

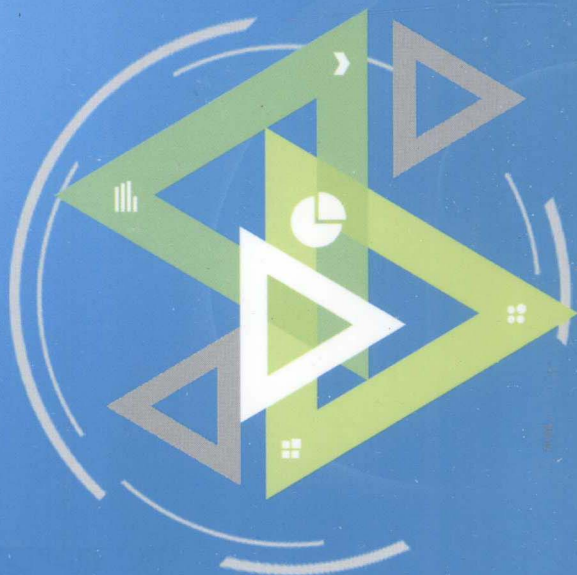
普通高等教育“十二五”规划教材

# Fundamentals of Manufacturing Technology

英汉双语对照

## 机械制造技术基础

任小中 任乃飞 王红军 © 编著



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# 机械制造技术基础

(英汉双语对照)

任小中 任乃飞 王红军 编著

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机械工业出版社

本书是按照我国高等教育要与国际接轨,培养国际性复合型人才的要求,结合作者近年来在“质量工程”建设方面的实践与成果编著的英汉双语教材。这是我国第一部以中、英文形式编写的“机械制造技术基础”双语教材。

本书由机械类专业的多门技术基础课的核心内容综合而成。本着“重基础、精内容、强实践”的原则,吸取国外同类教材的特点,以机械制造技术为主线,重视基本概念、基本理论和基本方法的学习,并通过相关实践教学环节的训练,理论联系实际,培养学生科技创新和工程实践的能力。

全书共有7章,主要内容包括绪论、金属切削原理、机床与刀具、机械加工工艺规程的制订、机床夹具设计原理、机械加工质量分析与控制、机械装配技术基础、先进制造技术简介等。

本书配套齐全,不仅有配套的电子教案和电子课件(教师版),还有对应的双语习题集(学生版)和主要习题解答(教师版),均由机械工业出版社出版或提供。

本书内容综合性强、编写体系新颖,可作为高等院校机械类专业和近机械类专业本、专科生的教材或教学参考书,特别适合作为同类课程的双语教材,也可供机械制造业工程技术人员参考。

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## Preface

With the globalization of the economy and the increase of international communication, the society requires higher foreign language proficiency and stronger international competitive capacity from talents. A significant measure of China's campus pedagogy to be in line with the international education is to teach bilingually, which could enhance students' foreign language level and open up their global perspective while imparting subject matter knowledge, and which is an effective way of cultivating high-quality international talents.

The basis of bilingual teaching lies in bilingual textbooks that are crucial to ensure the teaching quality. Original English textbooks introduced have their own advantages, but they do not correspond with the domestic teaching program and curriculum system. Therefore, combining the achievements and experiences acquired in the construction of "quality engineering", we have compiled, both in English and Chinese, this bilingual textbook, which is the first book on "Fundamentals of Manufacturing Technology" in China, to provide a better teaching resource for bilingual teaching and to improve bilingual teaching quality.

As a basic specialty course, its primary contents have inherited the essence of the traditional course. Some contents of such courses as "Metal Cutting Principle and Cutting Tools", "Machine Tools", "Machine Manufacturing Technology" and "Fixture Design", etc. have been synthesized, optimized and integrated, with an eye to the requirements of the 21st century for personnel training, together with the teaching achievements and experiences accumulated for many years by the authors, into this textbook, which reflects our compiling ideas to "emphasize the foundation, to refine the contents and to strengthen the practice". The rudimentary knowledge, principal theories and basic approaches of manufacturing technology are taken as the plot line of the book and both traditional and advanced manufacturing technologies and equipment are introduced. Thus the fundamental hierarchy of manufacturing technology is constructed in this textbook that possesses the following features:

- 1) Integral knowledge hierarchy. The book forms a complete fundamental hierarchy of manufacturing technology, covering the basic theory and knowledge of metal cutting principle and cutting tools, machine tools, equipment and machining quality control and so on.

- 2) New compiling system and wide application. Written in both English and Chinese, the book is fit for the students in bilingual classes as well as those in ordinary ones. Its main purpose is to help students understand better the knowledge hierarchy and contents, learn the technical terms and knowledge in machine manufacturing field, and lay the foundation for international communication in this field.

3) Proper arrangement and prominent key points. Based on the sufficiency-scale principle and in accordance with the mechanical engineering student training program, the contents to be mastered are discussed in detail, and the descriptive contents are simplified to thin the bilingual book.

4) Consistency, accuracy and better readability. The biggest challenge to domestic authors of bilingual books is not the word-for-word translation but the accuracy of English wording and the consistency of English sense with Chinese meaning. Therefore, professional vocabularies, descriptive manners, frequently-used grammars and simple and easy sentence patterns of the same kind of foreign textbooks are used to the greatest extent in this book so as to make it more readable.

5) Combination of theory with practice and concentration on practicality. While the metal-cutting theories, mechanical structures of the typical equipment and the manufacturing methods are introduced, how to apply the fundamental knowledge into production rationally and to build up the ability to analyze and solve practical problems are paid attention to in this book.

6) Complete supporting materials. The book is equipped with such supporting materials as the electronic teaching plan and courseware (for teachers only), the bilingual workbook (for students) and the keys to most exercises (for teachers' reference). The electronic courseware is open for the teachers to add, delete or recompose its contents according to their own will to satisfy various kinds of individualized teaching requirements.

The book has been compiled jointly by Prof. Ren Xiaozhong of Henan University of Science & Technology, Prof. Ren Naifei of Jiangsu University and Prof. Wang Hongjun of Beijing Information Science & Technology University. Besides, Xu Huili and Zhang Zhiwen (Henan University of Science & Technology), Chang Yunpeng (Luoyang Institute of Science and Technology) have also taken part in the compilation work. The specific division of the writing tasks is as follows:

Chinese manuscript: Ren Xiaozhong (Introduction, Chapter 4 and Chapter 7); Ren Naifei (Section 2. 1 to 2. 4 of Chapter 2); Wang Hongjun (Section 1. 1 to 1. 3 of Chapter 1, Section 3. 4 to 3. 6 of Chapter 3); Xu Huili (Section 1. 4 of Chapter 1, Section 2. 5 of Chapter 2, Section 3. 1 to 3. 3, 3. 7 of Chapter 3, Chapter 5 and Chapter 6).

English manuscript: Ren Xiaozhong (Introduction, Chapter 4); Ren Naifei (Section 2. 1 to 2. 4 of Chapter 2); Wang Hongjun (Section 1. 1 to 1. 3 of Chapter 1, Section 3. 4 to 3. 6 of Chapter 3); Zhang Zhiwen (Section 1. 4 of Chapter 1, Section 2. 5 of Chapter 2, Section 3. 1 to 3. 3, 3. 7 of Chapter 3, Chapter 5 and Chapter 6); Chang Yunpeng (Chapter 7).

Ren Xiaozhong is also in charge of the overall editing and compiling work of the entire book.

The Chinese manuscript of the book has been thoroughly reviewed and revised by Prof. Wang Guicheng of Jiangsu University and that of the English by Prof. Zhong Qinglun of Henan University of Science & Technology. They have offered valuable advice and suggestions and made some corrections. Here we extend our heartfelt thanks for their significant contributions.

Some textbooks published at home and abroad were used as reference during the compilation, for which we express most cordially thanks to the authors. At the same time, we also announce our sincerely acknowledgement to all those who have provided their help and kindness for the publication of the book.

The book has proudly acquired special financial support from the Textbook Publishing Fund of Henan University of Science & Technology. We gratefully announce our sincerely acknowledgement.

Due to various limitations, there may be some improper contents or even mistakes in the first edition. Criticisms and corrections from all experts and readers are respectfully welcome and invited so that the flaws and errors can be corrected in future editions of this book.

### Ren Xiaozhong

本書的出版得到河南省科技書刊出版專項資助。我們衷心感謝河南省科技書刊出版專項資助。本書的出版得到河南省科技書刊出版專項資助。我們衷心感謝河南省科技書刊出版專項資助。

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# 前 言

随着经济全球化和国际交流活动的日益频繁, 社会对人才外语水平和国际竞争能力的要求越来越高。双语教学是我国高等教育与国际教育接轨的一项重要举措。双语教学可以在传授学科知识的同时, 提高学生的外语水平, 开拓学生的国际视野, 是培养高素质国际性人才的有效途径。

双语教材是开展双语教学的基础, 合适的双语教材是保证双语教学质量的关键。尽管引进的原版教材有其优势, 但它们与国内教学大纲和教学体系不相适应。为此, 我们结合近年来在“质量工程”建设方面取得的成果与经验编写了这本英汉双语教材。这是我国第一部以中、英文形式编著的“机械制造技术基础”双语教材, 旨在为双语教学提供优质的教学资源, 提高双语教学质量。

本书针对专业基础课程的特点, 以“重基础、精内容、强实践”作为编写指导思想, 继承传统内容的精华, 融入作者多年积累的教学成果和经验, 着眼于 21 世纪对人才培养的要求, 对原金属切削原理与刀具、金属切削机床、机械制造工艺学与夹具设计等课程的主要内容进行了综合与优化。全书以机械制造技术的基础知识、基本理论和基本方法为主线, 在传承传统工艺与制造装备技术的同时, 也介绍了一些先进制造技术, 较系统地构建了机械制造技术的基础体系。本书具有以下特色:

1) 知识体系完整。本书涵盖了金属切削原理、机床与工艺装备、机械制造工艺以及加工质量控制等各方面的基本理论和知识, 形成了完整的机械制造技术基础体系。

2) 编写体系新颖, 适用范围广。教材用英汉双语编写, 不仅适合于双语班的学生, 也适合于非双语班的学生。其主要目的是通过英文内容的学习, 使学生更好地理解英文教材的体系和内容, 学习机械制造领域的专业术语和知识, 为在本专业领域内进行国际交流奠定基础。

3) 重点突出, 编排得当。为了不增加篇幅, 依据机械类专业人才培养大纲, 本着“够用为度”的原则, 对要求掌握的内容进行详述, 对叙述性的内容进行简化。

4) 中英文内容的一致性、准确性和可读性强。这是对作者的最大挑战。并非一味追求严格地按中文内容翻译, 而是注重中英文基本内容的一致性和英文词义的准确性。尽量采用国外同类教材中的专业词汇和描述方式, 尽量采用常用的语法和简单易懂的句子, 使内容易读、易懂。

5) 理论联系实际, 注重实用。在介绍金属切削理论、典型装备的机械结构以及机械制造方法的同时, 注重讲述在实际生产中如何合理运用这些基本知识, 强调培养分析和解决实际问题的能力。

6) 配套齐全。本教材配有电子教案和电子课件(教师版), 还有对应的双语习题集(学生版)和主要习题解答(教师版)。其中电子课件为开放式课件, 任课教师可根据各自

情况自行增、删或改编，以满足个性化的教学要求。

本书由河南科技大学任小中教授、江苏大学任乃飞教授和北京信息科技大学王红军教授共同编著。参加本书编写的还有许惠丽、张志文（河南科技大学）、常云朋（洛阳理工学院）。具体编写分工如下：

中文部分：任小中（绪论，第4章，第7章）；任乃飞（第2章的2.1~2.4节）；王红军（第1章的1.1~1.3节，第3章的3.4~3.6节）；许惠丽（第1章的1.4节，第2章的2.5节，第3章的3.1~3.3，3.7节，第5章，第6章）。

英文部分：任小中（绪论，第4章）；任乃飞（第2章的2.1~2.4节）；王红军（第1章的1.1~1.3节，第3章的3.4~3.6节）；张志文（第1章的1.4节，第2章的2.5节，第3章的3.1~3.3，3.7节，第5章，第6章）；常云朋（第7章）。

全书由任小中负责统稿。本书由江苏大学王贵成教授和河南科技大学钟庆伦教授分别担任中文部分和英文部分的主审，两位主审分别对教材进行了仔细的审阅，提出了很多宝贵的建议和意见，并对其中一些内容分别进行了订正，在此表示由衷的感谢！

本书参考了国内外出版的一些教材，谨此向有关作者表示诚挚的谢意！并向所有关心和帮助本书出版的人表示感谢！

本书得到了河南科技大学教材出版基金的资助，在此表示衷心的感谢！

由于编者所及资料和水平有限，书中难免有错漏和不当之处，敬请各位专家和广大读者批评指正。

编 者



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# Introduction

## 绪论

## 0.1 Manufacturing industry and its position in national economy

### 1. The concept of manufacturing industry

The wealth of a nation depends on its ability to retrieve natural resources and to manufacture goods. There are rich nations and poor nations, and rich people and poor people. However, the bottom line for creating national wealth is still to rely on the ability to manufacture.

The word “manufacture” originated from two Latin roots “manu”, meaning by hand, and “facere”, meaning to make. This means that for hundreds of years, manufacturing was done manually. With the development of society and the progress of manufacturing technology, the connotation of manufacturing shows a significant historical trend. Since the Industrial Revolution, machinery has played an increasingly important role. If you look up the dictionary you may find that the definition of manufacturing is “making of articles by physical labor or machinery, especially on a large scale”. With machine tools, humans can produce goods faster and better.

In short, manufacturing means the whole procedure by which people, according to their purpose and applying their knowledge and skills, make original materials into valuable products, and put them into market by means of manual or available objective tools and facilities.

Manufacturing industry is the social production department whose task is to provide production materials for national economic departments and daily consumer goods for whole society. As we know, there are different kinds of machines, tools and instruments in different factories, and the machines, or tools, or instruments are composed of many workparts with different shapes and sizes. The industry to produce various workparts and assemble them into tools, instruments and machines is called machine manufacturing industry.

### 2. Importance of manufacturing industry

With a general survey of the world, all economically powerful countries have their own developed manufacturing industry which has performed meritorious deeds for their economic boom. The importance of manufacturing industry can be listed below:

1) Manufacturing industry is the mainstay industry of national economy and the engine of economic growth. In the developed countries, the manufacturing industry has created about 60% social wealth and 45% national economy income. In the United States, about 68% wealth comes from the manufacturing industry. In Japan, 49% GNP comes from the manufacturing industry. In China, the production value of the manufacturing industry takes up about 45% of the total industrial output value.

2) Manufacturing industry is the basic carrier to realize the industrialization of high technologies. Take America for instance. Companies in manufacturing industry have covered all researches and developments in America industries, and provided most of technical innovations used in manufacturing industry. The most of technological advancements to promote the long-term economical growth of America have come from the manufacturing industry. It is found by surveying industrialization history that numerous science and technology achievements are conceived in the development of manufacturing industry. At the same time, the manufacturing industry also provides scientific and technological means. A large number of high technologies arisen in the 20th century, such as nuclear technology, space technology, information technology, biomedical technology etc. were all produced and converted into productive forces of scale. Its direct effectiveness was that many high-tech

## 0.1 制造业及其在国民经济中的地位

### 1. 制造业的概念

一个国家的财富取决于其拥有自然资源和制造商品的能力。世界上有穷国和富国、穷人和富人，但创造国民财富的根本仍然依赖于制造能力。

制造一词来源于拉丁语词根 manu（手）和 facere（做）。这说明几百年来，制造一直是靠手工完成的。随着社会的发展和制造技术的进步，制造也在顺应历史潮流有着更深层次的内涵。自第一次工业革命以来，机器发挥着越来越重要的作用。不妨查查字典，你会发现制造的定义是“利用人力或机器大规模制作物品”。人类使用机床可以把商品做得既快又好。

总之，制造是指人们根据自己的意图，运用掌握的知识和技能，利用手工或一切可以利用的工具和设备把原材料制成有价值的产品，并把这些产品投放市场的整个过程的总称。

制造业是为国民经济各部门提供生产原料和为全社会提供日常消费品的社会生产部门。制造业涉及国民经济各个行业。人们知道，在不同的工厂使用着各种各样的机器、工具和仪器，而这些机器、工具和仪器是由许多具有不同尺寸和形状的零件组成的。生产各种各样的零件并把它们装配成工具、仪器和机器的行业成为机械制造业。

### 2. 制造业的重要性

纵观世界各国，任何一个经济强大的国家，无不具有发达的制造业。许多国家的经济腾飞，制造业功不可没。制造业的重要性具体表现在以下几个方面：

1) 制造业是国民经济的支柱产业和经济增长的发动机。在发达国家中，制造业创造了约 60% 的社会财富、约 45% 的国民经济收入。其中美国 68% 的财富来源于制造业，日本 49% 的国民生产总值来源于制造业。我国制造业产值占工业总产值的比例为 45%。

2) 制造业是高技术产业化的基本载体。以美国为例，制造业企业几乎囊括了美国产业的全部研究和开发，提供了制造业内外所用的大部分技术创新，使得美国长期经济增长的大部分技术进步都来源于制造业。纵观工业化历史，众多的科技成果都孕育于制造业的发展之中。制造业也是科技手段的提供者，科学技术与制造业相伴成长。如 20 世纪兴起的核技术、空间技术、信息技术、生物医学技术等高新技术无一不是通过制造业的发展而产生并转化为规模生产力的。其直接结果是导致如集成电路、计算机、移动通信设备、国际互联网、机器人、核电站、航天飞机等产品相继问世，并由此形成了制造业中的高新技术产业。

3) 制造业是吸纳劳动就业的重要途径。在工业国家中，约有 1/4 的人口从事各种形式的制造活动。在我国，制造业吸引了一半的城市就业人口，农村剩余劳动力的转移也有近一半流入了制造业。

products, such as IC, computer, mobile communications equipment, Internet, robot, nuclear power station and space shuttle, etc. came out one after another, thereby, generating the high technology industries in manufacturing industry.

3) Manufacturing industry is the key industry to recruit labor employment. In industrialized countries, the people worked at manufacturing activities in various forms take up 1/4 of employers in whole country. In China, one half of employed population of a city works at the manufacturing industry and about half of surplus labors in countryside transfers into manufacturing industry.

4) Manufacturing industry is the main force in international trade. In recent years, the growth rate of international trade is nearly two times more than that of the world economy. As the primary products have lower technology content, and its competitiveness in international market is getting weaker and weaker, countries of the world are enlarging the export of finished goods by all means to increase its competitiveness and added value in international market. The exports of finished goods in America, Britain, France, Germany, Japan, Korea and Singapore have taken up above 90% of all exports. China's exports in the manufacturing industry have kept over 80% and created about 3/4 foreign exchange earnings since 1990s.

5) Manufacturing industry is an important assurance of national security. Modern wars have come into the time of high-tech warfare. The competition in armaments is just the competition in manufacturing technology to a large extent. Without the excellent equipments and powerful equipment manufacturing industry, any country would have no safety not only in military and political affairs, but in economical and cultural activities.

Machine manufacturing industry is the important component of manufacturing industry. It takes on the dual tasks of providing consumer goods for users and various technical equipments for national economic departments. Machine manufacturing industry is the important foundation of national industry system and the important part of national economy. The production level and economic benefit of national economic departments depend largely on the technical performance, quality and reliability of the equipments supplied by machine manufacturing industry.

## 0.2 Development of machine manufacturing technology

### 1. History of machine manufacturing technology

The earliest human's manufacturing activities could go back to the Stone Age. At that time, people made use of natural stones to make laboring tools which were used to hunt up natural resources for existence and survival. With the advent of the Bronze Age, and later the Iron Age, some primal manufacturing activities, such as spinning, smelting, forging, etc., began to come forth in order to meet the needs of natural economy based on agriculture.

The word "lathe", for instance, has a romantic root. It derives from the word "lath". It is said that the earliest lathe was named as "tree lathe". The lathe was operated by two people: one turning the bar being machined by means of a flexible tree branch (the lath) and a rope, the other holding a piece of shell or gallet as a cutting tool and moving along the bar. This was a relative crude turning process from a current view of achievable machining accuracy. Existence of some form of crude machine tools can be traced to as early as 700 B. C. In 1668, the horse-powered milling machine and pedal grinding machine were presented in China. In 1775, a British man named John Wilkinson in-



4) 制造业是国际贸易的主力军。近年来, 国际贸易的增长速度比世界经济的增长速度高约两倍。由于初级产品的技术含量低, 在国际市场的竞争力越来越弱, 各国都千方百计扩大制成品的出口, 以提高国际竞争力和附加价值。美、英、法、德、日等国家的制成品出口占全部出口比例的 90% 以上。20 世纪 90 年代以后, 我国制造业的出口一直维持在 80% 以上, 创造了接近 3/4 的外汇收入。

5) 制造业是国家安全的重要保障。现代战争已进入“高技术战争”的时代, 武器装备的较量在很大意义上就是制造技术水平的较量。没有精良的装备, 没有强大的装备制造业, 一个国家不仅不会有军事和政治上的安全, 而且经济和文化上的安全也会受到威胁。

机械制造业是制造业的重要组成部分。它肩负着直接为用户提供消费品和为国民经济各部门提供各种技术装备的双重任务。机械制造业是国家工业体系的重要基础和国民经济的重要组成部分。国民经济各部门的生产水平和经济效益, 在很大程度上取决于机械制造业所提供装备的技术性能、质量和可靠性。

## 0.2 机械制造技术的发展

### 1. 机械制造技术的历史

人类最早的制造活动可以追溯到石器时代。当时, 人类利用天然石料制作劳动工具, 用其猎取自然资源为生。随着青铜器以及后来的铁器时代的到来, 为了满足以农业为主的自然经济的需要, 出现了如纺织、冶炼、锻造等较为原始的制造活动。

例如, 车床这个词具有一个传奇的来源。它是由“lath”这个词派生出来的。据说最早的车床称为“树车床”。该车床由两个人操作, 一人利用一根柔韧的树枝和一根绳子转动被加工的棒料, 另一个人则手持一个坚硬的贝壳或碎石片作为刀具沿着棒料移动。从当前能达到的加工精度角度来看, 这是一种相当简易和粗糙的车削方法。早在公元前 700 年就出现了一些简易机床。1668 年, 我国就出现了马拉铣床和脚踏磨床。1775 年, 一位名叫 John Wilkinson 的人发明了一台镗床。该项发明为瓦特蒸汽机的制造扫清了障碍。后来就出现了由 Henry Maudsley 研制的第一台丝杠车床。1817 年, 一位名叫 Roberts 的人发明了龙门刨床。接着, John Nasmyth 大约在 1840 年研制了钻床。1845 年, Stephen Fitch 设计了世界上第一台转塔车床。全自动的转塔车床是由 Christopher Spencer 在 1869 年发明的, 这是首款利用凸轮控制刀具进给的自动车床, 因而可使大部分加工任务自动完成。Christopher Spencer 也因研制了多轴车床而享誉世界。第一台磨床是由美国人于 1864 年开发出来的。于是, 几乎所有通用机床均已研制成功。

由 Eli Whitney 发明的零件互换性为制造做出了卓越的贡献。运用互换性零件的制造理