高等职业教育机电类规划教材

第2版

数控专业英语

王兆奇 刘向红 主编

机械工业出版社
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SPECIFIED ENGLISH FOR CNC
2nd Edition

数控专业英语

第2版

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机械工业出版社

本书共分30个单元，内容涉及数控发展历史、数控机床、数控技术的优点、现代数控机床、数控加工过程、数控编程、伺服控制、MCU与CPU、计算机数字控制、进给与转速、连续路径加工、加工中心的种类与组成、刀具监控及在程检测、切削刀具、刀具系统、自适应控制、电火花线切割加工、数控车床、数控铣床、数控机床主轴、计算机图形编程、CAD、CAM、CAD/CAM/CNC、柔性加工系统、数控职业范畴、工业机器人、计算机集成制造、面向21世纪的制造技术等，涵盖了数控发展的各个方向。此外，每篇文章后都附有专业词汇、课文注释、练习以及参考译文，一些课文后面还附有阅读材料供读者自学。

本书可作为高职高专数控技术、CAD、机电一体化等专业学生使用的专业英语教材，也可供有关工程技术人员参考。

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第2版前言

《数控专业英语》第1版自2002年8月出版以来，受到了广大师生的欢迎。结合部分使用原教材师生的意见，在保留原教材风格的前提下，本次再版对原教材进行了较大幅度的修改和调整。

本书由陕西工业职业技术学院王兆奇教授、刘向红副教授担任修订主编，修订框架由王兆奇制订。Unit 1 ~ Unit 4 由北京电子科技职业学院黄桂芸负责修订，其中Unit 4 重新编写；Unit 5、Unit 6、Unit 25 ~ Unit 30 由陕西工业职业技术学院刘向红负责修订，其中Unit 5、Unit 6、Unit 29、Unit 30 重新编写；Unit 7 ~ Unit 10 由无锡职业技术学院李晓会负责修订，其中Unit 7 重新编写；Unit 15 ~ Unit 20 由陕西工业职业技术学院王颖负责修订，其中Unit 19、Unit 20 重新编写；Unit 11 ~ Unit 14、Unit 21 ~ Unit 24 由王兆奇负责修订，其中Unit 21 重新编写。王兆奇负责全书修订后的统稿，王颖负责统稿后的资料整理。本书由空军工程大学导弹学院王曙钊教授担任主审。

由于编者水平有限，书中难免还存在错误与不妥之处，希望广大读者批评指正。

编　者

第1版前言

《数控专业英语》是供高等职业技术学院数控、CAD、机电专业学生使用的专业英语教材。通过学习本教材，读者可提高英语阅读水平，掌握常用数控英语词汇，为阅读数控英文资料打下良好基础。

在本教材的编写中，我们精心选编了与数控专业相关的科技信息，涵盖了数控各个发展方向。书中附有插图、生词、短语、注释、练习、译文及阅读材料。全书安排由浅入深，循序渐进。主要内容有：数控的发展历史、数控机床、数控的优点、计算机类型、计算机存储器、输入介质的类型、穿孔带的制作过程、伺服控制系统、MCU及CPU、计算机数字控制、进给与转速、连续路径加工、加工中心种类与组成、刀具监控及在程监测、切削刀具、刀具系统、自适应控制、电火花线切割加工、计算机图形编程、CAD、CAM、CAD/CAM/CNC、柔性制造系统、数控职业范畴、工业机器人入门等。各校可根据教学需要选学其中的相关内容。

本书所载文章全部选自欧美文献原著。陕西工业职业技术学院王兆奇副教授任主编，刘向红任副主编，本书Unit1~Unit13由陕西工业职业技术学院胡梅贻老师编写；Unit4~Unit6由陕西工业职业技术学院段文洁老师编写；Unit7~Unit8由陕西工业职业技术学院夏粉玲老师编写；Unit9~Unit10以及所有阅读材料由常州机械学校汤彩萍老师编写；Unit11~Unit12由华北机电学校虞静老师编写；Unit13~Unit14由北京仪器仪表工业学校黄桂芸老师编写；Unit15由湖南工业职业技术学院周晓宏老师编写；Unit16~Unit23由陕西工业职业技术学院王兆奇教授编写；Unit24~Unit30由陕西工业职业技术学院刘向红老师编写。王兆奇教授对全书进行了总编和修改更正，刘向红负责全书的计算机整理和编辑工作。空军工程大学导弹学院王曙钊教授主审，为本书提出了大量的宝贵意见和建议。编写过程中还得到陕西工业职业技术学院机械系张普礼副教授、数控教研室李善术副教授、赵云龙副教授、杨勇老师、加拿大外籍教师John Whittaker以及澳大利亚外籍教师Christine Story女士的热忱帮助，他们为本书提出了许多建设性的意见和建议，在此一并表示感谢。

由于时间仓促，编者水平所限，疏漏之处在所难免，敬请广大读者及同行批评指正。

编　者

2003年7月于咸阳

CONTENTS

Unit 1 History of NC

Text

Welcome to the world of numerical control (NC). Numerical control has become popular in shops and factories because it helps solve the problem of making manufacturing systems more flexible. In simple terms, a numerical control machine is a machine positioned automatically along a preprogrammed path by means of coded instructions. The key words here are "preprogrammed" and "coded". Someone has to determine what operations the machine is to perform and put that information into a coded form that the NC control unit understands before the machine can do anything. [1] In other words, someone has to program the machine.

Machines may be programmed manually or with the aid of a computer. Manual programming is called manual part programming; programming done by a computer is called computer aided programming (CAP). Sometimes a manual program is entered into the machine's controller via its own keypad. This is known as manual data input (MDI).

Advances in microelectronics and microcomputers have allowed the computer to be used as the control unit on modern numerical control machinery. This computer takes the place of the tape reader found on earlier NC machines. In other words, instead of reading and executing the program directly from punched tape, the program is loaded into and executed from the machine's computer. These machines, known as computer numerical control (CNC) machines, are the NC machines being manufactured today.

In 1947, John Parsons of the Parsons Corporation, began experimenting with the idea of using three-axis curvature data to control machine tool motion for the production of aircraft components. In 1949, Parsons was awarded a U. S. Air Force contract to build what was to become the first numerical control machine. In 1951, the project was assumed by the Massachusetts Institute of Technology (MIT). In 1952, numerical control arrived when MIT demonstrated that simultaneous three-axis movements were possible using a laboratory-built controller and a Cincinnati Hydrotel vertical spindle. [2] By 1955, after further refinements, numerical control became available to industry.

Early NC machines ran off punched cards and tape, with tape becoming the more common medium. Due to time and effort required to change or edit tape, computers were later introduced as aids in programming. Computer involvement came in two forms: computer aided programming languages and direct numerical control (DNC). Computer aided programming languages allowed a part programmer to develop an NC program using a set of universal "pidgin English" commands, which the computer then translated into machine codes and punched into the tape. [3] Direct numerical control involved using a computer as a partial or complete controller of one or more numerical control machines (Fig. 1-1). Although some companies have been reasonably successful at implementing DNC, the expense of computer capability and software and problems associated with coordinating a DNC system renders such systems economically unfeasible for all but the largest companies. [4]

Recently a new type of DNC system called distributive numerical control has been developed (Fig. 1-2). It employs a network of computers to coordinate the operation of a number of CNC machines. Ultimately, it may be possible to coordinate an entire factory in this manner. Distributive numerical control solves some of the problems that exist in coordinating a direct numerical control system. There is another type of distributive numerical control that is a spin-off of the system previously explained. In this system, the NC program is transferred in its entirety from a host computer directly to the machine's controller. Alternately, the program can be transferred from a mainframe host computer to a personal computer (PC) on the shop floor where it will be stored until it is needed. The program will then be transferred from the PC to the machine controller.

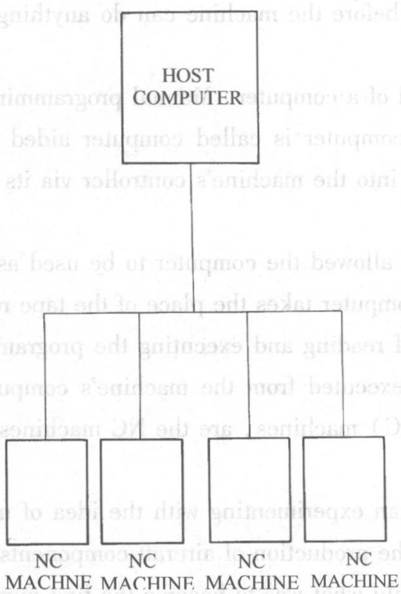

Fig. 1-1 Direct numerical control

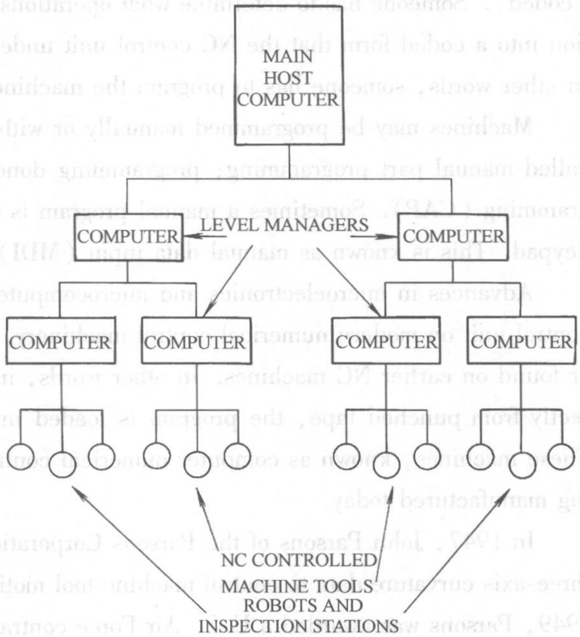

Fig. 1-2 Distributive numerical control

Technical Words

numerical [nju(:)'merikəl] adj. 数字的

manufacture [ˌmænju'fæktʃə] v. 制造，加工

n. 制造，制造业；产品

automatically [ˌɔːtə'mætikəli] adv. 自动地

program ['prəugræm] v. (为……) 编（制）程序

n. 程序

instruction [in'strʌkʃən] n. 指令

preprogram [ˌpriː'prəugræm] v. 预编程序

code [kəud] v. 编码

n. 代码，编码

information [ˌinfəˈmeiʃən]	n. 信息
manually [ˈmænjuəli]	adv. 手动地，人工地
keypad [ˈkiːpæd]	n. 键区
data [ˈdeitə]	n. 数据；参数
input [ˈinput]	n. 输入
	v. 输入
microelectronics [ˈmaikrəuilekˈtrɔniks]	n. 微电子学
execute [ˈeksikjuːt]	v. 执行
	n. 执行
punch [pʌntʃ]	v. 冲孔，打孔
	n. 冲压机；冲床
load [ləud]	v. 装载，加载
component [kəmˈpəunənt]	n. 部件；零件
technology [tekˈnɔlədʒi]	n. 工艺；技术
spindle [ˈspindl]	n. 主轴
medium [ˈmiːdjəm]	n. 方法；媒介
command [kəˈmɑːnd]	n. 命令
	v. 命令，指挥
translate [trænsˈleit]	v. 转变为；翻译
controller [kənˈtrəulə]	n. 控制器
software [ˈsɔftwεə]	n. 软件
coordinate [kəuˈɔːdinit]	v. 调整；协调
	n. 坐标
network [ˈnetwəːk]	n. 网络
transfer [trænsˈfəː]	v. 传递；改变
	n. 传递，转移
mainframe [ˈmeinfreim]	n. 主机，大型机
store [stɔː]	v. 存储，贮藏
	n. 储备

Technical Phrases

numerical control (NC)	数字控制（数控）
control unit	控制装置，控制单元
manual programming	手工编程
computer aided programming (CAP)	计算机辅助编程
manual data input (MDI)	手动数据输入
tape reader	读带机
punched tape	穿孔带
computer numerical control (CNC)	计算机数字控制

machine tool	机床
punched card	穿孔卡
direct numerical control（DNC）	直接数字控制
distributive numerical control（DNC）	分布式数字控制
host computer	主机
personal computer（PC）	个人计算机

Notes

（1）Someone has to **determine** what operations *the machine is to perform* and **put** that information into a coded form *that the NC control unit understands* before the machine can do anything.

主句中 Someone 作主语，has to determine 与（has to）put 是两个并列的谓语。定语从句 *the machine is to perform* 修饰 operations；定语从句 *that the NC control unit understands* 修饰 form。

（2）In 1952，numerical control arrived when MIT demonstrated that simultaneous three-axis movements were possible using a laboratory-built controller and a Cincinnati Hydrotel vertical spindle.

现在分词短语 using a laboratory-built controller and a Cincinnati Hydrotel vertical spindle 在句中作状语。

（3）Computer aided programming languages allowed a part programmer to develop an NC program using a set of universal "pidgin English" commands，*which the computer then translated into machine codes and punched into the tape.*

using a set of universal "pidgin English" commands 是现在分词短语作状语；which 引导的非限定性定语从句修饰 NC program。

（4）Although some companies have been reasonably successful at implementing DNC，the expense of computer capability and software and problems associated with coordinating a DNC system renders such systems economically unfeasible for all but the largest companies.

主句的主语较长，其中心词是 expense；computer capability，software，problems associated with coordinating a DNC system 作 expense 的定语；谓语动词是 render。此外，associated with coordinating a DNC system 是过去分词短语，作 problems 的后置定语；but 为介词，意为"除……之外"。

Exercises

（1）Place a "T" after sentences that are true and an " F" after those that are false.

1）An NC machine is positioned automatically along a preprogrammed path by means of coded instructions.

2）CNC stands for *computer numerical control.*

3）According to the last sentence of paragraph 5，DNC systems are economically unfeasible for all companies.

4）In a distributive numerical control system，it is impossible for the NC program to be transferred in its entirety from a host computer directly to the machine's controller.

(2) Fill in the blanks according to the text with the words given below. Make changes if necessary.

manually　punch　controller　network

1) Machines may be programmed ________ or with the aid of a computer.

2) A manual program is sometimes entered into the machine's ________ via its own keypad.

3) Early NC machines could run off ________ cards and tape, with tape being the more common medium.

4) A distributive numerical control system uses a ________ of computers to coordinate the operation of many CNC machines.

【参考译文】

第1课　数控的发展历史

欢迎来到数字控制（NC）世界。由于数字控制使制造系统柔性更强，因而已广泛应用于工厂与车间。简而言之，数控机床是通过代码指令使机床沿着预编程轨迹自动定位的机床，这里的关键词是“预编程”与“代码化”。机床运行前，必须有人确定需要机床执行什么操作，并将此信息译成数控装置能够识别的代码。换句话说，必须有人对机床编程。

人们可以手工编写加工程序，称其为手工编程；亦可借助计算机对机床编程，称为计算机辅助编程（CAP）。手工编好的程序有时可从机床键盘送入控制器，这叫做手动数据输入（MDI）。

微电子技术与微型计算机的发展已使计算机可用于现代数控机床的控制单元，取代了早期NC机床的读带机。换句话说，程序是由机床上的计算机存取和执行的，而不再直接取自穿孔带。这种计算机数控（CNC）机床就是当今制造的数控（NC）机床。

1947年，Parsons公司的John Parsons着手进行一项试验，他想用三轴曲度数据来操纵机床加工飞机零件。1949年，Parsons公司与美国空军签订了制造第一台数控机床的合同。1951年，美国麻省理工学院承担了这一项目。1952年，麻省理工学院（MIT）使用实验室制造的控制器和辛辛那提立式主轴展示三轴联动获得成功，这标志着数控时代的到来。到了1955年，几经改进之后，数控技术开始应用于工业生产。

早期的NC机床能运行穿孔卡与穿孔带，二者中以穿孔带更为通用。但是，鉴于更换、编辑纸带费时费力，后来便采用计算机作为编程的辅助工具。计算机在数控中的应用有两种形式：一是计算机辅助编程语言，二是实施直接数字控制（DNC）。有了计算机辅助编程语言，程序员可用一套通用“混杂英语”命令编写NC程序，然后由计算机将其释译为机器码并制成穿孔带。直接数字控制是指用一台计算机对一台或多台数控机床实施部分或整体控制（见图1-1）。虽然有些公司运用DNC已获得成功，但是，扩大计算机容量、购买软件、协调DNC系统等花费使这种系统并不适合所有公司，而只适用于一些大公司。

最近，一种叫做分布式数字控制的新型DNC系统（见图1-2）已经开发出来，它用计

算机网络来协调多台 CNC 机床的运行。这种方式最终有可能用来协调整个工厂的运转。这种分布式数字控制方法解决了协调直接数字控制系统时遇到的一些难题。在此基础上，人们还开发出另一种分布式数字控制系统。在这个系统中，整个 NC 程序可从主机直接传输到机床控制器。另外，该系统也可在必要时将程序从主机传输到车间的个人计算机（PC）上储存起来，以便需要时再传输到机床控制器。

Unit 2 Machines Using NC

Text

Early machine tools were designed so that the operator was standing in front of the machine while operating the controls. This design is no longer necessary, since in NC the operator no longer controls the machine tool movements. On conventional machine tools, only about 20 percent of the time was spent removing material. With the addition of electronic controls, actual time spent removing metal has increased to 80 percent and even higher. It has also reduced the amount of time required to bring the cutting tool into each machining position.

In the past, machine tools were kept as simple as possible in order to keep their costs down. Because of the ever-rising cost of labor, better machine tools, complete with electronic controls, were developed so that industry could produce more and better goods at prices which were competitive with those of offshore industries. [1]

NC is being used on all types of machine tools, from the simplest to the most complex. The most common machine tools are the single-spindle drilling machine, engine lathe, milling machine, turning center, and machining center.

1. Single-Spindle Drilling Machine

One of the simplest numerically controlled machine tools is the single-spindle drilling machine (Fig. 2-1). Most drilling machines are programmed on three axes:

a. The *X*-axis controls the table movement to the right and left.

b. The *Y*-axis controls the table movement toward or away from the column.

c. The *Z*-axis controls the up or down movement of the spindle to drill holes to depth.

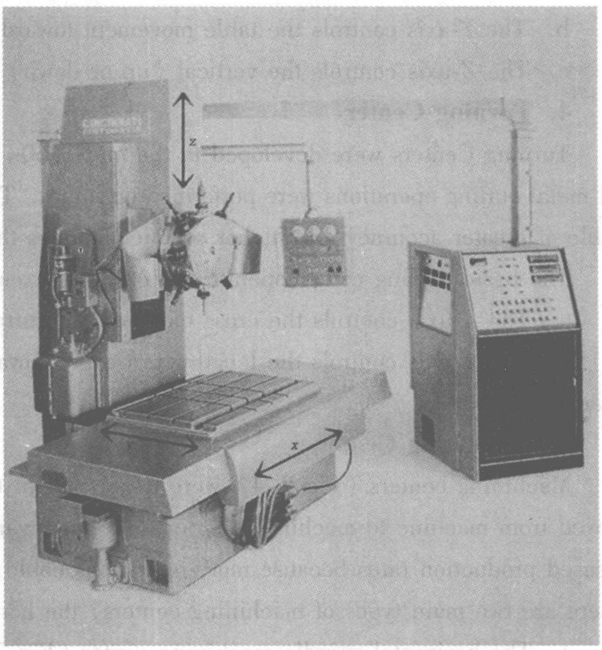

Fig. 2-1 Numerically controlled single-spindle drilling machine

2. Engine Lathe

The engine lathe, one of the most productive machine tools, has always been a very efficient means of producing round parts (Fig. 2-2). Most lathes are programmed on two axes:

a. The *X*-axis controls the cross motion (in or out) of the cutting tool.

b. The *Z*-axis controls the carriage travel toward or away from the headstock.

3. Milling Machine

The milling machine has always been one of the most versatile machine tools used in industry (Fig. 2-3). Operations such as milling, contouring, gear cutting, drilling, boring, and reaming are only a few of the many operations which can be performed on a milling machine. The milling machine can be programmed on three axes:

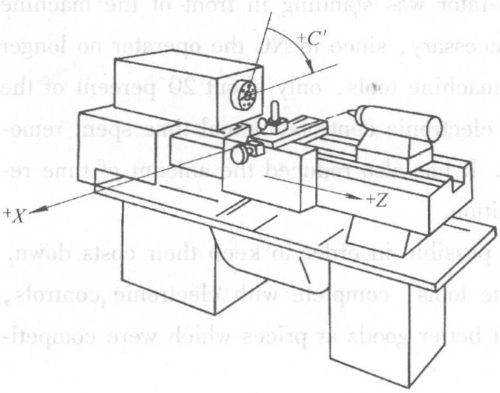

Fig. 2-2 The engine lathe cutting tool moves only on the *X* and *Z* axes

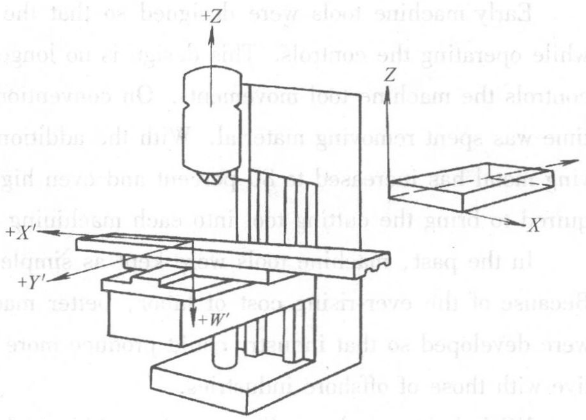

Fig. 2-3 The vertical knee and column milling machine

a. The *X*-axis controls the table movement left or right.

b. The *Y*-axis controls the table movement toward or away from the column.

c. The *Z*-axis controls the vertical (up or down) movement of the knee or spindle.

4. Turning Center

Turning Centers were developed in the mid-1960s after studies showed that about 40 percent of all metal cutting operations were performed on lathes. These numerically controlled machines are capable of greater accuracy and higher production rates than were possible on the engine lathe.

The basic turning center operates on only two axes:

a. The *X*-axis controls the cross motion of the turret head.

b. The *Z*-axis controls the lengthwise travel (toward or away from the headstock) of the turret head.

5. Machining Center

Machining centers (Fig. 2-4) were developed in the 1960s so that a part did not have to be moved from machine to machine in order to perform various operations. These machines greatly increased production rates because more operations could be performed on a workpiece in one setup. There are two main types of machining centers, the horizontal and the vertical spindle types.

a. The horizontal spindle machining center (Fig. 2-5) operates on three axes:

a) The *X*-axis controls the table movement left or right.

b) The *Y*-axis controls the vertical movement (up or down) of the spindle.

c) The *Z*-axis controls the horizontal movement (in or out) of the spindle.

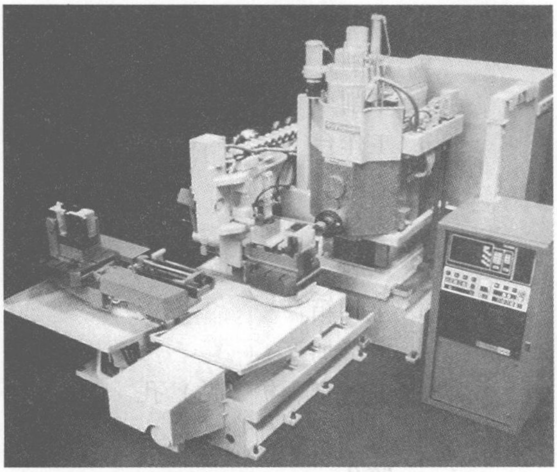

Fig. 2-4 Machining center

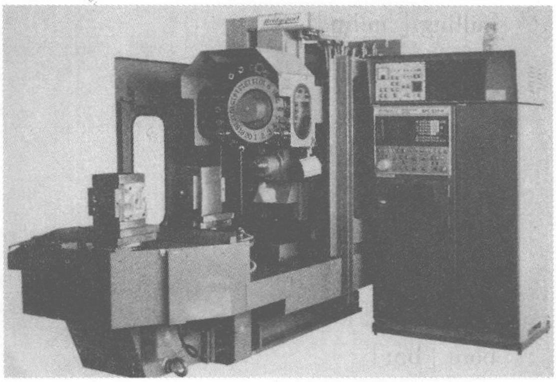

Fig. 2-5 Horizontal spindle machining center

b. The vertical spindle machining center (Fig. 2-6) operates on three axes:

a) The X-axis controls the table movement left or right.

b) The Y-axis controls the table movement toward or away from the column.

c) The Z-axis controls the vertical movement (up or down) of the spindle.

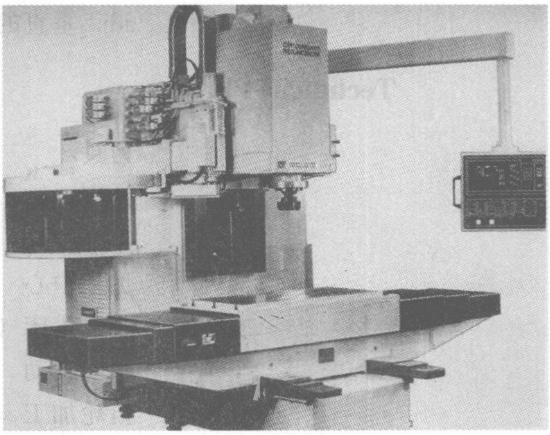

Fig. 2-6 Vertical spindle machining center

Technical Words

operator [ˈɔpəreitə] n. 操作者

operate [ˈɔpəreit] v. 操作；运行

electronic [ˌilekˈtrɔnik] adj. 电子的

drill [dril] v. 钻孔
n. 钻孔机

lathe [leið] n. 车床

v. 用车床加工
milling [ˈmiliŋ]　n. 铣削，铣加工
turning [ˈtəːniŋ]　n. 车削
table [ˈteibl]　n. 工作台
column [ˈkɔləm]　n. 立柱
part [pɑːt]　n. 零件，工件
carriage [ˈkæridʒ]　n.（机床的）滑板；刀架
headstock [ˈhedstɔk]　n. 主轴箱
contouring [kənˈtuəriŋ]　n. 成形加工
bore [bɔː]　v. 镗（穿、扩、钻）孔
boring [ˈbɔːriŋ]　n. 镗孔；镗削加工
ream [riːm]　v. 铰孔
reaming [ˈriːmiŋ]　n. 铰孔
knee [niː]　n. 升降台
accuracy [ˈækjurəsi]　n. 精确性，准确度，精度
workpiece [ˈwəːkpiːs]　n. 工件
setup [setʌp]　n. 安装；设备；机构
horizontal [ˌhɔriˈzɔntl]　adj. 水平的
vertical [ˈvəːtikəl]　adj. 垂直的，直立的

Technical Phrases

cutting tool　刀具
drilling machine　钻床
turning center　车削中心
machining center　加工中心
engine lathe　卧式车床（普通车床）
cross motion　横向运动
gear cutting　齿轮加工
metal cutting　金属切削
production rate　生产率
turret head　转塔头
lengthwise travel　纵向运动

Note

Because of the ever-rising cost of labor, better machine tools, complete with electronic controls, were developed so that industry could produce more and better goods at prices *which were competitive with those of offshore industries*.

句子主语是 better machine tools，谓语是 were developed；so that 引导结果状语从句；

which 引导的定语从句修饰 goods。

Exercises

(1) Fill in the blanks according to the text with the words given below. Make changes if necessary.

electronic　　axis　　cost　　operation　　program　　material

1) On conventional machine tools, only 20% of the time is spent removing ________.

2) Due to the addition of ________ controls, actual time spent removing metal has increased to 80% and even higher.

3) Machine tools used to be kept as simple as possible in order to keep their ________ down.

4) Most drilling machines can be ________ on three axes.

5) Milling, contouring, drilling, boring, and reaming are just a few of the ________ performed on a milling machine.

6) A basic turning center operates on only two ________.

(2) Explanation:

NC　　CNC　　CAP　　MDI　　MIT　　DNC　　PC

【参考译文】

第2课　数控机床

老式机床是按操作工站立在机床前进行操作来设计的。现在不需要这种设计了，因为操作工并不直接操纵数控机床的运行。在传统机床上加工时，只有约20%的时间用于切削材料。随着电控设备的加入，实际切削材料的时间已增至80%以上，并且缩短了将刀具送入每个加工位置的时间。

过去，人们尽量使机床结构简单，以便降低成本。由于劳动成本日益上涨，人们研制出性能更好的机床，并配有电控设备，这样企业可以生产更多更好的价格较低的产品，以和国际上的产品相竞争。

从最简单到最复杂的机床都会用到数控技术。最常见的机床有：单轴钻床、卧式车床、铣床、车削中心及加工中心。

1. 单轴钻床

单轴钻床是最简单的数控机床之一（见图2-1）。多数数控钻床可在三个坐标轴上编程：

1) *X* 轴控制工作台左右运动。

2) *Y* 轴控制工作台靠近或离开立柱。

3) *Z* 轴控制主轴上下运动，确定孔的加工深度。

2. 卧式车床

卧式车床是生产效率最高的机床之一，它是加工回转体零件时非常有效的工具。大部分数控车床可在两个坐标轴上编程（见图2-2）。