



普通高等教育“十一五”国家级规划教材

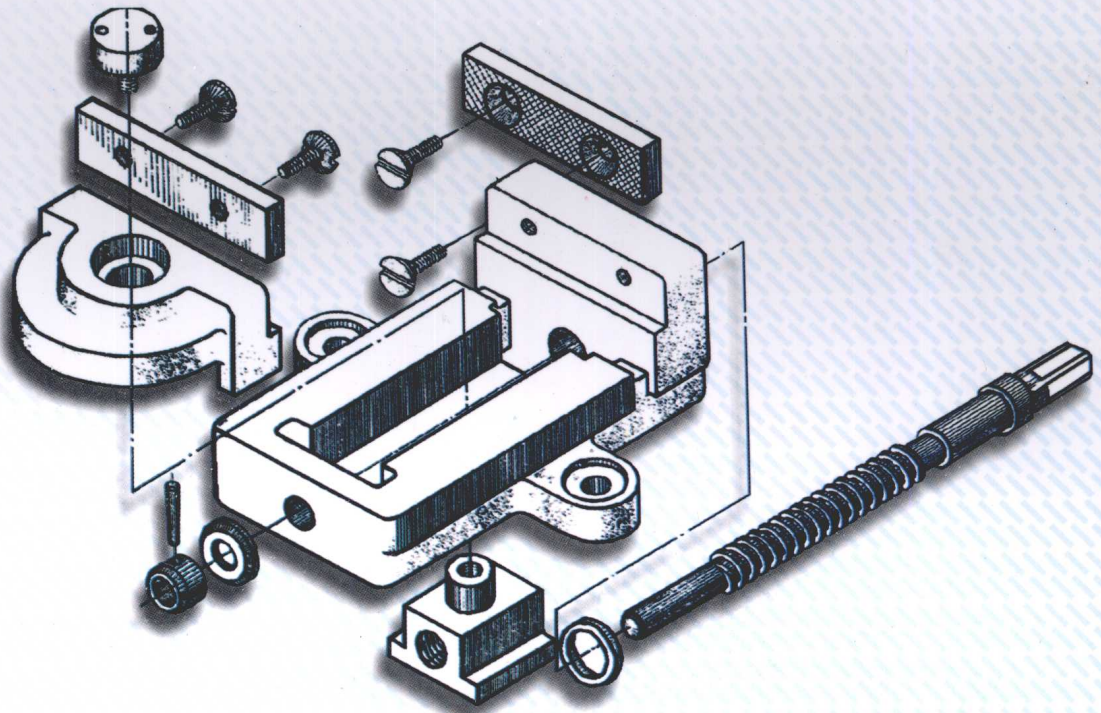
# 工程制图

## (英汉双语对照)

ENGINEERING DRAWING

第 2 版

胡 琳 主 编  
程 蓉 付 芩 孙 炜 副主编  
陈锦昌 马维银 主 审



机械工业出版社  
CHINA MACHINE PRESS

One of China's National "Eleventh Five-Year-Plan" Textbooks for Regular Higher Education  
普通高等教育“十一五”国家级规划教材

# ENGINEERING DRAWING

(English-Chinese Bilingual Edition)

Second Edition

## 工 程 制 图

(英汉双语对照)

第 2 版

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机械工业出版社

This book is one of China's National "Eleventh Five-Year-Plan" Textbooks for Regular Higher Education. It is the first bilingual textbook, in English and Chinese, on Engineering Drawing in China, providing a favorable condition for bilingual education of engineering drawing.

The book has eleven chapters, systematically covering such principles and skills of engineering drawing as basic knowledge of drawing, basic orthographic projection, solids and their intersections, composite solids, axonometric projection, general principles of representation, representation for commonly used parts, detail drawings, assembly drawings, drawings in applications other than mechanical engineering, computer graphics etc.

The supporting materials of the textbook include a CAI electronic teaching plan (for teachers), a bilingual exercise book, a CAI exercise CD (for students) and its answers (for teachers), all published or offered by China Machine Press.

This book can be used as a textbook on Engineering Drawing for students majoring in mechanical engineering or subjects closely related to that (72 to 108 class hours), university or college students of different specialties such as science, engineering, economy and management (36 to 64 class hours), and students of engineering-related subjects in vocational schools, advanced technical schools, broadcast colleges, vocational colleges, correspondence colleges and part-time colleges. It is also a very good reference book for engineering designers, mechanical and manufacturing engineers.

本书是普通高等教育“十一五”国家级规划教材。全书采用中英双语对照的编排形式,填补了国内“工程制图双语教材”的空白,为双语教学创造了良好的条件。

全书共分11章,系统地介绍了制图基本知识、正投影基础、立体及其交线、组合体、轴测图、图样画法、常用机件的表达、零件图、装配图、其他工程图、计算机绘图等内容。

本书配套齐全,不仅有与双语教材配套的CAI电子教案(教师版),还有对应的双语习题集、练习光盘(学生版)和习题解答(教师版),均由机械工业出版社同时出版或提供。

本书可作为高等院校理、工、经、管各专业学生“工程制图”课程(36~64学时)的教材,也可用于为近机械类专业学生开设的“工程制图”课程(72~108学时),还可作为高职、高专、电大、职大、函授大学、夜大等继续教育相近专业的教材,亦可作为从事工程设计与制造的有关技术人员和企业管理人员的自学参考书。

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## Foreword

The higher education in China is now upgrading into a new revolution phase, in which the bilingual education is emphasized in aspects of teaching foundation courses, professional foundation courses and professional courses in order to improve the internationalization of the higher education and the cultivation of advanced innovative specialists. Therefore, the bilingual education is a key of the higher education to parallel with the world, a challenge of new era, a major trend in the revolution of higher education. It is a strategic choice which must be made by china's higher education in 21st century. This book has contributed a solid foundation for bilingual education and met the requirements of current internationalizing phase in the revolution of the higher education.

According to the *Basic Requirements in Teaching Descriptive Geometry and Engineering Drawing Course* developed by the Engineering Drawing Advisory Committee for Higher Engineering Education, and based on the features of the reform of teaching Engineering Drawing courses in recent years, the book is well compiled and organized, focusing on training twenty-first era's senior engineering application-oriented personnel. This book concentrates on modern manufacturing technologies, and as a guideline, emphasizes comprehensible learning style and aims at the enhancement of practical abilities. The book endeavors to establish effective, refined, and comprehensive qualities. This book can be used as a textbook on Engineering Drawing for students majoring in mechanical engineering or subjects closely related to that (72 to 108 class hours), university or college students of different specialties such as science, engineering, economy and management (36 to 64 class hours), and students of engineering-related subjects in vocational schools, advanced technical schools, broadcast colleges, vocational colleges, correspondence colleges and part-time colleges. It is also a very good reference book for engineering designers, mechanical and manufacturing engineers.

The book is written based on the characteristics of Engineering Drawing as a foundation course, inheriting the essence of traditional teaching contents, integrating extensive experiences of many years teaching from the authors, and focusing on the education requirements of the new era in order to improve the comprehensive and creative abilities of students. Meanwhile, it strives to use the limited teaching resources to motivate students' learning interests without adding extra loads to students as well as lecturers. Therefore, the book contributes to the evolution of education in Engineering Graphics, which is being reformed from a "knowledge-skill focused" education style to a more comprehensive "knowledge-skill-methodology-capability-ability focused" education style. This book owns the following features:

1. Each page of the bilingual contents is represented in a double-column format, with English in one column while Chinese of the same contents in the other.

2. Practicability is implemented in terms of applicability and advancement. It simplified the contents on descriptive geometry, but emphasizes on topics relevant to practical engineering applications, such as the basic projection theory, representation of shapes and bodies, and the ability in reading engineering drawings. Plenty of typical examples and corresponding analysis and solutions are given for the purpose of training students in aspects of methodologies, capabilities, and the skill of problem solving.

3. The Training of freehand drawing skills is emphasized. Plenty of well-designed exercises are provided to ensure sufficient training in terms of freehand drawing and basic drawing skills, and moreover, to make sense of the relations among freehand drawing, instrumental drawing and computer-aided drawing.

4. To enhance students' ability of reading the national standards, and train them to be conditioned to work with up-to-date national standards, this book adopts the newly published national standards, the *Technical Drawing* and the *Mechanical Drawing*, which can be referred in the text and the appendices.

5. The contents of AutoCAD are added in Chapter 11, so that students can learn conveniently by themselves.

6. The supporting CAI multimedia electronic teaching plan edited by Lin Hu and Rong Cheng is published simultaneously, which covers the complete content of the book. The multimedia teaching plan takes advantage of several CAI softwares and adopts animation technology for shape illustrations, which is vivid, intuitional, heuristic and apt to inspire the learning interests of students. It is the MS PowerPoint format and open to be modified, allowing teachers to add, delete and re-organize the contents in it, or even recompose it according to their own styles to satisfy various kinds of individualized teaching requirements.

7. Another supporting material of the book, EXERCISE WORKBOOK OF ENGINEERING DRAWING edited by Lin Hu and Rong Cheng, is released with an exercise CD (for students). The CD contains animations of 3D solid models in the exercises, which can help students to review and master the corresponding contents after school. The exercises in the workbook cover a wide range in categories and vary from the simple to the difficult while with an appropriate average difficulty, owning characteristics of typicality as well as universality. Besides, the solutions and standard answers of the exercises (for teachers) is also provided. Teachers using the textbook can ask the publisher for it.

This book is primarily edited by Prof. Lin Hu of Shenzhen University as the Editor in Chief. Rong Cheng (Shenzhen University), Qin Fu (Jiangnan University) and Wei Sun (South China University of Technology) participate as the Associate Editors in Chief. The other editors include Fenghong Wang (South China University of Technology), Xiaobo Peng (Shenzhen University) and Mingli Zhang (North China Institute of Aerospace Engineering). The book is primarily reviewed by Prof. Jinchang Chen of South China University of Technology, the Vice Chairman of the Engineering Graphics Education Steering Committee of the Ministry of Education (China), the Director of the Guangdong Engineering Graphics Society as Chinese reviser, and Prof. Weiyin Ma of City University of Hong Kong as English reviser, both of whom have provided thorough reviews and revisions to this book, and contributed many invaluable advises and suggestions. We gratefully acknowledge them for their significant contributions.

This book contains various references from home and abroad publications and teaching materials, whose authors are highly acknowledged. For those who have provided their helps and kindness for this book, we announce our sincerely acknowledgement to all of them.

This book has proudly acquired special financial support from the Teaching Material Development Grant of Shenzhen University. We therefore gratefully announce our special acknowledgement.

Due to various limitations, this book may contain mistakes and all criticisms and corrections from all experts and readers are welcome.

Authors

# 前 言

当前,我国的高等教育进入了新一轮的改革阶段:大力开展基础课、专业基础课和专业课的双语教学,加速推进我国高等教育的国际化和培养高素质创造性应用型人才。因此,双语教学是我国高等教育与国际接轨,迎接新世纪挑战和教育改革发展的必然趋势,也是中国高等教育在 21 世纪必须做出的战略选择。本教材的编写为双语教学创造了一个良好的条件,及时地满足了高等教育与国际接轨这一教育改革形势发展的需要。

本书是依照高等学校工科制图课程教学指导委员会制订的“画法几何及工程制图课程教学基本要求”,结合近年来工程图学课程教学改革的特点编写而成的,立足培养面向 21 世纪的高级工程应用型人才。它面向现代制造技术,并紧紧围绕以“学”为中心、以“素质提高”为目的的指导思想,力求简明扼要、质量上乘、覆盖面广。本教材适合于高等院校为理、工、经、管各专业学生开设的“工程制图”课程(36~64 学时)使用,也可用于为近机械类及机械类各专业学生开设的“工程制图”课程(72~108 学时),还可作为继续教育同类专业的教材,亦可供企业的设计人员和工程技术人员作为自学参考书。

本教材针对基础课程的特点,继承传统内容的精华,融入编者多年积累的教学经验,着眼于新时期对人才培养的要求,以加强对综合素质及创新能力的培养为出发点,力求在不增加教师和学生负担的前提下,充分利用有限的教学资源,最大限度地调动学生的学习主动性和积极性,从而使“工程图学”教育从以“知识、技能”为主的教育向以“知识、技能、方法、能力、素质”综合培养的教育转化。本教材具有如下特点:

1. 采用中、英文左右两栏同页对照编排的形式。

2. 以实用为主导,突出实用性和先进性。删减了图解法的内容,重点突出了与工程应用密切相关的投影基本理论、形体的表达方法及工程图样的阅读等内容,提供了典型例题及分析和解决问题的思路和方法,重视方法、能力、技能等综合能力素质的培养。

3. 强调徒手绘图的基本功训练,精心设计的习题集保证了恰当的徒手画图练习和足够的基本功训练,并注意正确处理徒手绘图、仪器绘图和计算机绘图三者之间的关系。

4. 全书采用了最新颁布的《技术制图》和《机械制图》的国家标准,根据需要选择并分别编排在正文或附录中,以培养学生贯彻最新国家标准意识和查阅国家标准的能力。

5. 增加了 AutoCAD 绘图的内容,根据目前国内院校的实际情况,将计算机绘图内容集中放在第 11 章,以方便学生学习。

6. 本教材有配套的 CAI 多媒体电子教案(胡琳、程蓉等编)同时出版,该电子教案覆盖教材的全部内容,充分运用各种软件的功能,采用大量反映实物模型的动画演示,形象生动、逼真,启发性强,可大大激发学生的学习兴趣。该电子教案采用较易掌握的 PowerPoint 工具软件编制,为开放式课件。其最大的好处是:可由任课教师根据课程需要及教学习惯,方便地自行增加、删减或重组有关内容,或按自己的风格和特色进行改编,以满足个性化教学的要求。

7. 在与该教材配套的《EXERCISE WORKBOOK OF ENGINEERING DRAWING 工程制图习题集》(胡琳、程蓉主编)中附有一张练习光盘(学生版),在练习光盘中,有相应的立体模型动画演示等,便于学生自学或课外辅导,帮助学生掌握学习内容。练习题型博采众长,由浅入深,覆盖面宽,难度适宜,兼顾典型性和通用性。另外还配有习题解答和标准答案(教师版),请选用该教材的院校与出版社联系索取。

本书由深圳大学的胡琳教授任主编,程蓉(深圳大学)、付苓(江汉大学)、孙炜(华南理工大学)任副主编。参加本书编写的有:王枫红(华南理工大学)、彭小波(深圳大学)、张明莉(北华航天工业学院)。本书由教育部工程图学教学指导委员会副主任委员、广东省工程图学学会理事长、华南理工

大学的陈锦昌教授（中文）和香港城市大学的马维银教授（英文）担任主审，二位主审对书稿进行了仔细的审阅，提出了许多宝贵意见和非常好的建议，在此表示衷心的感谢！

本书参考了国内外一些著述和教材，在此向有关作者致意！并感谢其他关心和帮助本书出版的人员。

本书得到深圳大学教材建设基金资助，在此特别表示衷心的感谢！

由于编者水平有限，书中难免有错误和疏漏，敬请各位专家及广大读者批评指正。

编 者

## Foreword to the Second Edition

Since the first edition of the book was published in 2005, it is becoming a piece of unique academic work in the field with its innovative contents, wide practical use, and featured bilingual education. It received great support and was widely accepted by readers. The book was awarded the First Prize of Excellent Textbook of Shenzhen University. In 2008, it was selected as one of China's National Eleventh Five-Year-Plan Textbooks for Regular Higher Education. As a supporting teaching material, the bilingual electronic teaching plan published together with the book, was also very popular to readers and awarded several provincial and national Prizes of Excellent Multimedia CAI Software for Higher Education.

In the second edition, the book was revised according to the national standards newly formulated or improved in past years and feedbacks and suggestions from readers. The basic structure of the book remains unchanged except that a new chapter on "Other Drawings" was added as the 10th chapter. The contents of the book were revised or extended following the new national standards. Further typical examples used by home and abroad universities on part drawings and assembly drawings and their representation methods were illustrated in the book. The 11th chapter on "Computer Graphics", which was the 10th chapter in the first edition, was re-written, in which AutoCAD2008 was used as the demo software.

For the sake of comparative reading, the second edition adopts a two-column format, one column being the English contents while the other one being the corresponding Chinese version. And all tables and figures in the book are labeled bilingually in English and Chinese.

Primary participants who have contributed to the editing and revision of the second edition are Lin Hu, Rong Cheng, Xiaobo Peng, Wei Sun, Qin Fu, Fenghong Wang, and Mingli Zhang with Lin Hu being responsible for the general editing and final assembly of the entire book.

Support from Shenzhen University through a Teaching Material Development Grant is gratefully acknowledged. Comments, criticisms and submissions from readers are welcome as always.

Authors

## 第 2 版序

本书是一本内容新颖、富有特色、实用性强的双语教材，自 2005 年首次出版以来，深受广大读者的欢迎和厚爱，并荣获深圳大学优秀教材一等奖，2008 年入选为普通高等教育“十一五”国家级规划教材。与本教材配套的双语电子教案亦极受欢迎，曾多次获得全国及广东省高等教育优秀多媒体教学软件奖。

为了全面贯彻最新的国家标准，同时考虑到一些院校和读者的反馈意见和建议，本书第 2 版增加了“第 10 章 其他工程图”，按新国家标准更新修改或补充了相关的内容，并适当增加了几种其他类型的国内外零件图和装配图的典型图例及表达方法。原“第 10 章 计算机绘图”顺延为“第 11 章 计算机绘图”，并采用 AutoCAD 2008 版本的绘图软件重新进行了编写。

本书第 2 版在排版形式上作了较大改进，采用在同一页里中英文对应编排的形式；所有图、表均采用中英文合在一起的编排形式，以方便学生对照阅读。

参加本书再版编写和修订的人员有：胡琳、程蓉、彭小波、孙炜、付琴、王枫红、张明莉，胡琳为主编。

本书在再版编写和修订过程中得到深圳大学教材建设基金资助，在此表示诚挚的谢意，并衷心希望广大读者继续对本书提出宝贵意见。

编者



# Introduction

## 1. Subjects and features of this course

Engineering Drawing is an application oriented subject that introduces the preparation, representation and reading of engineering drawings. Similar to characters and numbers, it is one of the tools used by human for the expression, conception, analysis and communication of technical information. Considering scientific and technological level at the present time, engineering drawing is an important document in industry for design, manufacture, utilization and service, often called “the common technical language for engineers”. Engineering Drawing is not only a foundation subject for a specific major, but also a part in the entire spectrum of engineering education. It provides theories and methodologies for all engineering talents to express their spatial and visual imagination.

The course mainly studies the basic theories and methods for the preparation and reading of engineering drawings as well as related national standards on *Mechanical Drawing* and *Technical Drawing*. The main features of the book are as follows:

(1) Foundation. It is a foundation subject for other engineering-related subjects and education and provides a basis for studying other subjects afterwards.

(2) Interdiscipline. It is a cross disciplinary subject that integrates geometry, projection theory, basic engineering knowledge, basic engineering specifications and standards, and advanced drawing techniques.

(3) Engineering. It is an engineering subject which has a close connection with body and shape construction, analysis and representation in engineering applications and requires continuous integration with engineering regulations and methodologies.

(4) Practicability. It is a widely used practical subject integrating both theoretical and engineering practices.

(5) Methodology. It provides a method covering engineering and visual imagination that could effectively train students with the ability in comprehensive spatial imagination and analysis.

(6) Universality. It is a common engineering language applicable to different regions, different disciplines, different languages, and whether for the past, present or the future. The representation of engineering drawings is always the same.

# 绪 论

## 1. 本课程的研究对象及特征

工程图学是一门研究工程图样的绘制、表达和阅读的应用学科。工程图样和文字、数字一样，也是人类借以表达、构思、分析和进行技术交流的不可缺少的工具之一。就当代科学技术水平而言，工程图样仍是工业生产中设计、制造、使用、维修时的重要技术文件，有“工程界共同的技术语言”之称。因此，工程图学并不是仅为某个特定专业提供基础，而是作为“工程教育”的一部分，为一切涉及工程领域的人才提供空间思维和形象思维表达的理论及方法。

本课程主要研究绘制、阅读工程图样的基本理论和方法，学习国家标准《机械制图》、《技术制图》的相关内容。其主要特征体现为：

(1) 基础性 工程图学是作为一切工程和与之相关人才培养的工程基础课，并为后续的工程类专业课的学习提供基础。

(2) 交叉性 工程图学是几何学、投影理论、工程基础知识、工程基本规范及现代绘图技术等多个学科相结合的产物。

(3) 工程性 工程图学与工程中的形体构成、分析及表达紧密相连，需要随时与工程规范、工程思想相结合。

(4) 实用性 工程图学具有广泛的实际应用性，是理论与工程实践相结合的学科。

(5) 方法性 工程图学中所蕴涵的工程思维和形象思维的方法可以有效地培养学生的空间想象力和分析、综合能力。

(6) 通用性 工程图学作为工程界的通用语言，具有跨地域、跨行业性，无论古今中外，尽管语言不同，但是工程图的表达方法都是相通的。

## 2. Nature and tasks of this course

Engineering Drawing is the study for the representation and communication of products and processes. It is a carrier of engineering and product information and the communication language in engineering and industry. The course is based on rigorous theoretical and highly practical materials that are important to train students with scientific thinking and innovation. It is an important technical foundation undergraduate course for general higher education in universities and colleges.

The tasks of this course are as following:

- (1) To study the basic theory and applications of orthographic projection and train students with abilities in design and innovation.
- (2) To train students with a balanced skill in hand drawing, instrument drawing and computer assisted drawing as well as the ability in reading mechanical drawings.
- (3) To train students with abilities in spatial and logical thinking, visual imagination, conceptualization, exploration and innovation.
- (4) To train students with serious working attitude, meticulous working style and their persistence in complying with related national standards.

## 3. Aims and topics of this course

This course has four major aims and topics:

- (1) Equip students with basic theory and methodologies and the ability of projection and spatial imagination.
- (2) Equip students with strong expression abilities to correctly, completely, clearly and reasonably represent parts and components.
- (3) Equip students with proficient drawing skills in producing skilled and qualified drawings meeting related standards.
- (4) Equip students with the ability in identifying and reading related national standards and proficiency in reading engineering drawings.

The study of the above topics enables students to develop their skills and abilities in spatial imagination, representation, and preparation and reading of engineering drawings. It can also help establish a solid foundation for future studies of technical subjects and produce a new generation of engineering talents with strong spatial imagination and creativity.

## 4. Study methodologies of this course

The course consists of projection theory and engineering practices. Different methodologies may be applied when studying different parts of this course.

## 2. 本课程的性质和任务

工程图学是研究工程与产品信息表达、交流与传递的学问。工程图形是工程与产品信息的载体,是工程界表达、交流的语言。本课程理论严谨,实践性强,对培养学生掌握科学思维方法、增强工程和创新意识有重要作用,是普通高等院校本科专业重要的技术基础课程。

本课程的主要任务是:

- (1) 学习正投影法的基本理论及应用,培养创造性构型设计能力。
- (2) 培养徒手绘图、尺规绘图、计算机绘图的综合能力及阅读简单机械图样的能力。
- (3) 培养对物体的空间及逻辑思维能力和形象思维能力、构思造型能力和开拓创新精神。
- (4) 培养严肃的工作态度、细致的工作作风、贯彻执行国家标准的意识。

## 3. 本课程的学习目的及内容

本课程的学习目的及内容可分为四个部分:

- (1) 掌握正投影基本理论和方法,具有丰富的投影和空间想象能力;
- (2) 能正确、完整、清晰、合理地表达机件,具有较强的表达能力;
- (3) 能熟练、准确地绘制规范、合格的图样,具有扎实的绘图能力;
- (4) 能查阅有关国家标准、看懂并正确理解工程图样,具有熟练的读图能力。

通过这四个部分的学习,培养起学生的空间想象能力、表达能力、绘图能力、读图能力,为进一步的专业课学习和实践打下坚实的基础,塑造一代具有丰富空间想象力和创新、创造能力的现代工程技术人才。

## 4. 本课程的学习方法

本课程既有投影理论,又有较强的工程实践性,各部分又有各部分的特点,其学习方法不尽相同。

(1) When studying the projection theory, one should understand the basic concepts and basic rules. It should integrate projection analysis and geometry drawing techniques with their spatial imagination, logic reasoning and analytics judgment and establish the corresponding relationship between plane drawing and spatial shape. To improve one's spatial imagination is a step-by-step process and requires repeated studies from spatial shapes to planar representations and vice versa.

(2) When studying the representation of parts and components, one should master the theory and methodologies of shape and body analysis and line and plane analysis through attending lectures or self-learning. One should be skilled in simplifying complicated problems such that the problem could be solved with minimum effort. One should also ensure careful observation, profound thinking, persistent trying and exercises and thus continuously improve his/her ability in spatial analysis and conceptualization.

(3) When studying drawing techniques, attention should be paid to proper usage of tools and mastery of methods and skills in freehand drawing. All drawings must comply with related national standards. Skilled drawing using AutoCAD requires comprehensive exercise on computers and practice. Be patient in the course of drawing, always keep a precise, serious, responsible and meticulous attitude, and pay more attention on exploration, observation, and practice. Each drawing should be finished on schedule with all quality requirements satisfied.

(4) When learning reading drawings, one should participate in real engineering work and accumulate knowledge through practice. One should try to apply the knowledge in practice and thus develop ability in making observation, thinking, conclusion, application and skills in problem solving. In the process of drawing reading and exercises, try to learn from duplication, revision, exploration and creative thinking. One must be able to complete this subject through typical examples and continued synthesis of exercises and practices.

In conclusion, one can master and consolidate the knowledge of this course through the integration of learning and practice, carefulness and seriousness, step-by-step learning approach and correct completion of related exercises in a timely manner.

(1) 在学习投影理论部分时,应注意对基本概念、基本规律的掌握,结合作业将投影分析、几何作图同空间想象、逻辑推理和分析判断结合起来,建立起平面图形与空间形象的对应关系。提高空间想象力是一个循序渐进的过程,通过从空间到平面、从平面到空间的反复研究过程,不断总结经验,才能不断提高和丰富空间想象能力。

(2) 在学习表达机件的方法时,通过听讲和自学,注意掌握和运用形体分析法和线面分析法等构形分析的理论和方法,善于把复杂的问题转化为简单的问题,许多难题便可迎刃而解,也可收到事半功倍的效果。做到细心观察、勤于思考、不断尝试、认真练习,就能不断提高空间分析能力和构思能力。

(3) 在学习绘制图样时,应注意绘图工具的使用方法以及徒手绘图的方法和技巧,并自觉遵守国家标准的有关技术制图、机械制图中的规定。在学习 AutoCAD 绘图时,应多上机练习并实践。作图时要有耐心,多摸索、多看、多画、多练,以严谨、认真、负责、细致的态度,按时、优质地完成每一幅图样。

(4) 在学习读图时,注意联系工程实践并积累知识,注重将所学的理论知识在实践环节中加以运用,培养观察、思考、总结以及运用这些知识解决实际问题的能力。应在反复读图的练习过程中,注意“继承模仿、改造变换、联想创新”的运用,抓住典型例题,不断总结读图经验,就一定能完成本课程的学习任务。

总之,只要学与练相结合,发扬一丝不苟的精神,一步一个脚印地学习,保质保量地完成相应的练习题,就能使所学知识得以巩固,并真正学好本课程。

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# Chapter 1 Basic Knowledge of Drawing

# 第 1 章 制图基本知识

This chapter introduces basic knowledge of engineering drawing for further studies. Topics covered in this chapter include drawing tools and their utilization, related national standards, and drawing techniques based on geometric construction.

本章将重点介绍制图工具及其使用方法、国家标准的有关规定、几何作图方法等，其目的是为今后的学习打下必要的基础。

## 1.1 Drawing Tools and Their Utilization

## 1.1 制图工具及其用法

In order to efficiently produce quality drawings, all tools must be used correctly.

为了提高绘图质量和效率，必须正确地使用绘图工具。

### 1.1.1 Drawing board

### 1.1.1 图板

A drawing board is used to fix drawing sheet and produce drawings on the sheet. The surface of the board should be flat and smooth. The left side is the lead side and should be straight for guiding rulers as shown in Fig. 1-1a.

图板是用来固定图纸并进行绘图的。板面要求平整光滑，左侧为导边，必须平直。如图 1-1a 所示。

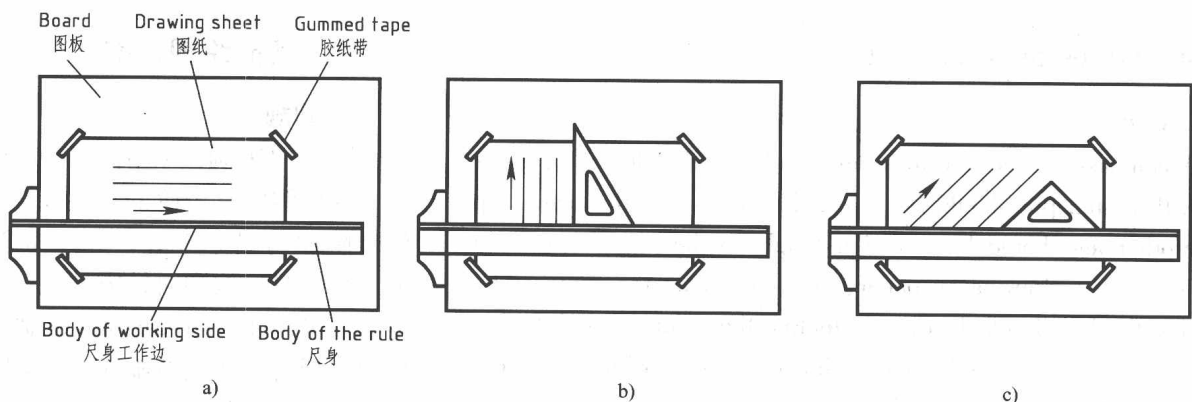


Fig. 1-1 Drawing board and T-square 图板及丁字尺的应用

- a) Position the paper and draw horizontal lines 固定图纸及画水平线  
b) Draw vertical lines 画竖直线 c) Draw parallel lines 画平行线

### 1.1.2 T-square

### 1.1.2 丁字尺

A T-square can be directly used to draw horizontal lines. It can also be used to draw vertical lines in combination with a triangle as shown in Fig. 1-1. To drawing horizontal lines, place the head of the T-square in contact with the left edge of the drawing board with left hand and move the T-square to the desired position. Hold the pencil and draw the line from its left end to the right end. One should not directly use a T-square to draw vertical lines. One should not use the lower edge of a T-square to draw horizontal lines either.

丁字尺主要用来画水平线，通常与三角板配合画铅垂线，如图 1-1。丁字尺由尺身和尺头构成，使用时，需用左手扶住尺头并使尺头内侧紧靠图板左侧导边，上下滑移到所需位置，然后沿丁字尺工作边自左向右画水平线。禁止直接用丁字尺画铅垂线，也不能用尺身下缘画水平线。

### 1.1.3 Triangles

A triangle is often used in combination with a T-square to draw vertical lines, lines with an inclination angle of  $30^\circ$ ,  $45^\circ$  or  $60^\circ$  with horizontal lines as shown in Fig. 1-1 b and c. One can also use two triangles to draw parallel lines and orthogonal lines of any orientation as shown in Fig. 1-2.

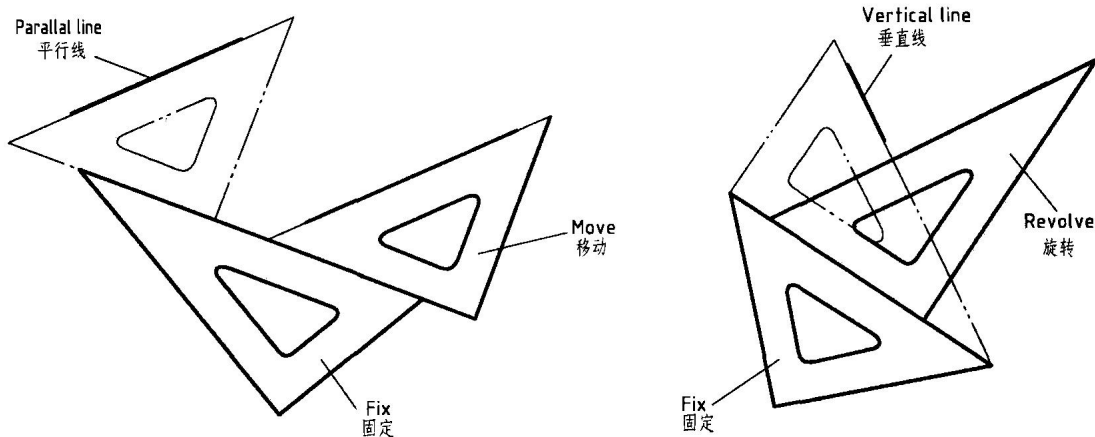


Fig. 1-2 Using two triangles to draw parallel lines and orthogonal lines of any orientation  
用两块三角板配合作平行线或垂直线

### 1.1.3 三角板

三角板常与丁字尺配合使用，画水平线的垂直线，以及与水平成  $30^\circ$ 、 $45^\circ$  或  $60^\circ$  的斜线，如图 1-1b、c 所示。两块三角板配合使用，可画任意方向倾斜线的平行线和垂直线，如图 1-2 所示。

### 1.1.4 Other drawing tools

#### 1. Compass

A compass is used to draw circles and arcs. The leg of the compass with a step pin should be facing downward and the pencil tip on the other leg should have similar height to the pin as shown in Fig. 1-3a. When drawing on paper, one can rotate the compass by revolving the handle clockwise and incline the compass slightly forward as shown in Fig. 1-3b. When drawing circles with a different diameter, adjust the pin and the pencil of the compass as necessary, but they should always be adjusted perpendicular to the paper as shown in Fig. 1-3c and 1-4.

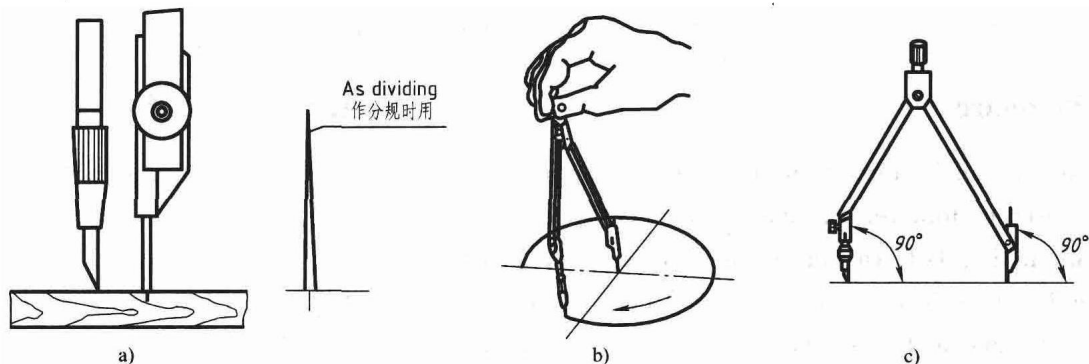


Fig. 1-3 The use of a compass 圆规的使用方法

- a) Needle point slightly longer in the pencil lead 针尖略长于铅芯
- b) Draw a circle in clockwise direction 按顺时针方向画圆
- c) Steel needle and pencil lead straddle are perpendicular to paper 钢针和铅芯插腿垂直于纸面

### 1.1.4 其他绘图仪器

#### 1. 圆规

圆规用来画圆和圆弧。使用时，应将圆规钢针有台阶的一端朝下，并使台阶面与铅芯平齐，如图 1-3a 所示。画图时，按顺时针方向旋转并稍向前倾斜，如图 1-3b 所示。画不同直径的圆时，要注意随时调整钢针和铅芯插腿，使其始终垂直于纸面，如图 1-3c 和图 1-4 所示。

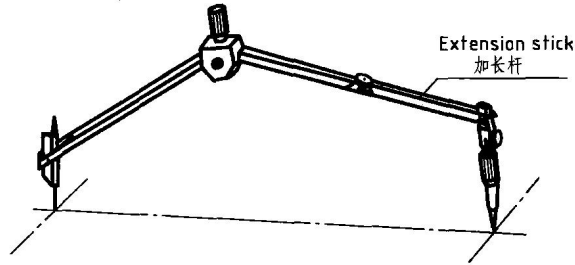


Fig. 1-4 Adding an extension stick to draw big circles 用加长杆画大圆

## 2. Dividers

Dividers are used for transferring distances and for equal subdivision of lines and circles. The two tips should meet together at the position shown in Fig. 1-5.

## 2. 分规

分规用来量取和等分线段。当两脚并拢时，两针尖应对齐，其用法如图 1-5 所示。

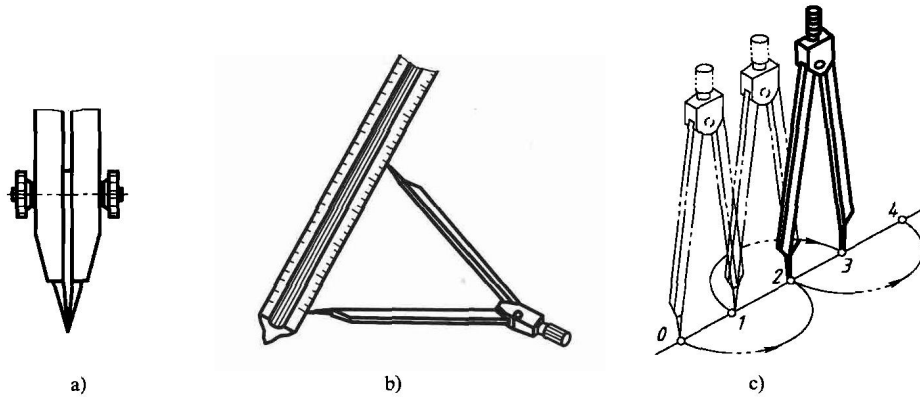


Fig. 1-5 The use of dividers 分规的用法

- a) Tip of needles 针尖并拢于一点 b) Size taking 量取尺寸  
c) Size with equal subdivision 连续截取等长线段

### 1. 1. 5 Measures for pencil sharpening

There are soft and hard drawing pencils. 2B pencil or B pencil is used to draw thick lines. H or 2H pencil is used to draw thin lines. HB pencil is used to write characters. There are two methods for pencil sharpening as shown in Fig. 1-6. The cone form shown in Fig. 1-6b is used to draw manuscript and to write, while the wedge form shown in Fig. 1-6c is used for deepening and thickening.

### 1. 1. 5 铅笔的削法

绘图铅笔的铅芯有软硬之分，用标号 B 或 H 表示。通常用 2B 或 B 铅笔画粗线；H 或 2H 铅笔画细线；HB 铅笔用于写字。铅笔的铅芯有两种磨削方法，如图 1-6 所示。削成圆锥形用来画底稿和写字，如图 1-6b 所示；削成楔形用来加深粗线如图 1-6c 所示。

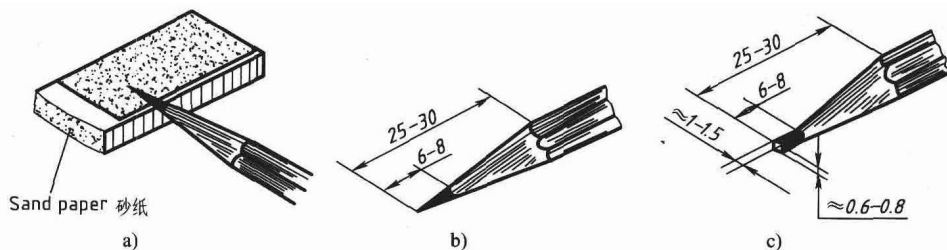


Fig. 1-6 Pencil sharpening 铅笔的磨削

- a) Sharpening 刃磨 b) Cone form 锥形 c) Wedge form 楔形



## 1.2 Related Provisions in National Standards

Engineering drawing is an important documentation used during the process of design and manufacturing. For the sake of convenience in communication, all drawings should comply with national standards. National standards are abbreviated as “GB”.

### 1.2.1 Size and layout of drawing sheets (GB/T 14689—2008)

GB/T14689—2008 is the standard for defining size and layout of drawing sheets. Here, GB/T is the abbreviation of the National Standard (GUO JIA BIAO ZHUN in Chinese). The code 14689 is a serial number of the standard. The code 2008 indicates the year when the standard was published.

## 1.2 国家标准有关规定

工程图样是设计和制造过程中的重要技术资料，为了便于指导生产和技术交流，国家标准对图样上的内容作出了有关规定，绘制工程图样时必须认真贯彻执行。国家标准简称“国标”，用代号“GB”表示。

### 1.2.1 图纸幅面和格式 (GB/T 14689—2008)

GB/T 14689—2008 是图纸幅面和格式的标准编号。其中“GB/T”是“国家标准(推荐性)”的汉语拼音字母缩写，“14689”是标准的顺序号，“2008”表示该项标准颁布的年份。

Table 1-1 Basic formats 基本幅面

(mm)

Format codes 幅面代号	Dimensions 尺寸 $B \times L$	Margin 周边		
		$a$	$c$	$e$
A0	841 × 1189	25	10	20
A1	594 × 841			
A2	420 × 594		5	10
A3	297 × 420			
A4	210 × 297			

### 1. Formats

While producing the drawing, one should usually adopt standard basic formats and layout illustrated in Table 1-1. There are five standard sheets, namely A0, A1, A2, A3 and A4. If it is necessary, one may also use extended sheets of larger dimensions specified in the standard, as shown in Fig. 1-7.

### 2. Frame format

One must use continuous thick lines to draw the border. There are two layouts to follow, i. e., with or without space for book binding (see Fig. 1-8 or Fig. 1-9). The dimensions for each of the layouts for the five standard sheets are shown in Table 1-1. For A4 paper, one usually adopts a portrait orientation, while for A3, one usually adopts a landscape orientation. However, one may use a different orientation in case of certain products.

### 3. Title block

One must draw a title block on each drawing sheet. The position of the title block should be located on the lower right corner of the sheet as shown in Fig. 1-8 and Fig. 1-9.

### 1. 图纸幅面

绘制图样时，应优先采用表 1-1 所规定的基本幅面。幅面代号为 A0、A1、A2、A3、A4 五种，必要时，也允许选用国标规定的加长幅面，如图 1-7 所示。

### 2. 图框格式

在图纸上必须用粗实线画出图框，其格式分不留装订边和留装订边（见图 1-8 及图 1-9）两种，尺寸如表 1-1 所示。当图纸选用留装订边格式时，一般应采用 A4 幅面竖装和 A3 幅面横装。但同一产品的图样只能采用一种格式。

### 3. 标题栏

每张图纸上都必须画出标题栏。标题栏应位于图纸的右下角。如图 1-8 和图 1-9 所示。