiative and ingenuity to develop efficient tooling, worker and machine relationships, and workstations on new jobs in advance of production, thus assuring that the product will stand the test of stiff competition. Here is where they are creative in improving existing methods and products to help the company attain leadership in its product line. In this activity, good labor relations may be maintained through establishing fair labor standards, or may be impeded by setting one inequitable rate.

Methods, standards, and work design offer real challenges. Industries with competent engineers, business administrators, industrial relations personnel, specially trained supervisors, and psychologists all using methods, standards, and work design techniques are inevitably better able to meet competition and better equipped to operate profitably.

The objective of the manufacturing manager is to produce a quality product, on schedule, at the lowest possible cost, with a minimum of capital investment and a maximum of employee satisfaction. The focus of the reliability and quality control manager is to maintain engineering specifications and satisfy customers with the product's quality level and reliability over its expected life. The production control manager is principally interested in establishing and maintaining production schedules with due regard for both customer needs and the favorable economics obtainable with careful scheduling. The manager of methods, standards, and work design is mostly concerned with combining the lowest possible production cost with maximum employee satisfaction without sacrificing workplace safety. The maintenance manager is primarily concerned with minimizing facility downtime due to unscheduled breakdowns and repairs. Figure 1–1 illustrates the relationship of the manager of the methods, standards, and work design department to the staff and line departments under the general manager.



A—Cost is largely determined by manufacturing methods.
B—Time standards are the bases of standard costs.
C—Standards (direct and indirect) provide the bases for measuring the performance of production departments.
D—Time is a common denominator for comparing competitive equipment and supplies.
E—Good labor relations are maintained with equitable standards and a safe work environment.
F—Methods work design and processes strongly influence product designs.
G—Standards provide the bases for preventive maintenance.
H—Standards enforce quality.
I—Scheduling is based on time standards.
J—Methods, standards, and work design provide how the work is to be done and how long it will take.

Figure 1–1 |
Typical organization chart showing the influence of methods, standards, and work design on the operation of the enterprise.

METHODS AND STANDARDS SCOPE

Methods engineering includes designing, creating, and selecting the best manufacturing methods, processes, tools, equipment, and skills to manufacture a product based on the working drawings that have been developed by the product engineering section. When the best method interfaces with the best skills available, an efficient worker–machine relationship exists. Once the complete method has been established, the responsibility for determining the standard time required to produce the product falls within the scope of this work. Also included