高等学校教材

测绘专业英语

Surveying and Mapping in English

柴华彬　编

测绘出版社

高等学校教材

测绘专业英语

Surveying and Mapping in English

柴华彬　编

测绘出版社

·北京·

内容简介

本书涵盖了测绘专业所涉及的主要知识，包括测绘的基本概念、基本理论和基本操作技能，测绘仪器、测量方法、测量误差及数据处理、工程测量、地图制图、全球定位系统、遥感和地理信息系统等测绘基础知识。为了便于教师、学生和工程技术人员自学，本书每章最后都配有词汇表。此外，以国家发布的测绘术语标准为依据，给出常用测绘专业术语的英语词汇表。

本书面向学生，深入浅出，易学好用，结构体系清晰合理，专业知识内容丰富、系统全面，不仅适合测绘专业的本科生和研究生阅读，也适合从事测绘工程专业的技术人员与研究人员阅读或参考。

图书在版编目(CIP)数据

测绘专业英语/柴华彬编.—北京：测绘出版社，2015.9
高等学校教材
ISBN 978-7-5030-3732-0

Ⅰ.①测… Ⅱ.①柴… Ⅲ.①测绘学—英语—高等学校—教材 Ⅳ.①H31

中国版本图书馆 CIP 数据核字(2015)第 076359 号

责任编辑 王 波　　封面设计 李 伟　　责任校对 宣 东　　责任印制 喻 迅

出版发行	测绘出版社	电　　话	010-83543956(发行部)
地　　址	北京市西城区三里河路50号		010-68531609(门市部)
邮政编码	100045		010-68531363(编辑部)
电子信箱	smp@sinomaps.com	网　　址	www.chinasmp.com
印　　刷	三河市世纪兴源印刷有限公司	经　　销	新华书店
成品规格	184mm×260mm	字　　数	305千字
印　　张	12.00		
版　　次	2015年9月第1版	印　　次	2015年9月第1次印刷
印　　数	0001-1500	定　　价	38.00元

书　　号 ISBN 978-7-5030-3732-0/P·795

前　　言

测绘科学与技术快速发展，已进入信息化和国际化阶段。在新时期，为了让测绘专业的本科生、研究生和专业技术人员同国外同行进行学术交流，追踪和掌握国外发达国家先进的测绘科学与技术，特编写了《测绘专业英语》（ Surveying and Mapping in English ），以供测绘专业相关的教师、学生和工程技术人员阅读、参考。

本书主要面向测绘专业的本科生和研究生，注重测绘专业的基础知识，深入浅出，易学好用，特别是与本科生的专业知识和基础英语水平相适应。本书结构清晰合理，与本科生专业培养计划和专业基础课程的教学大纲相衔接，能够让学生同步地学习和掌握专业英语与专业课知识。同时，为了便于测绘工程专业相关的教师、学生和工程技术人员自学，本书每章最后都配有词汇表。此外，以国家发布的测绘术语标准为依据，给出常用测绘专业术语的英语词汇表。

本书主要阐述测绘专业所涉及的基础知识，包括测绘的基本概念、基本理论和基本操作技能，测绘仪器、测量方法、测量误差及数据处理、工程测量、地图制图、全球定位系统、遥感和地理信息系统等测绘基础知识。本书共包含十二章内容：第一章，概述；第二章，测绘基准；第三章，距离测量；第四章，高程测量；第五章，角度测量；第六章，测量误差；第七章，控制测量；第八章，工程测量；第九章，地图与制图；第十章，全球定位系统；第十一章，遥感；第十二章，地理信息系统。

本书由河南理工大学柴华彬编写完成。本书的出版得到了河南理工大学测绘与国土信息工程学院的大力支持和资助！在本书编写过程中，引用了国内外有关学者（如武汉大学尹晖教授，美国西弗吉尼亚大学 Syd S. PENG 教授等）的著作和发表的文献资料，在此对所引文献的作者表示深深的感谢！同时，感谢河南理工大学邹友峰教授、郭增长教授、袁占良教授、杨娜博士和李克昭博士等诸多领导和同事们为本书编写提供的指导和帮助！

由于编者水平有限，书中缺点和错误在所难免，恳请读者批评指正！

编者
河南理工大学
2015 年 1 月

Contents

Chapter 1 Overviews

1.1 Introduction

Surveying may be defined as the technology and science for the study of the Earth's shape and size, as well as making measurements of the relative positions of natural and man-made features on, above or below the Earth's surface, and representing this information in analog forms as contoured maps or sections, paper plans or charts, or as figures in report tables, or in digital form as a three dimensional mathematical model stored in the computer.

The actual measurements of surveys have to do with the determination of the relative spatial location of points on or near the surface of the Earth. They are the technologies of measuring horizontal and vertical distances between objects, measuring angles between lines or the direction of lines and determining the elevations of the points. After the actual measurements of surveys, mathematical calculations are made to determine the distances, angles, directions, locations, elevations, areas and volumes from surveying data. Then much surveying information is portrayed graphically in forms of maps, such as topographic maps, construction maps, profiles, cross-sections and diagrams.

The essential work of surveying is to accurately determine the positions of the features on the surface of the Earth (horizontal surveying) and the elevations of the features (vertical surveying), or a combination of both. Although different surveys are for different purposes, the basic operations by surveyors or geodesists include measurements (fieldwork), computations and mapping (office work). From another point of view, the work of surveying is either to determine the locations (three-dimensional coordinates) of ground features and drawing all kinds of maps, or to mark out the designed buildings or structures in maps at their proposed positions.

The surveying operations mainly include: ① design of the surveying procedures and selection of equipments appropriate for the project; ② acquisition of data in the field; ③ reduction or analysis of data in the office or in the filed; ④ storage of surveying data; ⑤ preparation of maps or other displays in the graphical or numerical forms needed for the purpose of surveying; ⑥ layout of monuments and boundaries in the field, as well as providing control surveying for constructions. Performance of these tasks requires a familiarity with the uses of surveying equipments and techniques, knowledge of fundamentals of the surveying process and knowledge of various means by which data can be prepared for presentation.

The surveying work should follow some basic procedures or rules: ① control surveying should be firstly carried out, and then detail surveying; ② the surveying work should be conducted from the whole to parts; ③ high-precision surveying should control the low-precision surveying; ④ each step of surveying work should have a check. These basic procedures or rules can be used to divide surveying area into different map units, reduce the error accumulation, ensure the precision of mapping and speed up the mapping process. Control surveying refers to the measurements of control points, which are well spaced in the form of network and play controlling roles in survey area. Detail surveying refers to the work of measuring the terrain features around each control point.

1.2 Branches of surveying

Surveying can be divided into different branches, such as geodetic surveying, plane surveying, engineering surveying, topographic surveying, cadastral surveying, hydrographic surveying, mine surveying, etc.

1.2.1 Geodetic surveying

Geodetic surveying refers to the measurement and representation of the Earth's shape and size, gravity field and geodynamic phenomena (such as polar motion, Earth tides and crustal motion), and establishment of control networks of large areas for other surveys.

In geodetic surveying, large areas of the Earth's surface are involved and the true shape of the Earth must be taken into account, and the surveying stations (with permanent monuments) are normally long distances apart, thus distances measured on or near the surface of the Earth are not along straight lines or planes, but on a curved surface. In geodetic surveying, a large number of precise instruments and surveying methods are required. In geodetic surveying, these basic surveying stations with permanent monuments are called geodetic control points, which support the production of consistent and compatible reference coordinates for other surveying and mapping projects.

The geodetic surveying adopts the parameters determined by measurements of the Earth, and in return the results of geodetic surveying are provided for the measurements of the Earth.

1.2.2 Plane surveying

The type of surveying in which the mean surface of the Earth is considered a plane, or in which the curvature of the Earth can be disregarded without significant error, is generally called plane surveying.

In plane surveying, distances or areas involved are of limited extent, horizontal distances and directions are considered mathematically straight. Formulas of plane trigonometry, algebra and analytical geometry are used to make computations. For small areas, precise results may be obtained with plane surveying methods, but the accuracy and precision of such results will decrease as the surveying areas increase in size. The plane surveying is generally connected to the control points of the geodetic surveying.

1.2.3 Topographic surveying

Topographic surveying is made to determine the configuration (relief) of the surface of the Earth, locate the natural and artificial features thereon and produce maps, plans or sections to suitable scales. Many natural and artificial features, such as relief, hydrography, vegetation, roads, trails, buildings, canals and boundary lines, have to be represented by conventional symbols in topographic maps.

Topographic maps have height information either as spot heights or as contours, and their scales have different ranges. Topographic maps have a multitude of use, such as navigation, recreation, geographical and geological study, military application, exploration, etc.

1.2.4 Engineering surveying

Engineering surveying refers to the surveys required in design, construction and management stages of engineering constructions.

In the stage of engineering construction, large-scale topographic maps or plans are required as a basis for design, and then the proposed position of any new item of the construction must be marked out on the ground both in plane and height. These operations are generally termed setting out, as-built surveys and deformation monitoring.

The design and construction of new routes, such as roads and railways, the calculations of the areas and volumes of land, are also the aspects of engineering surveying.

1.2.5 Cadastral surveying

Cadastral surveying refers to the work of making measurements and plotting the measurements to produce plans of property boundaries for legal purposes. In many countries, the registrations of ownership of lands are based on such plans.

The management of cadastral surveying is one of the government's administrative responsibilities. In 1985, the State Bureau of Surveying and Mapping (SBSM) of China started the re-establishment of cadastre, mainly in urban areas at the scale of 1 : 500, 1 : 1 000 and 1 : 2 000. SBSM had issued regulations on cadastral surveying and the cadastre map format, and set up administrative systems of cadastral surveying for qualification of survey units, cadastral results checking and quality supervision.

1.2.6 Hydrographic surveying

Hydrographic surveying refers to the work of making measurements for lakes, streams, reservoirs and other bodies of water.

In China, the hydrographic charting mainly consists of the nautical charting and special purpose charting. The equipments used in hydrographic charting include depth-sounder, side-scan sonar, marine gravimeter, magnetometer, depth-sounding automatic system and one-thousand-ton comprehensive survey ships. The hydrographic charting is widely used in ocean transportation, fishery, ocean petroleum and gas exploration, and development of ocean resources.

In the past decades, Global Positioning System Global Positioning System (GPS) and Differential GPS (DGPS) technologies have been used in hydrographic charting, and a lot of charts at various scales were compiled for coastlines, ports and islands. The construction of hydrographic charting database has started for data collection and processing. Some new-generation electronic charting has been provided to users. A few national standards have been published, such as the regulations on hydrographic charting, the formats for hydrographic charting.

1.2.7 Mine surveying

Mine surveying is concerned with measurements of surface and underground mines, obtaining data in digital form and making graphical representation for prospecting mineral deposits, constructing mines and exploiting minerals. A few centuries ago, mine surveying was extensively developed for the determination of the boundaries of the mining claims. The early period of mine surveying may be considered as the art of running underground traverses. However, as it developed, mine surveying included, apart from techniques of mine surveying, the estimation of the accuracy of measurements and calculations based on the method of least squares adjustment, the mine surveying instrumentation, the geometry of mineral resources, study of tectonics, etc. All these aspects of mine surveying are made for the precision of geological exploration, as well as the safety and efficiency in mining.

As the progress has been made in the methods of mine surveying, the mine surveyors are using the gyro-theodolite, high-precision theodolites and optical range finders to solve the problems of orientation and construction of reference networks. Self-adjusting levels and lasers have recently become very popular to give lines and grades and check on the directions of mines, and provide control for such operations as mine shafting equipment, laying railway tracks, installing conveyors, putting through pipelines and others. Moreover, new techniques and instruments are made for plotting mine graphics and preparing mine plans as well as longitudinal and transverse sections.

1.3 Developments of surveying

Equipments available and methods applicable for measurements and calculations have changed tremendously in past decade. Optical theodolites, tapes, spirit levels, etc, are traditional equipments for measurements. Electronic Distance Measurements (EDM), electronic theodolites, Total Station, photogrammetry, satellite observation, Remote Sensing (RS), inertial surveying, and laser ranging techniques are the examples of modern data acquisition and processing systems that are utilized in surveying process. At the same time, the relatively easy access to electronic computers of all size facilitates the rigorous processing and storage of large volumes of data.

With the development of these modern data acquisition and processing systems, the duties of the surveyor have expanded beyond the traditional tasks of the field work of taking measurements and the office work of computing and drawing. Surveying is required not only for conventional construction engineering projects, mapping and property surveys, but also for other physical sciences, such as geology, geophysics, biology, agriculture, forestry, hydrology, oceanography, geography, etc.

1.3.1 Surveying techniques

Historically, distances were measured by different means, for instance, tapes made of steel or invar were pulled taut to reduce sagging and slack to measure horizontal distances. Additionally, attempting to measure up a slope, the surveyors might have to use increments less than the total length of the tape.

In the past, horizontal angles were measured by using a compass, which would provide a magnetic bearing, from which deflections could be measured. This type of instrument was later improved, with more carefully scribed discs providing better angular resolution, as well as through mounting telescopes with reticles for more-precise sighting atop the disc. Additionally, levels and calibrated circles allowing measurement of vertical angles were added, along with verniers for measurement to a fraction of a degree—such as transit.

Historically, the simplest method for measuring heights was using air pressure as an indication of height with an altimeter (basically a barometer). But as surveying required greater precision, a variety of means, such as precise leveling (also known as differential leveling), have been developed. With precise leveling, a series of measurements between two points are taken using a level instrument and a pair of leveling rods. Differentials in height between the measurements are added and subtracted in a series to derive the difference in elevation between the two end points of the series. With the advent of the Global Positioning System (GPS), elevation can also be derived with sophisticated GPS receivers, but usually it somewhat has less accuracy than that traditional precise leveling. However, the accuracies may be similar if the traditional leveling would have to run over a long distance.

Triangulation is another method of horizontal location which was widely used in the past years. With the triangulation method, distances and directions between objects at great distance from one another can be determined. In the early stages of surveying, the triangulation was the primary method of determining accurate positions of objects for topographic maps of large areas. A surveyor first needs to know the horizontal distance between two of the objects. Then the distances and angular position of other objects can be derived, as long as they are visible from one of the original objects, and high-accuracy theodolites can be used for implementing this kind of surveying work, and angles between objects were measured repeatedly for increased accuracy.

1.3.2 Surveying equipments

In the past, the basic tools used in planar surveying were the tapes for determining shorter distances, the level instruments for determining height or elevation differences and the theodolites for measuring horizontal or vertical angles.

A modern instrument is a Total Station, which is a theodolite with an Electronic Distance Measurement (EDM). A Total Station can be used for measuring distances, angles, elevations, and also can be used to directly achieve the three dimensional coordinates of points.

Some advanced Total Stations no longer require reflectors or prisms (used to return the light pulses) to measure distances. They are fully robotic and can even e-mail point data to the office computers.

With the advancement of satellite positioning technology, the speed and precision of surveying greatly increased by using Global Positioning System (GPS). Because GPS system do not work well in areas with dense tree cover or constructions, Total Stations are still widely used along with other types of surveying instruments. Now robotic-guided Total Stations allow surveyors to gather precise measurements without extra persons to look through and turn the telescope or record surveying data.

1.3.3 Origin of Geomatics

Geomatics is a relatively new scientific term created by Pollock and Wright in 1969, with the intention of combining the terms geodesy and geoinformatics. It includes the tools and techniques used in surveying and mapping, Remote Sensing (RS), Geographic Information Systems (GIS), Global Navigation Satellite Systems (GNSS), cartography, photogrammetry, geography, geosciences, computer sciences and various spatial observation technologies, land development and the environmental sciences, etc.

The term was originally used in Canada, and now it has been adopted by the International Organization for Standardization, the Royal Institution of Chartered Surveyors and many other international authorities. Although some (especially in the United States) authorities have shown a preference for the term geospatial technology, the rapid progress of Geomatics has been made possible by advances in computer hardware, computer science, and software engineering, as well as airborne and space observation remote sensing technologies since 1990s.

A working definition of Geomatics is the science and technology of acquiring, storing, processing, managing, analyzing and presenting geographically referenced information. This broad term applies to science and technology, and integrates the following more specific disciplines and technologies including surveying and mapping, geodesy, satellite positioning system (GPS, GLONASS, Galileo, Beidou Compass), photogrammetry, Remote Sensing (RS), Geographic Information Systems (GIS), cartography, land management, computer systems, environmental visualization and computer graphics, etc.

The term Geomatics has been introduced worldwide to a number of institutes of higher education during the past few years, mostly by renaming what was previously called 'geodesy' or 'surveying' and by adding a number of computer science, information science and GIS, RS, GPS-oriented courses. For example, some university departments were once titled surveying, survey engineering or topographic science have re-titled themselves as Geomatics or Geomatic engineering. The term

Geomatics can bridge wide arcs from the geosciences through various engineering sciences and computer sciences to spatial planning, land development and the environmental sciences, and being better used to convey the true collective and scientific nature of these related activities and also have the flexibility to incorporate the future technological developments in these fields.

The advent and adoption of the term Geomatics do not suggest that the term 'surveyor' out of use and so as some other related terms such as 'land surveyor' or 'building surveyor', etc. The traditionally-used term 'surveyor' is still appropriate to collectively describe those engaged in surveying activities. The job descriptions such as 'land surveyor', 'engineering surveyor' or 'hydrographic surveyor', are still commonly used by practitioners to clearly describe their specialized expertise. In the last decade, there have been dramatic developments and growths in the use of hardware and software solutions to both measure and process geo-spatial data. This has created and will continue to create new areas of applications, and provides the suitably qualified practitioners with more related job opportunities. As a result, the role of the 'surveyor' is expanding beyond traditional areas of practice and into new areas of opportunity.

1.4 Achievements of China's surveying

The State Bureau of Surveying and Mapping (SBSM) of China, established in 1956, is an administrative agency of the Chinese government for surveying and mapping. In 2011, SBSM was renamed State Bureau of Surveying & Mapping and Geoinformation (SBSMG). The SBSMG, as the administrative organization in charge of the surveying and mapping work in the whole country, has the following main responsibilities:

(1) To formulate laws, regulations and rules of surveying and mapping, to formulate development plans for the surveying and mapping, to formulate management policies and technical standards for the surveying and mapping industry and supervise their implementation.

(2) To organize and manage basic surveying and mapping, international and administrative boundary surveying and mapping, cadastral surveying and mapping, and other national level or key surveying and mapping projects, to establish and manage national surveying and mapping data and control systems.

(3) To formulate cadastral surveying and mapping plans, technical standards and specifications, to ratify cadastre surveying and mapping results.

(4) To take charge of regulating surveying and mapping market order, to manage surveying and mapping qualifications, to supervise quality control of surveying and mapping results and other surveying and mapping activities like geographic information data capture and application.

(5) To take charge of rendering surveying and mapping services for the public and emergency management, to organize and guide social services of fundamental geographic information, to examine and approve key geographic information and data and to publish them upon authorization.

(6) To manage national basic surveying and mapping results, to guide and supervise the management of surveying and mapping results of various kinds and the protection of surveying and mapping markers nationwide, to formulate system for and supervise the implementation of summarizing and submitting surveying and mapping results.

(7) To take charge of management of maps, to supervise and manage maps market, to manage map compilation, to examine maps to be published, to manage and approve the denotation of geographic names.

(8) To take charge of surveying and mapping technical innovation, to guide basic research of surveying and mapping, and key surveying and mapping programs, to promote the popularization of surveying and mapping technology and the commercialization of its research findings.

(9) To undertake other tasks designated by the State Council and the Ministry of Land and Resources.

For many years, great achievements on surveying and mapping have been made in China. Quite a few important projects have been completed, such as geodetic network, framework constructions, map productions, etc. The achievement are as follows:

(1) Geodetic network establishments. Since 1991, SBSM, jointly with other agencies in China, have made the remeasurement of the first-order leveling, with 241 leveling lines and 77 closing loops, and field results of 93 000 km. The data processing was completed in 1999. The vertical datum in China is in Qingdao City, Shandong Province. Through 7 years' efforts, a national GPS network of China was established in 1998, including A-order control network and B-ordercontrol network. The A-order control network consists of 33 stations, while the B-order control network consists of 818 points.

The first national gravity network of China was established in 1957. The 1985 National Gravity Network (NGN 1985) has been used for over a decade of years. Since 1999, SBSM, together with other agencies, started to establish the 2000 National Gravity Network (NGN 2000), which consists of 18 original stations and 119 basic points. The field work was completed in the end of 2000 and data processing was done in 2001.

(2) Framework constructions. After the establishment of 1 : 1 000 000 national database in 1990s, SBSM completed the construction of 1 : 250 000 national database in 1998. The database consists of three sub-databases: the topographic sub-database, Digital Elevation Model (DEM) database and geographic name sub-database. The data for the databases are from 816 sheets of 1 : 250 000 maps. The topographic database includes 14 layers, such as hydrography, transportation, boundaries, settlement, topography, vegetation, etc. The DEM database includes two kinds: 100 m×100 m and 3" ×3". The geographic database has over 800 000 place names registered.

For the establishment of the national spatial data infrastructure, SBSM launched the construction of 1 : 50 000 national databases in 1999, including the Digital Raster Graphic (DRG) database, the Digital Elevation Model (DEM) database, the Digital Orthophoto Map (DOM)