

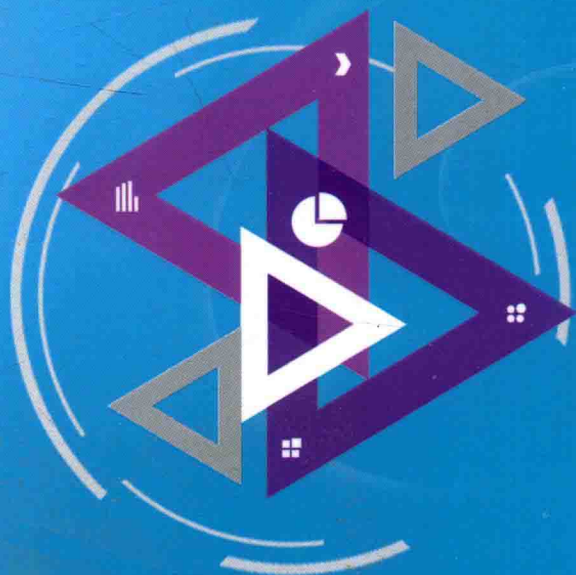
普通高等教育“十三五”规划教材

# Machine Manufacturing Technology

英汉双语对照

## 机械制造工艺学

任小中 周近民 ◎ 等编著



机械工业出版社  
CHINA MACHINE PRESS

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# 机械制造工艺学

(英汉双语对照)

任小中 周近民 等编著

任乃飞 钟庆伦 主审

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,根据机械设计制造及其自动化专业“卓越工程师”培养方案和机械制造工艺学教学大纲,结合作者近年来在“双语教学示范课程”建设方面的实践与成果编著的英汉双语教材。这是我国第一本“机械制造工艺学”方面的英汉双语对照教材。

本书依据“重基础、精内容、强实践”的原则编写,在吸取国内外同类教材优点的基础上,以产品制造工艺为主线,重视基本概念、基本理论和基本方法,通过与相关实践教学环节配合,理论联系实际,可以达到培养学生科技创新和工程实践的能力的目的。

全书共有7章。主要内容包括机械制造工艺的基础知识、机械加工工艺规程的制订、典型零件加工、机床夹具设计原理、机械加工质量分析与控制、机械装配工艺基础,以及先进制造工艺。

本书内容综合性强、详略适当、重点突出,编写手法新颖,可作为高等院校机械工程类专业和近机械类专业本、专科学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,也可供机械制造工程技术人员参考。

## 图书在版编目(CIP)数据

机械制造工艺学 = Machine Manufacturing Technology: 英汉双语对照/任小中,周近民等编著. —北京:机械工业出版社,2016.1

普通高等教育“十三五”规划教材

ISBN 978-7-111-51416-9

I. ①机… II. ①任… ②周… III. ①机械制造工艺-高等学校-教材-英、汉 IV. ①TH16

中国版本图书馆CIP数据核字(2015)第203758号

机械工业出版社(北京市百万庄大街22号 邮政编码100037)

策划编辑:刘小慧 责任编辑:刘小慧 李超

责任校对:刘怡丹 封面设计:张静 责任印制:乔宇

保定市中国画美凯印刷有限公司印刷

2016年2月第1版第1次印刷

184mm×260mm·23.25印张·576千字

标准书号:ISBN 978-7-111-51416-9

定价:48.00元

凡购本书,如有缺页、倒页、脱页,由本社发行部调换

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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 knowledge, and which is an effective way to cultivate the 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 from abroad have their own advantages, but they do not fit with the domestic teaching program and the curriculum system. Therefore, based on the "Excellent Engineer Training Program" of the Mechanical Design Manufacturing and Automation, and the syllabus of "Machine Manufacturing Technology", combining the achievements and experiences acquired in the construction of "bilingual teaching demonstration course", we have compiled this bilingual textbook with Chinese characteristics so as to provide a better teaching resource for bilingual teaching and to improve the bilingual teaching quality. This is the first textbook written both in English and Chinese on "Machine Manufacturing Technology" in China.

As a professional book, its primary contents have inherited the essence of the traditional contents. Taking "emphasizing the foundation, refining the contents and strengthening the practice" as our compiling ideas, with an eye to the requirements of the 21st century for personnel training, the basic knowledge, principal theories and basic approaches of the manufacturing technology are taken as the main line of the book, and both traditional and advanced manufacturing technologies are introduced. And thus the curriculum hierarchy of the machine manufacturing technology is constructed in this textbook. The characteristics of this book are as follows:

1) Integral knowledge hierarchy. The book not only covers the basic theory and knowledge of the manufacturing technology and machining quality control, but integrates the design of the machine tool fixture into the manufacturing technology.

2) New compiling system and wide application. Written in both English and Chinese, the book is fit not only for the teaching in English, but also for the teaching in bilingual classes as well as in ordinary classes. Through reading this book, the students can not only learn the professional terms and knowledge in the machine manufacturing field, but improve the professional English level and lay the foundation for international communication in this field.

3) Prominent key points and appropriate arrangement. Based on the sufficiency-scale principle and the training program for the mechanical engineering talents, the contents to be mastered are dis-

cussed in detail, and the descriptive contents are simplified.

4) Consistency and accuracy in both Chinese and English. In compiling this book, we especially pay attention to the accuracy of English wording and the consistency of English sense with Chinese meaning instead of the word-for-word translation. 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 the theory with practice and concentration on practicality. While introducing the manufacturing technological theories, many cases come from the production practice are brought into this book. The analysis on the machining processes of several typical workparts is helpful for students to build up the ability to analyze and solve practical problems.

6) Complete supporting materials. The book is equipped with the courseware (for teachers only). A exercise book corresponding to this book will soon be published. 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 by Ren Xiaozhong, Zhou Jinmin, Su Janxin and Yang Jianjun of Henan University of Science and Technology, Yu Daguo of North University of China, Li Jun of Luoyang Institute of Science and Technology, Li Fei of Anyang Institute of Technology, and Ma Haiying of Huanghe Jiaotong University. The specific division of the writing task is as follows:

Chinese manuscript: Ren Xiaozhong (Preface, Introduction, Section 4.2 to 4.5 of Chapter 4, Chapter 6); Zhou Jinmin (Chapter 2, Section 3.3 of Chapter 3, Section 4.1 of Chapter 4, Chapter 5); Su Janxin (Chapter 7); Yang Jianjun (Section 3.4 of Chapter 3); Yu Daguo (Section 3.1 of Chapter 3); Ma Haiying (Chapter 1, Section 3.2 of Chapter 3).

English manuscript: Ren Xiaozhong (Preface, Introduction, Section 2.5 to 2.6 of Chapter 2); Zhou Jinmin (Section 3.3 of Chapter 3); Su Janxin (Section 4.2 to 4.3 of Chapter 4); Yang Jianjun (Chapter 1, Section 3.4 of Chapter 3); Yu Daguo (Section 2.1 to 2.4 of Chapter 2, Section 3.1 of Chapter 3); Li Jun (Section 4.1 of Chapter 4, Chapter 5); Li Fei (Section 4.4 to 4.5 of Chapter 4, Chapter 7); Ma Haiying (Section 3.2 of Chapter 3, Chapter 6).

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

The Chinese and English manuscripts of the book have been thoroughly reviewed and revised respectively by Prof. Ren Naifei of Jiangsu University and by Prof. Zhong Qinglun of Henan University of Science and 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 domestic and abroad were used as the references during the compilation, for which we express most cordial 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 this book.

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



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

**Ren Xiaozhong in Luoyang**

# 前 言

随着经济全球化和国际交流活动的日益频繁,社会对人才的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,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,根据机械设计制造及其自动化专业“卓越工程师培养方案”和机械制造工艺学教学大纲,结合作者近年来在“双语教学示范课程”建设方面的实践与成果,编写了这本具有中国特色的双语教材,旨在为双语教学提供优质的教学资源,提高双语教学质量。这是我国第一本以中、英文形式编著的“机械制造工艺学”方面的教材。

针对专业课程的特点,本书继承了传统内容的精华;着眼于21世纪对人才培养的要求,本书以“重基础、精内容、强实践”作为编写指导思想,以机械制造工艺的基础知识、基本理论和基本方法为主线;在传承传统制造工艺的同时,本书还介绍了一些先进制造工艺方法,系统地构建了机械制造工艺的课程体系。本书具有以下特色:

1) 知识体系完整。本书不仅涵盖了机械制造工艺以及加工质量控制等方面的基本理论和知识,还把机床夹具设计的内容融入机械制造工艺中,实现两者的有机结合。

2) 编写体系新颖,适用范围广。教材用英汉双语编写,不仅适合于本课程的全英文教学,也适合于双语班和普通班的教学。通过阅读本书,学生不仅可以学到机械制造领域的专业术语和知识,还可以提高专业英语水平,为在本专业领域进行国际交流奠定基础。

3) 重点突出,详略适当。依据机械工程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) 保持中英文内容的一致性和准确性。在编写双语教材时,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。在介绍机械制造工艺理论的同时,引入了很多来自生产实际的案例、典型零件的加工工艺分析,旨在培养学生分析和解决实际问题的能力。

6) 配套齐全。本书配有专供教师用的电子课件,还将出版与本书对应的习题集。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、周近民、苏建新、杨建军,(中北大学)于大国、(洛阳理工学院)李军、(安阳工学院)李菲、(黄河交通学院)马海英编著。具体编写分工如下:

中文部分:任小中(前言、绪论、第4章的4.2~4.5节、第6章);周近民(第2章、

第3章的3.3节、第4章的4.1节、第5章); 苏建新(第7章); 杨建军(第3章的3.4节); 于大国(第3章的3.1节); 马海英(第1章、第3章的3.2节)。

英文部分: 任小中(前言、绪论、第2章的2.5~2.6节); 周近民(第3章的3.3节); 苏建新(第4章的4.2~4.3节); 杨建军(第1章、第3章的3.4节); 于大国(第2章的2.1~2.4节、第3章的3.1节); 李军(第4章的4.1节、第5章); 李菲(第4章的4.4~4.5节、第7章); 马海英(第3章的3.2节、第6章)。

全书由任小中负责统稿。

本书由江苏大学任乃飞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士表示感谢!

本书的出版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。

任小中  
于洛阳



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# Introduction

## 绪 论

## 0.1 Machine manufacturing industry and its position in national economy

### 1. The definition of manufacturing industry

The wealth of a nation depends on its ability to retrieve natural resources and to manufacture goods. 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.”

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 our 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. The 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. For instance, American 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



## 0.1 机械制造业及其在国民经济中的地位

### 1. 机械制造业的定义

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。不妨查阅字典，你会发现制造的定义是“利用人力或机器大规模制作物品”。

总之，制造是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，并把这些产品投放到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。我们知道，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、仪器和机器的行业称为机械制造业。

### 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，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。其直接结果是导致诸如集成电路、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，农村剩余劳动力也有近一半流入了制造业。

4) 制造业是国际贸易的主力军。近年来，国际贸易增长速度高于世界经济增长近两



and converted into productive forces of scale. Its direct effectiveness was that many high-tech products, such as IC, computer, mobile communications equipment, Internet, robot, nuclear power station and space shuttle, etc. come 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 the entire 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 American, Britain, France, Germany, Japan, etc. 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 to provide 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 economical benefit of national economic departments depend largely on the technical performance, quality and reliability of the equipments supplied by machine manufacturing industry.

## 0.2 The development of machine manufacturing technology

### 1. History of machine manufacturing technology

Manufacturing technology is a generic term of all production technologies which are used in manufacturing industries to produce various necessities for national economic construction and people's life. It refers to a group of technologies which are used to change raw materials and other production elements economically and rationally into finished/semi-finished products which can be directly used with higher added value. These technologies include how to make use of certain knowledge and skills, how to control available materials and tools and how to adopt all kinds of effective strategies and methods. The development of manufacturing industry is affected by many factors, of which the most important ones are the drive of technology and the traction of market.

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 re-

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重的90%以上。20世纪90年代以后，我国制造业的出口一直保持在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。没有精良的装备与强大的装备制造业，一个国家不仅不会有军事和政治上的安全，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 机械制造工艺的发展

### 1. 机械制造工艺的历史

制造技术是制造业为国民经济建设和人民生活生产各类必需物资所使用的一切生产技术的总称，是将原材料和其他生产要素经济合理地转化为可直接使用的、具有较高附加值的成品/半成品和技术服务的技术群。这些技术包括运用一定的知识和技能，操纵可以利用的物质、工具，采取各种有效的策略、方法等。制造技术的发展取决于多方面因素，但最主要的因素是技术的推动和市场的牵引。

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，用其猎取自自然资源为生。随着青铜器以及后来铁器时代的到来，为了满足以农业为主的自然经济的需要，出现了诸如纺织、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，我国出现了马拉铣床和脚踏磨床。1775年，约翰·威尔金森（John Wilkinson）发明了一台镗床。该项发明为瓦特蒸汽机的制造铺平了道路。后来出现了由亨利·莫斯里（Henry Maudsley）研制的第一台丝杠车床。1817年，罗伯特（Roberts）发明了龙门刨床。接着，乔治·内史密斯（John Nasmyth）大约在1840年研制出了钻床。1845年，斯蒂芬·菲什（Stephen Fitch）设计出世界上第一台转塔车床。全自