

# 机械工程专业英语

## Subject-Based English for Mechanical Engineering

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2012-11-16

# 教学要求及目的

1. 了解专业英语的语法特点，熟悉专业词汇，逐步培养学生具有比较熟练的专业文献阅读理解能力、翻译能力和英文学术论文的写作能力。
2. 掌握国外英文专利和文献资料的查询方法，能以英语为工具，获取本专业所需信息。
3. 了解国际学术交流的常用表达方式。

# 教学方式

课堂讲授、讨论与自学相结合。以教师讲授为主，引导学生积极阅读指定参考文献，完成课外作业，参与课堂讨论。有意识地积累与自己研究方向相关的词汇与文献资料，掌握专业英语学习方法。

# 教材及参考文献

教材：施平 《机械工程专业英语教程  
（第二版）》北京：电子工业出版社，2008

## 参考文献：

叶邦彦，陈统坚编：《机械工程英语》北京：机械工业出版社，  
2006

唐一平主编：《先进制造技术》北京：机械工业出版社，2004；

王慧莉，贾卫国编《国际学术交流英语》大连：大连理工大学出版社，2005



# 主要教学内容

**Lesson 1 Basic Concept in Mechanics**

**Lesson 2 Forces and Their Effects**

**Lesson 3 Overview of Engineering Mechanics**

**Lesson 4 Shafts and Couplings**

**Lesson 5 Shafts and Associated Parts**

**Lesson 6 Belts, Clutches, Brakes, and Chains**

**Lesson 7 Fasteners and Springs**

**Lesson 14 Physical Properties of Materials**

**Lesson 29 Tolerances and Surface Roughness**

**Lesson 35 Coordinate Measuring Machine**

**Lesson 36 Lathes**

**Lesson 37** Milling Machines and Grinding Machines

**Lesson 38** Drilling Operations

**Lesson 44** Nontraditional Manufacturing Processes

**Lesson 62** The Computer and Manufacturing

**Lesson 63** Computers in Design and Manufacturing

**Lesson 64** Computer-Aided Analysis of Mechanical Systems

**Lesson 65** Computer-Aided Process Planning

**Lesson 66** Numerical Control

**Lesson 71** Industrial Robots

**Lesson 77** Technical Report Elements

**Lesson 78** Writing the Technical Report

**Extra lesson 1** English for International Academic Exchange

**Extra lesson 2** Expression of Numbers, Signs, Equations and Graphs in English

**Extra lesson 3** Professional Literature and Patent Retrieval

# 课外学习内容

通过学校图书馆网页上“电子资源”栏查询与自己研究方向相关的英文文献。重点是“[EI工程索引](#)

（[www.engineeringvillage2.com.cn](http://www.engineeringvillage2.com.cn)）”、“[ELSEVIER](#)

（[www.sciencedirect.com](http://www.sciencedirect.com)）”和“[IEL](#)  
[\(IEEE/IEE\)](#)（[ieeexplore.ieee.org](http://ieeexplore.ieee.org)）”

通过“小木虫”、“科学网”、“学问社区”等网站查找专业英语学习资料，学习科学研究方法。

学习使用参考文献的管理软件如EndNote。

通过“google学术搜索

（[scholar.google.cn](http://scholar.google.cn)）”和“google 专利检索（[www.google.com/patents](http://www.google.com/patents)）”查询英文文献和英文专利。

掌握一些在线翻译软件作为辅助工具。如“有道”。

# 专利检索资源荟萃（一）

新！百度专利搜索网址：

<http://zhuanli.baidu.com/>

1.因特网专利数据库介绍（中华人民共和国国家知识产权局）：

[http://www.sipo.gov.cn/sipo//wxfw/ytwzlsukjs/ytwzlsjkjs/200508/t20050816\\_67485.htm](http://www.sipo.gov.cn/sipo//wxfw/ytwzlsukjs/ytwzlsjkjs/200508/t20050816_67485.htm)

2.中国专利检索：

<http://www.sipo.gov.cn/sipo/zljs/>

3.中国专利法律状态检索：

<http://search.sipo.gov.cn/sipo/zljs/searchflzt.jsp>

4.中国专利实施数据库（中国专利信息中心）：

[http://www.cnpat.com.cn/aboutus/actualize/hishiku/tuiguang\\_edit.asp](http://www.cnpat.com.cn/aboutus/actualize/hishiku/tuiguang_edit.asp)

5.专利信息服务平台试验系统（数据含中、美、日、欧、WO、德、法、英、俄、加、印、瑞士、韩国、澳大利亚）：

<http://pub.cnipr.com/pubpisfts/index.do>

6.中外专利数据库报务平台：

<http://search.cnipr.com:8080/cnipr/index.htm>

7.中国专利数据库检索系统：

<http://search.cnpat.com.cn/Search/CN/>

8.美国专利检索：

<http://www.uspto.gov/patft/index.html>

9.欧洲专利检索：<http://ep.espacenet.com/>

## 专利检索资源荟萃（二）

10.从ESPACENET数据库提取世界各国专利文献的方法（国知局提供）：

<http://www.sipo.gov.cn/sipo/wxfw/ytwggsjks/ytwzlsjks/ESPACENET.doc>

11.欧洲专利局免费专利数据库（含欧洲各国入口）：

<http://www.espacenet.com/access/index.en.htm>

12.欧洲专利局专利数据高级检索（含欧洲、PCT和世界范围三个数据库）：

[http://ep.espacenet.com/advancedSearch?locale=en\\_ep](http://ep.espacenet.com/advancedSearch?locale=en_ep)

13.欧洲专利法律状态查询：

<http://www.epoline.org/portal/public/registerplus>

14.PCT专利检索：

<http://www.wipo.int/pctdb/en/>

15.英国专利检索：

<http://www.ipo.gov.uk/search/index.htm>

## 专利检索资源荟萃（三）

16英国专利法律状态查询：

<http://www.ipo.gov.uk/patent/p-find/p-find-number.htm>

17.德国专利检索1：<http://www.deutsches-patentamt.de/suche/patentdatenbanken.html>

18德国专利检索2：

[http://publikationen.dpma.de/set\\_ing.do?loc=en](http://publikationen.dpma.de/set_ing.do?loc=en)

19.瑞士专利检索：<https://client.ip-search.ch/?c=login&a=client&l=1>

20.俄罗斯专利检索（英文）：

<http://www.fips.ru/ensite/>

21.台湾专利检索：<http://www.patent.org.tw/>

22. 韩国专利检索（英文）：

<http://eng.kipris.or.kr>

23. 加拿大专利检索：

<http://patents1.ic.gc.ca/intro-e.html>

24. 法国专利检索：

[http://www.boutique.inpi.fr/inpiboutic/index\\_anglais.htm](http://www.boutique.inpi.fr/inpiboutic/index_anglais.htm)

25. 印度同族专利库（多国、多组织）：

<http://patinfo.nic.in/>

# 机械工程专业信息检索

ASME-American Society of Mechanical Engineers 美国机械工程师协会

SAE-Society of Automobile Engineers 美国汽车工程师协会

EI-Engineering Index 工程索引

IEEE-Institute of Electrical and Electronics Engineers (美国)电机及电子工程师学会

IET-The Institution of Engineering and Technology 英国工程技术学会（IET）系英国电气工程师学会（IEE）和英国企业工程师学会（IIE）于2006年初合并组建而成

NTIS-National Technical Information Service 美国国家技术情报服务局

UMI-美国UMI公司，学位论文的信息服务（ProQuest）。

ISO-International Organization for Standardization 国际标准化组织。

# Lesson 1 Basic Concept in Mechanics

**Terminology** 术语,专有名词

[,tə:mi'nɒlədʒi]

**Text tour**



# Terminology

**Gear** 齿轮, 传动装置

1. A **toothed** machine part, that **meshes** with another toothed part to transmit motion or to change speed or direction.

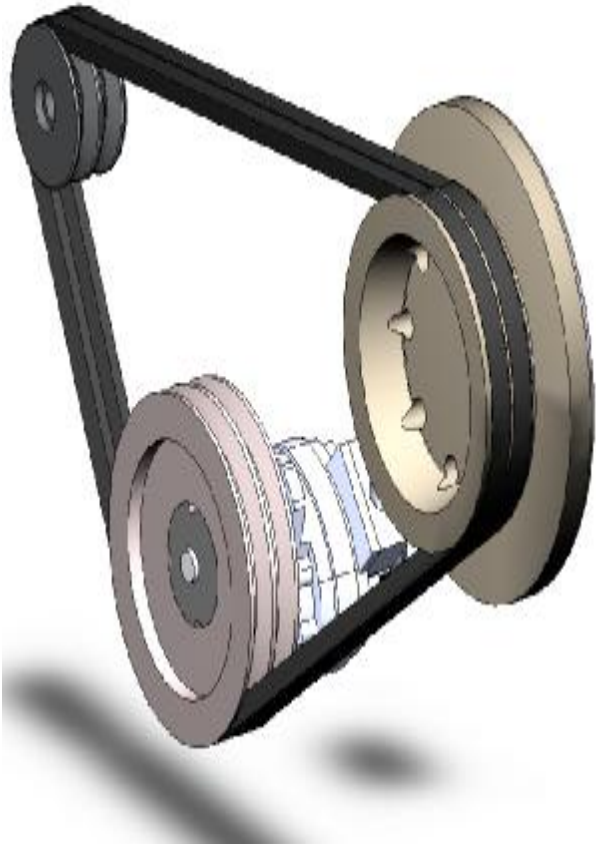
齿轮：有齿的机器零件，与另一个有齿零件相啮合，从而传递运动或者改变运动的方向或速度。



2. A complete **assembly** that performs **a specific function** in a larger machine

传动装置：一套装置，在一个更大机器中发挥具体功能

## V belt and pulley['puli] V带和带轮



## Bearing

A device that supports, guides, and reduces the **friction** of motion between fixed and moving machine parts.

轴承：在机器的固定和运动部件之间起支撑、引导和减少运动摩擦的装置。

## Couple

A pair of forces of equal **magnitude** acting **in parallel** but opposite directions, capable of causing **rotation** but not **translation**

力偶：数值相等但方向相反的两平行力，它能使物体转动但不能产生平移。

## Scalar

A **quantity**, such as **mass**, length, or speed, that is completely **specified by** its **magnitude** and has no direction.

标量：一个只有大小没有方向的量，如质量、长度或速度等

# Momentum [məu'mentəm]

A **measure** of the motion of a body **equal to** the **product** of its **mass and velocity**

动量：表示物体运动特性的一个物理量，等于运动物体的质量和速度的乘积。

## ***Text tour***

The **branch** of scientific analysis which deals with motions, time, and forces is called **mechanics** and is made up of two parts, **statics** and **dynamics**. Statics deals with the analysis of **stationary** systems, **i.e.**, those in which time is not a factor, and dynamics deals with systems which change with time.

对运动、时间和作用力做出科学分析的分支称为力学。它由静力学和动力学两部分组成。静力学对静止系统进行分析，即在其中不考虑时间这个因素，动力学对随时间而变化的系统进行分析。

Forces are transmitted into machine members through mating surfaces, e. g., from a gear to a shaft or from one gear through meshing teeth to another gear, from a V belt to a pulley, or from a cam to a follower.

力通过配合表面传到机器中的各构件上。例如，从齿轮传到轴或者从齿轮通过啮合的轮齿传到另一个齿轮，从V带传到带轮，或者从凸轮传到从动件。

If the forces between gear teeth are too large, the oil film may be squeezed out from between them. This could result in flaking and spalling of the metal, noise, rough motion, and eventual failure.

如果齿轮间相啮合的齿与齿之间的力过大，就会将油膜从齿间挤压出来。这会造成金属的碎裂和剥落，噪音增大，运动不精确，直至报废。

Two equal and opposite forces acting along two non-coincident parallel straight lines in a body cannot be **combined** to obtain a single **resultant force**. Any two such forces acting on a body **constitute** a couple. The arm of the couple is the **perpendicular** [ˌpəːpən'dɪkjʊlə] distance between their **lines of action**, and the **plane** of the couple is the plane **containing** the two lines of action.

作用在同一个刚体上的两条不重合平行线上的两个大小相等, 方向相反的力不能被合并成一个合力。作用在一个刚体上的两个这样的力构成一个力偶。力偶臂是这两条作用线之间的垂直距离, 力偶面是包含这两条作用线的平面。

Mechanics deals with two kinds of quantities: scalars and vectors. Scalar quantities are those with which a magnitude alone is associated. Examples of scalar quantities in mechanics are time, volume, density, speed, energy, and mass. Vector quantities, on the other hand, possess direction as well as magnitude. Examples of vectors are displacement, velocity, acceleration, force, moment, and momentum.

力学涉及到两种类型的量：标量和矢量。标量是那些只有大小的量。在力学中标量的例子有时间，体积，密度，速率，能量和质量。另一方面，矢量既有大小又有方向。矢量的例子有位移，速度，加速度，力，力矩和动量。



# Lesson 2 Forces and Their Effects

Terminology

Text tour

# ***Terminology***

## **Compressive**

Serving to or able to compress

**压缩的**：起压缩作用或能够压缩的

## **Turning**

The shaping of metal or wood on a lathe

**车削**：用车床将金属或木材加工成型的过程

## **Lathe 车床**



# Rectilinear[,rek'ti'liniə]

Moving in, consisting of, bounded by, or characterized by a straight line or lines:

**直线的：**以直线运动的，向直线组成的，以直线为边的，具有直线之特点的

**micrometer 千分尺**

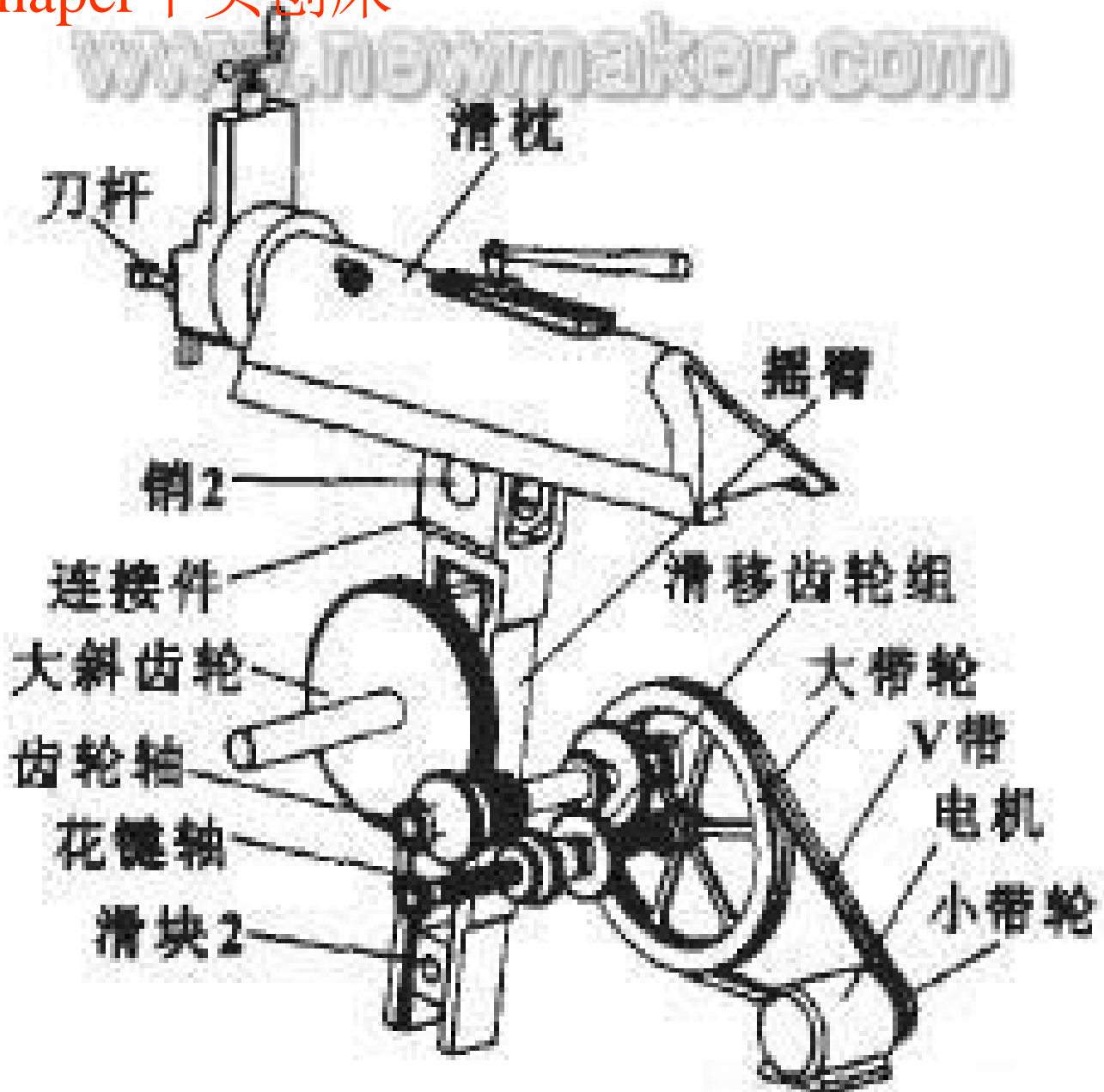


## Thread

A helical or spiral ridge on a screw, nut, or bolt

**螺纹：**螺钉、螺母或螺栓上螺旋型的凸棱

## Shaper牛头刨床



## ***Text tour***

A study of any machine or mechanism shows that each is made up of movable parts. These parts transform a given motion to a desired motion. In other words, these machines perform work. Work is done when motion results from the application of force. Thus, a study of mechanics and machines deals with forces and the effects of forces on bodies.

参考译文：研究表明机器或者机构都是由若干运动零件组成的。这些零件将给定运动转换成目标运动。换句话说，这些机器做功。因为力的作用产生运动而做功。因此，力学和机械（学）研究力以及力对物体的影响。

**A force is a push or pull. The effect of a force either changes the shape or motion of a body or prevents other forces from making such changes. Every force produces a stress in the part on which it is applied. Forces may be produced by an individual using muscular action or by machines with mechanical motion.**

参考译文：力分为推力和拉力，力可以改变物体的形状或运动状态或者防止其他力作这样的改变。施加在零件上的力会在其内部产生应力。力可以由个人的肌肉活动或者由机器的机械运动产生。

**Forces are produced by physical or chemical change, gravity, or changes in motion. When a force is applied which tends to stretch an object, it is called a tensile force. A part experiencing a tensile force is said to be in tension. A force can also be applied which tends to shorten or squeeze the object. Such a force is a compressive force.**

参考译文：力由物理或化学变化、地心引力或者运动变化产生。当力用于拉伸物体时叫拉力。零件受拉力作用被称为受拉（处于拉伸状态）。力也可用于缩短或挤压物体，这种力叫压力。

A third force is known as a **torsional force**, or a **torque** since it tends to twist an object. Still another kind of force, which seems to make the layers or molecules ['mɒlikjuls] of a material slide or slip on one another, is a **shearing force**.

参考译文：（我们知道的）第三种力是**扭转力**，或者叫**扭矩**，因为它会扭曲物体。还有另一种力，它似乎会使材料的各层或分子间产生相对滑移，称为**剪切力**。



Each of these forces may act independently or in combination. For example, a downward force applied on a vertical steel beam tends to compress the beam. If this beam is placed in a horizontal position and a load is applied in the middle, the bottom of the beam tends to stretch and is in tension. At the same time, the top area is being pushed together in compression. If the compressive and tensile forces are greater enough to make the layers of the material slide upon each other, a shearing force results.

参考译文：这些力都可以单独或者组合起来起作用。例如，一个向下的力施加在垂直钢梁上会压缩它。如果将梁水平放置，载荷施加在梁的中央，则梁的下方会伸长而受拉。同时梁的上方被压缩而受压。如果压力和拉力足够大到使材料的各层产生相对滑移，则会出现剪切力。

The turning of a part in a lathe is another example of several forces in action (as shown in Figure 1).<sup>[1]</sup>

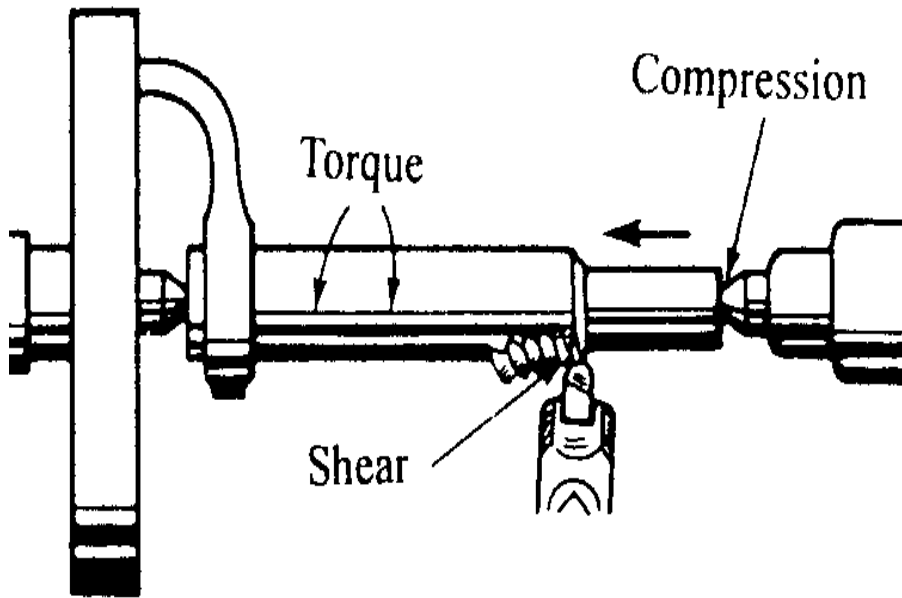


Fig. 1 The turning of a part in a lathe

1. **turning of a part** 这里指“对一个零件进行车削加工”。全句译为：

几个力同时作用的另外的一个例子是在车床上对零件进行车削加工（**如图1所示**）。

As the work revolves and the cutting tool moves into the work, the wedging action of the cutting edge produces a shear force. This force causes the metal to seem to flow off the work in the form of chips.<sup>[2]</sup>

2. **chip** 这里指“切屑”。**work** 这里指“工件，即 **workpiece**”。全句可译为：

工件旋转时刀具切入工件，切削刃的楔入动作产生剪切力。这个力使得金属看起来像以切屑的形式从工件上流出来一样。

If this workpiece is held between the centers of the lathe, the centers exert a compressive force against the work.<sup>[3]</sup>

3. **centers of the lathe** 意为“车床的两个顶尖”。全句可译为：

如果一个工件被安装在车床的两个顶尖之间，顶尖对工件施加一个压力。

**The lathe dog which drives the work tends to produce a shearing force. The pressure of the cutting tool against the work produces tension and compression, as well as a shearing action.**

参考译文：驱动工件的车床夹头会产生一个扭转力。刀具顶在工件上的压力会同时产生拉力和压力，以及剪切作用。

Considerable attention is given to the action of centrifugal force in grinding wheels. That is, the bonding agent that holds the abrasive particles on the wheel must be stronger than the forces which tend to make the revolving wheel fly apart at high speeds. For this reason, the speed of a grinding wheel should not exceed the safe surface speed limit specified by the manufacturer. Centrifugal force increases with speed.

参考译文：对磨削用的砂轮来讲离心力的影响要特别给以关注。即把磨料颗粒粘合在砂轮上的粘合剂它的粘合力必须大于使高速旋转的砂轮分崩离析的离心力。因此，砂轮的转速不能超过制造商给定的安全表面速度限制。离心力随转速的增加而增大。

**The principles of centrifugal force are used in the design of centrifuge-type machines. Some centrifuges are used to separate chemicals; others are used to remove impurities in metals by centrifugal casting processes. Centrifugal force principles are also used in common appliances such as clothes dryers and in devices to control motor speeds and accelerate moving machines.**

参考译文：离心力的这种原理用在离心型机器的设计中。一些离心分离机用于分离化学制品；还有的通过离心铸造工艺分离金属中的杂质。离心力作用也有普通的应用如干衣机、控制发动机转速的装置以及用于加速运动的机器。

**Centripetal force** causes an object to travel in circular path. This action is caused by the continuous application of forces which tend to pull the object to the center. In other words, the inward force which resists the centrifugal force is called the centripetal force. The centripetal force of objects spinning at a constant rate produces an acceleration toward the center which is equal and opposite to the centrifugal force.

参考译文：向心力使物体沿着圆形轨道运动。这种现象的产生是由于将物体拉向（轨道）中心的力的持续作用。换句话说，这种抵抗离心力的向内的力就叫向心力。以固定速率作旋转运动的物体的向心力产生一个向心的加速度，这个向心力与离心力大小相等，方向相反。

The materials used in the construction of rapidly moving machine parts and mechanisms must be structurally strong enough to provide the centripetal force required to hold the parts to a circular path. At the same time, the materials must be able to withstand the centrifugal force which tends to pull the parts apart.

参考译文：用于制造高速运动的机械零件和机构的材料组织上必须有足够强度，以提供保持零件在圆形轨道上所需的向心力。同时，这种材料必须能经得起可将零件拉裂的离心力的作用。



Motion and the basic laws which affect motion are important considerations because of the numerous applications of these principles to produce work through mechanical devices.

参考译文：对运动和影响运动的基本定律需要重视，因为有许多根据这些原理通过机械装置做功的应用。

There are two primary mechanical motions: rotary and rectilinear. These terms suggest that rotary motion is a circular movement around a *center* line and rectilinear motion is a straight line motion.

参考译文：有两个主要的机械运动：回转运动和直线运动。这些术语表明（顾名思义），回转运动是一种绕着一根中心线的环状运动，而直线运动是沿着一根直线的运动。

For either rotary or rectilinear motion, it is possible, with added mechanical devices, to produce other forms of motion such as intermittent motion and reciprocating motion.

参考译文：对回转运动或直线运动来说，如果可能的话，加上机械装置则可产生其他形式的运动如间歇运动和往复运动。

**Rotary Motion.** The motion that is commonly transmitted is rotary motion. This type of motion may be produced with hand tools or power tools. Rotary motion is required to drill holes, turn parts in a lathe, mill surfaces, or drive a generator or fan belt.<sup>[4]</sup>

**4. rotary motion** 意为“回转运动”。  
全句可译为：

回转运动 通常称为回转运动，这种运动可以由手动工具或动力工具产生。钻孔、在车床上车削零件、铣平面、驱动发电机或风扇的带等都需要回转运动。

## **Rectilinear [,rek'ti'liniə] Motion.**

The feed of a tool on a lathe, the cutting of steel on a power saw, or the shaping of materials are all situations in which rectilinear or straight line motion produces work. In each of these situations a part or mechanism is used to change rotary motion to straight line motion. The screw of a micrometer and the threads in a nut are still other applications where the direction of motion is changed from rotary to rectilinear.<sup>[5]</sup>

**5. the screw of a micrometer** 意为“千分尺中的螺杆”,全段可译为:

**直线运动** 车床上刀具的进给、在锯床上锯钢材以及材料的刨削等都是直线运动做功的情况。每个这些(类)情况都要用一个零件或机构将回转运动转化为直线运动。千分尺中的螺杆和螺母中的螺纹是把运动方向从转动变为直线的另外一些应用实例。

Harmonic and Intermittent Motion.<sup>[6]</sup> Any simple vibration, such as the regular back-and-forth movement of the end of a pendulum, is simple harmonic motion.<sup>[7]</sup>

**6. harmonic and intermittent motion** 意为“谐波运动和间歇运动”。

**7. simple harmonic motion** 意为“简谐运动”。全句可译为：任何简单的振动，例如摆的下端有规律的往复运动是简谐运动。

**However, many manufacturing processes require intermittent or irregular motion. For example, the fast return stroke of a power hacksaw or shaper ram is desirable because no cutting is done on the return stroke.**

**Therefore, as more time is saved in returning the cutting tool to the working position, the less expensive is the operation.**

参考译文：然而，很多制造工艺要求间歇运动或不规则运动。例如，电动弓锯或刨床滑枕的快速回程（快回）就是令人想要的结果，因为在回程中没有进行切削。因此，在刀具回到工作位置的过程中节省的时间越多，这道工序的成本越低。

**The combinations of rotary and rectilinear motion obtainable are unlimited because of the large variety of parts such as gears, cams, pulleys, screws, links, and belts which can be combined in many arrangements.**

参考译文：可得到的回转运动和直线运动的组合是无限的，因为有大量的零件如齿轮、凸轮、带轮、螺杆、连杆和带等可以以不同的排列形式组合起来。



# Lesson 3 Overview of Engineering Mechanics

Terminology

Text tour

# ***Terminology***

## **Interactive**

Acting or capable of acting on each other

互相作用的或能互相作用的

## **Iterative** ['itərətɪv]

Characterized by or involving  
**repetition, recurrence, reiteration, or  
repetitiousness** [,repi'tiʃəsnɪs]

重复的, 反复的, 迭代的: 以反复、循环、重述或重复为特征的, 或与之相关的

## **Pinpoint** 精确地定位或确认

To locate or identify with precision

精确地定位或确认

## **Equilibrium [ˌi:kwi'libriəm]**

**A condition in which all acting influences are canceled by others, resulting in a stable, balanced, or unchanging system**

平衡，均衡：一种所有动作的影响都互相抵消，整个系统处于平稳的、均势的、不变的状态。

**Tractable Easily handled or worked**

易于处理或操作的

**Order of magnitude : A range of values between a designated lower value and an upper value ten times as large, such as the masses of Earth and the sun differ by five orders of magnitude**

数量级：处于相差10倍的两个数值之间的那一段数值的范围。例如，地球与太阳的质量相差五个数量级。

## ***Text tour***

As we **look around** us we see a world **full of** “things”: Machines, devices, tools; things that we have designed, built, and used; things made of wood, metals, ceramics, and plastics. We know from experience that some things are better than others; they last longer, cost less, are quieter, look better, or are easier to use.

参考译文：看看我们周围可以发现一个充满了“东西”的世界：机器、装置、工具等等；这些东西是我们设计、建造和使用的；这些东西是由木材、金属、陶瓷和塑料制成的。我们从经验知道一些东西比其他的要好；它们寿命更长，成本更低，更安静，更好看，或更易于使用。

Ideally, however, every such item has been designed according to some set of “functional requirements” as **perceived** by the designers—that is, it has been designed so as to answer the question, “Exactly what function should it perform?”<sup>[1]</sup>

1. **so as to** 意为“使得，如此，以至于”。全句可译为：

然而，在理想的情况下，每一件产品都是设计人员根据其对某些“功能要求”的理解而设计出来的，也就是说，在设计过程中，应该回答这样的问题，即“它应该具有那种确切的功能？”

In the world of engineering, the major function frequently is to support some type of loading due to weight, inertia, pressure, etc. From the beams in our homes to the wings of an airplane, there must be **an appropriate melding of materials, dimensions, and fastenings** to produce structures that will perform their functions **reliably for a reasonable cost over a reasonable lifetime.**

参考译文：在工程世界里，主要的功能常常是去支撑一些由重量、惯性、压力等产生的负荷。从我们家里的房梁到飞机的机翼，一定有适当的材料、尺寸、紧固件的组合应用，以制造出在合理的使用寿命里以合理的成本满足功能要求的结构。

In practice, the **engineering mechanics** methods are used in two quite different ways:

The development of any new device requires an **interactive, iterative** consideration of form, size, materials, loads, **durability**, safety, and cost.

参考译文：在实践中，工程力学方法有两个很不相同的用途：

(1) 任何一个新装置的设计都需要在形式、尺寸、材料、载荷、耐久度、安全性和造价等方面进行反复的、交互式的考虑。

**2 When a device fails (unexpectedly) it is often necessary to carry out a study to pinpoint the cause of failure and to identify potential corrective measures.<sup>[2]</sup> Our best designs often evolve through a successive elimination of weak points.**

2. carry out 意为“进行，完成”，  
correct measure 意为“改正措施”。  
全句可译为：

当一个装置意外地失效后，通常需要进行研究工作，来找出失效的原因和确定可能的改正措施。我们最好的设计通常是通过逐渐的消除缺点来实现的。



**To many engineers, both of the above processes can prove to be absolutely **fascinating and enjoyable**, not to mention (at times) lucrative.**

参考译文：对许多工程师来说，以上两个过程能带来迷人的、令人愉悦的体验，更不用说可以获利了。

In any “real” problem there is never sufficient good, useful information; we seldom know **the actual loads and operating conditions with any precision**, and the analyses are seldom exact.<sup>[3]</sup> While our mathematics may be precise, the overall analysis is generally only **approximate**, and different skilled people can obtain different solutions.

3. **operating condition** 意为“**工作状态，工作条件**”。全段可译为：对于任何实际的问题，总是缺乏足够完整和有用的信息。我们很少准确地知道实际荷载和工作状态，因此，所做的分析工作也很少是精确的。虽然数学可能是精确的，但是全面分析通常只是近似的，而且不同的专业人员可得到不同的（分析）结果。

In the study of engineering mechanics, most of the problems will be **sufficiently "idealized"** to permit unique solutions, but it should be clear that the "real world" is far less idealized, and that you usually will have to **perform some idealization** in order to obtain a solution.

参考译文：在工程力学研究中，大部分问题要足够理想化以获得唯一解，但我们要清楚“真实世界”远不是理想的，以致我们常常不得不做一些理想化（简化）以获得一个解。

The technical areas we will consider are frequently called "statics" and "strength of materials", "statics" referring to the study of forces acting on stationary devices, and "strength of materials" referring to the effects of those forces on the structure (deformations, load limits, etc.).

参考译文：我们经常研究的技术领域叫“静力学”和“材料力学”，“静力学”研究作用于静态装置上的力，而“材料力学”是指这些力在结构上的影响（变形、负荷极限等）。

While a great many devices are not, in fact, static, the methods developed here are **perfectly applicable to dynamic situations** if the extra loadings **associated with the dynamics are taken into account**. Whenever the dynamic forces are small **relative to** the static loadings, the system is usually considered to be static.

参考译文：然而很多装置实际上不是静态的，如果与动力学有关的额外负荷已经有考虑了，那么这里的方法用于动态环境也是完美的。无论何时（只要）动态力相对静态负荷要小，系统常常被认为是静态的。

In engineering mechanics, we appreciate the various types of approximations that are inherent in any real problem:[4]

4 . be inherent in 意为“为...所固有，是...的固有性质”。

全句可译为：

在工程力学中，我们非常重视与实际问题的本质有关的各种类型的近似方法。

**Primarily**, we will be discussing things which are in “equilibrium”, i.e., not accelerating. However, if we look closely enough, everything is accelerating. We will consider many structural members to be “weightless” —but they never are. We will **deal with forces** that act at a “point”, but all forces act over an area. We will consider some parts to be “rigid”—but all bodies will **deform under load**.

参考译文：首先，我们要讨论的是处于“平衡”状态即没有加速的物体。然而任何东西都在加速，如果我们观察足够仔细的话。我们认为很多结构件是“没有重量”的——但它们从来不是这样；我们认为力作用在一个“点”上，但所有力都作用在一个区域上；我们认为有些零件是“刚性的”——但所有物体在负载作用下都会变形。

We will **make many assumptions** that clearly are false. But these assumptions should always **render** the problem easier, more **tractable**. You will discover that the goal is to make as many **simplifying assumptions** as possible without seriously degrading the result.

参考译文：我们会作一些明显是错误的假设。（但）这些假设常可使问题简化，更容易驾驭。你会发现目标是只要不使结果严重降级（歪曲），就尽可能多的做出简化的假设。



Generally there is no clear method to determine how completely, or how precisely, to treat a problem: If our analysis is too simple, we may not **get a pertinent answer**; if our analysis is too detailed, we may not be able to obtain any answer. It is usually **preferable to** start with a relatively simple analysis and then add more detail as required to **obtain a practical solution**.

参考译文：通常没有明确的方法去确定怎么完整（全面）或精确地去处理问题：如果我们的分析太简单，（我们）可能不会得到一个中肯的答案；如果我们的分析太详细，（我们）也许得不到任何答案。通常更好的是从相对简单的分析开始，添加一些需要的细节以获得实用解。

During the past two decades, there has been a **tremendous** growth in the **availability** of **computerized methods** for solving problems that previously were beyond solution because the time required to solve them would have been **prohibitive**. At the same time the cost of computer capability and use has decreased by orders of magnitude. [5] We are **experiencing an influx** of "personal computers" on campus, in the home, and in business.

参考译文：在过去二十年间，用以解决问题的计算机方法可用性得到了巨大的提升，过去不能解决是因为解决问题所需的时间受到限制。同时计算机的性能成本和使用成本有成数量级的降低。我们在校园里、在家中，在商务场所都正在经历着一个“个人计算机”的浪潮。

# Lesson 4 Shafts and Couplings

Terminology

Text tour

# ***Terminology***

## Coupling

A coupling is **a device for** connecting the ends of **adjacent shafts**.

联轴器：联轴器是用来把相邻的两个轴的轴端联接起来的装置



## Socket wrench

**A wrench with a usually interchangeable socket to fit over a nut or bolt**

套筒扳手：通常带有可替换套筒以适于螺帽或螺栓的扳手

## Keyway

**A slot for a key in the hub or shaft of a wheel**

键槽：轮毂里或轴上装键的沟槽

## Bolt 螺栓, 螺杆



## ***Text tour***

Virtually all machines contain shafts. The most common shape for shafts is circular and the cross section can be either solid or hollow (hollow shafts can **result in weight savings**). Rectangular shafts are sometimes used, as in screw driver blades, **socket wrenches** and control knob stems.

实际上，几乎所有的机器中都装有轴。轴的最常见的形状是圆形，其截面可以是实心的，也可以是空心的(空心轴可以减轻重量)。有时也采用矩形轴，例如，螺丝起子的头部、套筒扳手和控制旋扭的杆。

A shaft must **have adequate torsional strength** to **transmit torque** and not be over stressed. It must also be **torsionally stiff** enough so that one **mounted** component does not **deviate excessively from its original angular position** relative to a second component mounted on the same shaft. Generally speaking, the angle of twist should not exceed one degree in a shaft length equal to 20 diameters.

为了在传递扭矩时不发生过载，轴应该具有适当的抗扭强度。轴还应该具有足够的抗扭刚度，以使在同一个轴上的两个传动零件之间的**相对转角**不会过大。一般来说，在长度等于轴的直径的**20**倍时，轴的扭转角不应该超过**1°**。

Shafts are mounted in bearings and **transmit power** through such devices as **gears, pulleys, cams and clutches**. These devices introduce forces which attempt to bend the shaft; hence, the shaft must be rigid enough to **prevent overloading of the supporting bearings**. In general, the bending deflection of a shaft should not exceed 0.01 in. per ft of length between bearing supports.

轴安装在轴承中，通过齿轮、皮带轮、凸轮和离合器等零件传递动力。通过这些零件传来的力可能会使轴产生弯曲变形。因此，轴应该有足够的刚度以防止支撑轴承受力过大。总而言之，在两个轴承支撑之间，轴在每英尺长度上的弯曲变形不应该超过0.01英寸。



In addition, the shaft must be able to sustain a combination of bending and torsional loads. Thus an equivalent load must be considered which takes into account both torsion and bending. Also, the allowable stress must contain a factor of safety which includes fatigue, since torsional and bending stress reversals occur.

此外，轴还必须能够承受弯矩和扭矩的组合作用。因此，要考虑扭矩与弯矩的当量载荷。因为扭矩和弯矩会产生交变应力，在许用应力中也应该有一个考虑疲劳现象的安全系数。

For diameters less than 3 in. , the usual shaft material is **cold-rolled steel** containing about 0.4 percent carbon. Shafts are either cold-rolled or **forged** in sizes from 3 in. to 5 in.. For sizes above 5 in. , shafts are forged and **machined to size**.<sup>[1]</sup> **Plastic shafts are widely used for light load applications.** One advantage of using plastic is safety in electrical applications, since plastic is **a poor conductor of electricity**.

直径小于3英寸的轴可以采用含碳量大约为0.4%的冷轧钢，直径在3~5英寸之间的轴可以采用冷轧钢或锻造毛坯。当轴的直径大于5英寸时，则要采用锻造毛坯，然后经过机械加工达到所要求的尺寸。轻载时，广泛采用塑料轴。由于塑料是电的不良导体，在电气中采用塑料比较安全。

Components such as gears and pulleys are mounted on shafts by means of key. The design of the key and the corresponding keyway in the shaft must be properly evaluated. For example, stress concentrations occur in shafts due to keyways, and the material removed to form the keyway further weakens the shaft.

齿轮和带轮等零件通过键联接在轴上。在对键及轴上与之相对应的键槽的设计中，必须进行认真的计算。例如，轴上的键槽会引起应力集中，由于键槽的存在会使轴的横截面积减小，会进一步减弱轴的强度。

If shafts are run **at critical speeds, severe vibrations** can occur which can seriously damage a machine. It is important to know the magnitude of these critical speeds so that they can be avoided. **As a general rule of thumb<sup>[2]</sup>**, the difference between the **operating speed** and the critical speed should be at least 20 percent.

如果轴以临界速度转动，将会发生强烈的振动，可能会毁坏整台机器。知道这些临界速度的大小是很重要的，因为这样可以避开它。一般凭经验来说，工作速度与临界速度之间至少应该相差20%。

Many shafts are supported by three or more bearings, which means that the problem is **statically indeterminate**. Texts on strength of materials give methods of solving such problems. The design effort should be **in keeping with the economics of a given situation**.

许多轴需要三个或更多的轴承来支撑，这就意味着它是一个超静定问题。材料力学教科书介绍了求解这类问题的方法。但是，设计工作应该与特定场合的经济性相符合。

For example, if one line shaft supported by three or more bearings is needed, it probably would be cheaper to **make conservative assumptions** as to moments and design it as though it were determinate. The extra cost of an oversize shaft may be less than the extra cost of an elaborate design analysis.

例如，需要一根由三个或更多个轴承来支撑的主传动轴，可以对力矩做出保守的假定，按照静定轴对其进行设计，其成本可能会更低一些。由于轴的尺寸增大所增加的成本可能会比进行复杂、精细的设计分析工作所多花费的成本要低一些。

Another important **aspect** of shaft design is the method of directly connecting one shaft to another. This is **accomplished** by devices such as **rigid and flexible couplings**.

轴的设计工作中的另一个重要方面是一根轴与另一根轴之间的直接连接方法。这是由刚性或者弹性联轴器来实现的。

1. A coupling is a device for connecting the ends of adjacent shafts. In machine construction, couplings are used to **effect a semipermanent connection between adjacent rotating shafts**. The connection is permanent in the sense that it is not meant to be broken **during the useful life of the machine**, but it can be broken and restored in an emergency or when worn parts are replaced.

2. 联轴器是用来把相邻的两个轴端连接起来的装置。在机械结构中，联轴器被用来实现相邻的两根转轴之间的**半永久性**连接。在机器的正常使用期间内，这种连接一般不必拆开，在这种意义上，可以说联轴器的连接是永久性的。但是在紧急情况下，或者在需要更换已磨损的零件时，可以先把联轴器拆开，然后再连接上。



There are several types of **shaft couplings**, their characteristics depend on the purpose for which they are used. If an exceptionally long shaft is required in a manufacturing plant or a propeller shaft on a ship, it is made in sections that are coupled together with rigid couplings.

**联轴器**有几种类型，它们的特性随其用途而定。如果制造工厂中或者船舶的螺旋桨需要一根特别长的轴，可以采用分段的方式将其制造出来，然后采用刚性联轴器将各段连接起来。

**A common type of rigid coupling consists of two mating radial flanges (disks) that are attached by key driven hubs to the ends of adjacent shaft sections and bolted together through the flanges to form a rigid connection. Alignment of the connected shafts is usually effected by means of a rabbet joint on the face of the flanges.[3]**

一种常用的联轴器是由两个配对的法兰（盘）组成，这两个法兰盘借助靠键传动的轴套连接到相邻两节轴的两端，然后用螺栓穿过法兰连接起来形成刚性接头。相互连接的两根轴通常是靠法兰面上的槽口来对准的。

In connecting shafts belonging to separate devices (such as an electric motor and a gearbox), precise aligning of the shafts is difficult and a flexible coupling is used. This coupling connects the shafts in such a way as to minimize the harmful effects of shaft **misalignment**.

在把属于不同的设备(例如一个电动机和一个变速箱)的轴联接起来的时候，要把这些轴精确地对准是比较困难的，此时可以采用弹性联轴器。这种联轴器联接轴的方式可以把由于被联接的轴之间的轴线的不重合所造成的有害影响减少到最低程度。

Flexible couplings also permit the shafts to **deflect** under their separate systems of loads and to move freely (float) in the axial direction without interfering with one another. Flexible couplings can also **serve to reduce the intensity of shock loads and vibrations transmitted from one shaft to another.**

弹性联轴器也允许被联接的轴在它们各自的载荷系统作用下产生偏斜或在轴线方向自由移动(浮动)而不至于产生相互干扰。弹性联轴器也可以用来减轻从一根轴传到另一根轴上的冲击载荷和振动的强度。

# Lesson 5 Shafts and Associated Parts

Terminology

Text tour

# ***Terminology***

## **Sprocket**

Any of various **toothlike projections** arranged on a wheel rim to **engage** the links of a chain.

链轮：在轮缘上有牙状凸出物，与链条相啮合的轮子。



## Universal joint

A joint or coupling that allows parts of a machine not **in line with** each other limited freedom of movement in any direction while **transmitting rotary motion**. Also called universal coupling .

**万向接头：**一种接头或连轴节，能使互相不在一条线上的机械零件在传输旋转运动时在任意方向上具有有限的运动自由度。也称作 universal coupling。



## Self-aligning bearing 调心轴承，球面轴承，自位轴承



## Dry ice

Solid carbon dioxide that sublimates at  $-78.5^{\circ}\text{C}$  and is used primarily as a coolant.

**干冰：** 固态二氧化碳，在 $-78.5^{\circ}\text{C}$ 升华，主要用作制冷剂。



## ***Text tour***

The term shaft usually refers to a relatively long member of round cross section that rotates and transmits power. One or more members such as gears, sprockets, pulleys, and cams are usually attached to the shaft by means of pins, keys, splines, snap rings, and other devices.<sup>[1]</sup>

1. **attach to**意为“连接到...上，安装在...上”。全句可译为：

轴通常是指有圆形截面的相对较长的构件，轴旋转并传递动力。一个或多个诸如齿轮，链轮，皮带轮和凸轮等类的构件通常借助于销、键、花键、卡环或其它装置连接到轴上。

These latter members are among the “associated parts” considered in this text, as re couplings and universal joints, which **serve to connect the shaft** to the source of power or load.<sup>[2]</sup>

2. **associated parts** 意为“相关零件”。全句可译为：

后面提到的这些构件在本篇课文中被称为“相关零件”，还有联轴器和万向节，它们被用来实现轴与动力源或与载荷之间的联接。

A shaft can have a nonround cross section, and it need not necessarily rotate. It can be stationary and **serve to support a rotating member**, such as the short shafts that support the nondriving wheels of an automobile. The shafts supporting idler gears can be either rotating or stationary depending on whether the gear is attached to the shaft or supported by it through bearings.

轴也可以是非圆截面的并且不一定要旋转。它可以是固定的去支撑一个回转构件，就像汽车里支撑非驱动轮的短轴一样。支撑换向齿轮的轴可以旋转也可以静止不动，这取决于这个换向齿轮是联接在轴上还是通过轴承（由轴）支撑的。

It is apparent that shafts can be subjected to various combinations of axial, bending, and torsional loads, and that these loads may be static or fluctuating.<sup>[3]</sup>

3. it is apparent that 意为“很显然，很明显”。

全句可译为：

很显然，轴将承受轴向、弯曲、扭转等载荷的各种组合的作用。而且，这些载荷可能是静态的，也可能是波动的。

Typically, a rotating shaft transmitting power is subjected to a constant torque (producing a mean torsional stress) together with a completely reversed bending load (producing an alternating bending stress).

典型地，一根传递动力的轴受到一个恒定的扭矩（产生一个平均的扭转应力）和一个完全的交变弯曲载荷（产生一个交变弯曲应力）的共同作用。

In addition to **satisfying strength requirements**, shafts must be designed so that deflections are within acceptable limits. **Excessive lateral shaft deflection** can **hamper gear performance** and cause objectionable noise. The associated angular deflection can **be very destructive to non-self-aligning bearings** (either plain or rolling).

除了满足强度要求之外，所设计轴的挠度也必须在可接受的极限范围内。过大的侧向挠度会影响齿轮的性能并产生讨厌的噪音。相关的角向挠度对非调心轴承（滑动轴承或滚动轴承）来说极具破坏性。

**Torsional deflection can affect the accuracy of a cam or gear driven mechanism.**

**Furthermore, the greater the flexibility—either lateral or torsional—the lower the corresponding critical speed.<sup>[4]</sup>**

**4. critical speed 意为“临界转速”。**

全句可译为：

此外，柔性（横向的或扭转的）越大，则相应的临界转速就越低。

- Sometimes members like gears and cams are **made integral with** the shaft, but more often such members (which also include pulleys, sprockets, etc. ) are made separately and then **mounted onto** the shaft. The portion of the mounted member in contact with the shaft is the hub. Attachment of the hub to the shaft is made in a variety of ways.

A gear can be gripped axially between a shoulder on the shaft and a spacer, with torque being transmitted through a key.[5] The grooves in the shaft and hub into which the key fits are called keyways.

5. shoulder on the shaft 意为“轴肩”。

全句可译为：一个齿轮可以用轴肩和挡圈进行轴向固定，并通过键来传递扭矩。



**A simpler **attachment** for transmitting relatively light loads is provided by pins. Pins provide a relatively inexpensive means of transmitting both **axial and circumferential** loads.**

更简单的用来传递相对较轻载荷的连接的是销。销提供了一种能同时传递轴向和周向载荷的较便宜的手段。

**An excellent and inexpensive method of axially positioning and retaining hubs and bearings onto shafts is by means of retaining rings, commonly called snap rings. Shaft snap rings require grooves that weaken the shaft, but this is no disadvantage if they are located where stresses are low.**

一种极好的又很便宜的使轮毂和轴承在轴上轴向定位并固定的方法是用定位环，通常叫卡环。轴卡环需要（在轴上）开槽，这会使轴的强度降低，但如果槽开在应力较小的地方这也不算什么缺点。

Perhaps the simplest of all **hub-to-shaft attachments** is by means of **an interference fit**<sup>[6]</sup> (hub bore is slightly smaller than shaft diameter, with assembly being made with a press, or by **thermally expanding the hub**——sometimes also **contracting** the shaft, as with dry ice——prior to **making a quick assembly** before the temperatures equalize).

6. **interference fit** 意为“过盈配合”。全句可译为：

借助于过盈配合来实现的联接可能是轮毂与轴之间的最简单的固定方式。毂孔比轴径稍小，用压装法或使毂热膨胀——有时也用干冰让轴冷缩——在它们温度相同之前快速装配。

The strongest provision for **torque transmission** is usually by means of mating splines cut in the shaft and hub.<sup>[7]</sup>

**7. mating splines** 意为“配套的花键”。  
全句可译为：最好的传递扭矩的方式是借助于在轴和轮毂上加工出来的相对应  
的花键来实现的。



**With respect to** lateral vibration and critical speeds, the practicalities of manufacturing and operation are such that the center of mass of a rotating system can never **coincide exactly with** the center of rotation. Hence as the shaft rotating speed is increased, **centrifugal force** acting at the mass center **tends increasingly to bow the shaft.** 参考译文：关于横振动和临界速度，制造和使用的实践是回转系统的质心从来不会和回转中心重合。因此当轴的转速增加，作用在质心的离心力也增加从而使轴弯曲

The more the shaft bows, the greater the **eccentricity** and the larger the centrifugal force.

Below the lowest (or fundamental) critical speed of rotation, the centrifugal and shaft elastic forces balance at a finite shaft deflection. At the critical speed, equilibrium theoretically requires an infinite displacement of the mass center.轴弯曲得越多，**偏心**越厉害，离心力也越大。在最低临界转速以下，离心力和轴的弹力在一个有限的轴挠度的情况下达到平衡。在临界转速时，这个平衡理论上要求轴的质心有无限的偏移量。

Damping causes equilibrium to occur at a finite displacement. However, this displacement is often large enough to break the shaft. Rotation sufficiently above the critical speed **results in** a satisfactory equilibrium position by moving the mass center toward the center of rotation.

阻尼使这个平衡在有限的偏移下出现。然而，偏移量常常大到足以破坏轴。充分大于临界转速的旋转通过将质心移向回转中心会得到令人满意的平衡位置。

In unusual situations (as some high-speed turbines), satisfactory operation is provided by **quickly going through the critical speed** (not allowing sufficient time for an equilibrium deflection to be reached) and then **running well above the critical speed**.

在特殊情况下（如一些高速涡轮机），通过快速通过临界转速（不给达到平衡挠度足够的时间）可以达到满意的效果，并顺利使转速超过临界转速。



**Place necessary stress raisers away from highly stressed shaft regions if possible.**<sup>[8]</sup> Consider **local surface strengthening processes (as shot-peening or cold-rolling).**<sup>[9]</sup>

8. **stress riser** 意为“应力集中源”。  
全句可译为：

尽可能使必要的应力集中源远离轴上承受较高应力的区域。

9. **surface strengthening process**  
意为“表面强化工艺”。全句可译为：  
考虑采用局部表面强化工艺（诸如喷丸硬化和冷轧）。

The shaft (journal) deflection across a plain bearing must be small compared to the oil film thickness.<sup>[10]</sup>

10. journal 意为“轴颈”。

全句可译为：在滑动轴承中，轴（轴颈）的偏转必须小于油膜厚度。

The shaft angular deflection at a ball or roller bearing should generally not exceed 0.04 deg. unless the bearing is self-aligning.<sup>[11]</sup>

11. ball or roller bearing 意为“球轴承或滚子轴承”。

全句可译为：如果没有采用调心轴承，轴在球轴承或滚子轴承中的角度偏转通常不能超过0.04°。

# Lesson 6 Belts, Clutches, Brakes, and Chains

Terminology

Text tour

# ***Terminology***

## **Clutch**

**Any of various devices for engaging and disengaging two working parts of a shaft or of a shaft and a driving mechanism**

**离合器：**一种使一根轴的两个工作部分或一根轴与机械驱动装置处于相接合或分离状态的装置

# Friction

**1. Friction is the resistance to motion of two moving objects or surfaces over each other**

**摩擦：** 两个相互接触的物体当有相互运动或相互运动趋势时，在接触面产生的阻碍运动的作用。

**2. A force that resists the relative motion or tendency to such motion of two bodies in contact**

**摩擦力：** 一种阻碍两个相接触物体之间产生相对位置移动的力。

# Chain

A connected, flexible series of links, typically of metal, used especially for **holding objects together** or **restraining** or for **transmitting mechanical power**.

**链，链条：**一系列相连的，可折叠弯曲的环节，通常为金属，用来将物体联结到一起或限定物体的位置或用来传送机械能。



# Timing belt

## 同步带



## ***Text tour***

Belts, clutches, brakes, and chains are examples of machine elements that **employ friction as a useful agent**. A belt provides a convenient means for transferring power from one shaft to another. **Belts are frequently necessary to reduce the higher rotative speeds of electric motors to the lower values required by mechanical equipment.**

参考译文：带、离合器、制动器和链是利用摩擦力的机械元件的例子。带提供将动力从一根轴传向另一根的简便方法。带常用于将电机的较高转速降低为机械设备需要的较低转速。



Clutches are required when shafts must be frequently connected and disconnected. The function of the brake is to turn mechanical energy into heat. The design of frictional devices is subject to uncertainties in the value of the coefficient of friction that must necessarily be used. Chains provide a convenient and effective means for transferring power between parallel shafts.

参考译文：离合器用于轴需要经常联接和断开的场合。制动器的功能是将机械能转化为热能。摩擦装置的设计受到必须使用的摩擦系数值的不确定性影响。链提供一种在平行轴间传递动力的方便而有效的方法。

The rayon and rubber V-belt is **widely used for power transmission**.<sup>[1]</sup> Such belts are made in two series: the standard V-belt and the high-capacity V-belt. Other types of belts are **available for** power transmission purposes. The teeth of so-called timing belt will **keep shafts completely synchronized**.<sup>[2]</sup>

1. **power transmission** 意为“动力传送，动力传动装置”。全句可译为：人造纤维和橡胶V带被广泛用来进行动力传送。

2. **timing belt** 意为“同步带”。全句可译为：所谓的同步带上的齿可以使轴与轴之间实现完全同步。

When **designing a V-belt drive** it is a good plan to calculate the cost of two or three different **layouts of belts and pulleys** to determine which has the smallest overall cost. The catalogs of the various manufacturers of V-belts contain much practical information.

参考译文：当设计V带传动时最好计算两到三种带和带轮的不同布局以决定哪种具有最小的整体成本。V带制造商的目录包含有更多的实际信息。

**The V-belt is an important element in the field of power transmission. It is continually being improved by the various manufacturers and loading values are revised from time to time. The designer generally is guided by the current literature for the particular brand of belt he expects to use. The forgoing development should be considered a method that shows how the fatigue life of a belt is influenced by factors such as bending, centrifugal effects, and power transmitted.**

参考译文：V带在动力传输领域中是一个重要的元件。它得到各个制造商不断的发展，负荷值也不时地得到改进。设计者一般根据特别品牌的当前文献来选择他想用的带。即便不发展也要考虑一种方法来显示带的疲劳寿命如何受弯曲、离心力的作用和动力传输等参数的影响。

**A clutch is a device for quickly and easily connecting or disconnecting a rotatable shaft and a rotating coaxial shaft.<sup>[3]</sup>**

3. rotatable shaft 意为“可以转动的轴，从动轴”；rotating shaft 意为“转动的轴，主动轴”。全句可译为：

离合器是一个用来使从动轴与位于同一轴线上的主动轴进行快速和顺利的联接或脱开的装置。

**Clutches are usually placed between the input shaft to a machine and the output shaft from the driving motor, and provide a convenient means for starting and stopping the machine and permitting the driver motor or engine to be started in an unloaded state.**

离合器通常位于机器的输入轴和驱动电机的输出轴之间，以提供一个方便地启动和停止机器的手段，并使得驱动电机或发动机在无荷载的状态下启动。

The rotor (rotating member) in an electric motor has **rotational inertia**, and a torque is required to bring it up to speed when the motor is started. If the motor shaft is rigidly connected to a load with a large rotational inertia, and the motor is started suddenly by closing a switch, the motor may not **have sufficient torque capacity to** bring the motor shaft up to speed before the windings in the motor are burned out by the excessive current demands.<sup>[4]</sup>

#### 4. **rotational inertia** 意为“转动惯量”。

电机中的转子有转动惯量，当电机启动时需要一个转矩带动其运转。如果电动机的轴与具有很大转动惯量的负载刚性地联接在一起，当合上开关使电动机突然启动时，有可能在电动机没有来得及产生足够的扭矩，使电动机的轴达到应有的转速之前，电动机内的线圈就会因为过大的电流而被烧毁。

A clutch between the motor and the load shafts will **restrict the starting torque** on the motor to that required to accelerate the rotor and parts of the clutch only. On some machine tools it is convenient to let the **driving motor** run continuously and to start and stop the machine by operating a clutch.

参考译文：电机和负载轴之间的离合器会限制电机的启动转矩只到所需要的加速转子和离合器部件的数值。在一些机床上让驱动马达持续运转而通过操作离合器使机器启停是方便的。

A brake is similar to a clutch except that one of the shafts is replaced by a fixed member. The basic function of a brake is to **absorb energy** (i.e., to **convert kinetic and potential energy into friction heat**)<sup>[5]</sup> and to **dissipate the resulting heat without developing destructively high temperatures**.

5. kinetic and potential energy 意为“动能与势能”。

全句可译为：

除了把一根轴换成固定构件外，制动器和离合器很相似。制动器的功能是吸收能量（即：将动能与势能转化为摩擦热）并散热使之不会达到破坏性的高温。



Clutches also **absorb energy and dissipate heat**, but usually at a lower rate. Where brakes (or clutches) are used more or less continuously **for extended periods of time**, provision must be made for rapid transfer of heat to the surrounding atmosphere. For intermittent operation, the thermal capacity of the parts may permit much of the heat to be stored, and then dissipated over a longer period of time. Brake and clutch parts must be designed to **avoid objectionable thermal stresses and thermal distortion**.

参考译文：离合器也吸收能量并散热，只是通常效率较低。在制动器（离合器）或多或少持续使用的情况下，必须有将热量快速传向周围大气的预防措施。对间歇操作来说，零件的热容量可以储存更多的热量，并在较长的时间里散热。制动器和离合器的设计必须能避免讨厌的热应力和热变形。

The rate at which heat is generated on a unit area of friction interface is equal to the product of the normal pressure, coefficient of friction, and rubbing velocity.<sup>[6]</sup>

6. coefficient of friction 意为“摩擦系数”。

全句可译为：

在摩擦面之间单位面积上所产生热的速率等于正压力，摩擦系数和摩擦速度三者的乘积。

Manufacturers of brakes and of brake lining materials have conducted tests and accumulated experience enabling them to arrive at **empirical values** of  $pV$  (**normal pressure times rubbing velocity**) and of power per unit area of friction surface that are **appropriate for** specific types of brake design, brake **lining** material, and **service conditions**.

参考译文：制动器及其内衬材料的制造商有测试和经验积累他们能得到  $pV$ （标准压力乘摩擦速率）和摩擦表面的单位面积功率的经验值，适用于特定类型的制动器设计，制动器内衬材料以及工作条件。

**Chain drives** combine some of the more advantageous features of **belt and gear drives**. Chains provided almost any speed ratio for any practical **shaft separation distance**. Their chief advantage over gears is that chains can be used with arbitrary center distances. **Compared with** belts, chains offer the advantage of positive (no slip) drive and therefore **greater power capacity**.<sup>[7]</sup>

**positive (no slip) drive** 意为“强制（无滑动）传动”。全句可译为：

链传动组合了带传动和齿轮传动的一些优点。链在任意实际的轴间距上几乎可以实现任意的传动比。与齿轮相比它们最主要的优点是链能在任意的中心距情况下使用。与带传动相比，链传动的优点是强制（无滑动）传动，因此具有更大的传递动力的能力。

An additional advantage is that not only two but also many shafts can be driven by a single chain at different speeds, yet all have synchronized motions. Primary applications are in conveyor systems, farm machinery, textile machinery, and motorcycles.

还有一个优点是一根单链可以驱动两根以上的轴以不同的转速作同步运动。主要应用在输送系统，农机，纺织机械和摩托车上。

In its simplest form a chain drive **consists of** two sprockets of arbitrary size and a chain loop. Sprockets are wheels with external teeth shaped so that they can **fit into** the links of the drive or driven chain. The shape of the teeth varies with the number of teeth. In some recent automotive applications, tooth shape and/or size is **modified to reduce noise generation.**

最简单的链传动由两个任意尺寸的链轮和一圈链组成。链轮是带有外部齿廓的轮子，它能嵌入到主动链或被动链的链节中。齿的形状随齿数变化。在新近的一些汽车应用中，齿形和/或尺寸被修正以减少噪声的产生。

Chains are available in a range of accuracies extending from precision to nonprecision. Nonprecision chains are low in cost and **intended primarily for** noncritical drives of less than 40-kW power ratings, precision chains, by contrast, are designed for high speeds and power capacity.<sup>[8]</sup>

8. **power rating** 意为“额定功率”。全句可译为：

链可在从精密到普通的精度范围中使用。普通链的成本低，主要用于额定功率在40kW以下的非关键性的传动中，与之相反，优质链被设计用于高速和传递大功率的场合。

# Lesson 7 Fasteners and Springs

Terminology

Text tour



# ***Terminology***

## **Nut**

**A small block of metal with a central, threaded hole that is designed to **fit around** and **secure a bolt or screw.****

**螺母，螺帽：**中部有带螺纹的孔，用于与螺栓或螺钉相配合并将其紧固的小金属块。



## Rivet ['rivit]

A rivet is a metal **pin with** a head used to **fasten** two or more materials **together**.

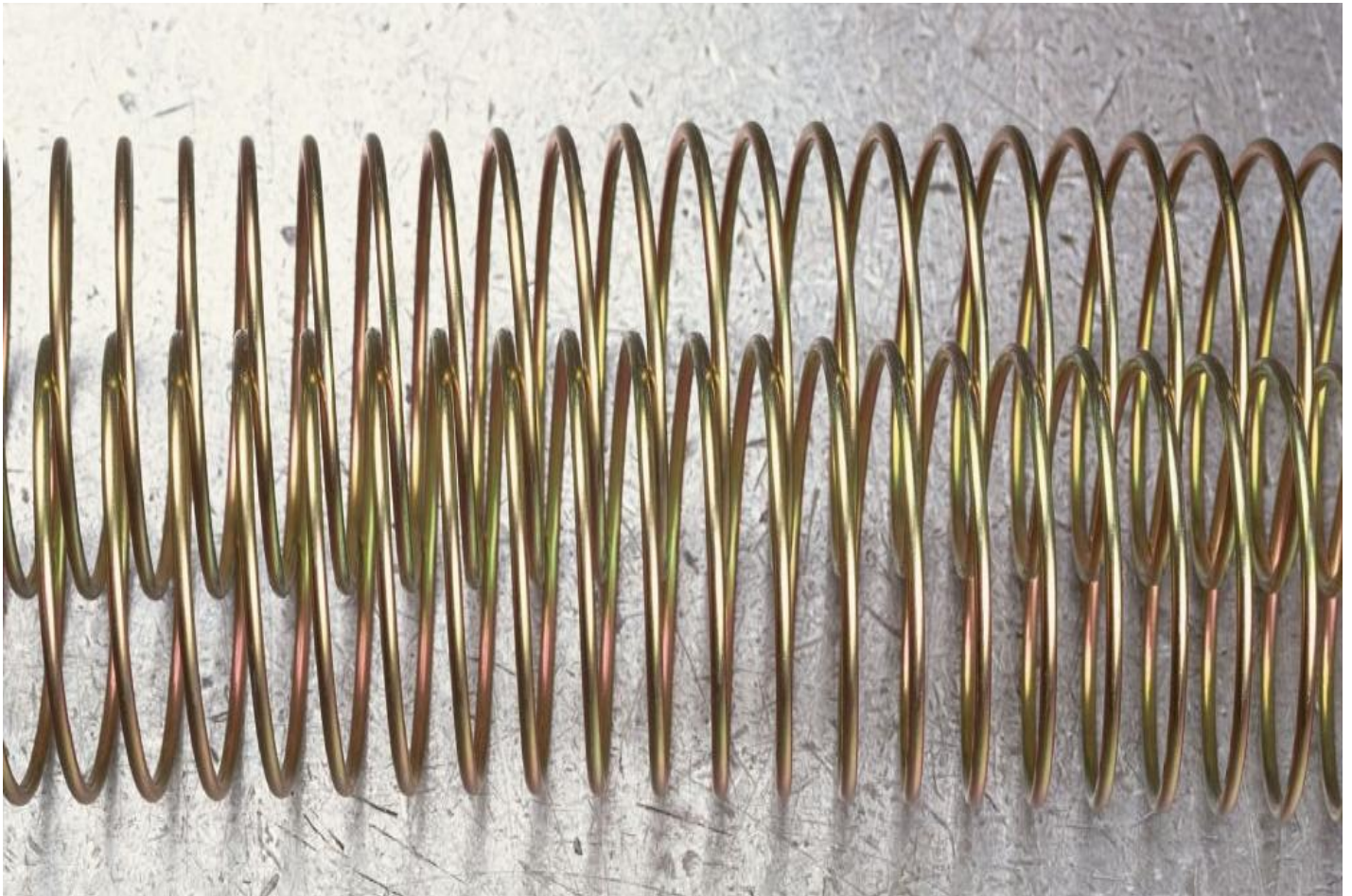
**铆钉**：铆钉是一头有帽的金属钉，用来将两种或多种材料紧固在一起。



# Spring

An elastic device, that **regains its original shape** after being **compressed or extended**

弹簧：一种弹性装置在被压缩和拉伸后仍能恢复原来的形状。



# ***Text tour***

**Fasteners** are devices which permit one part to be joined to a second part and, hence, they are **involved in** almost all designs. The **acceptability** of any product depends not only on the selected components, but also on the means by which they are fastened together. **The principal purposes of fasteners are to provide the following design features:**

紧固件是将一个零件与另一个零件进行联接的零件。因此，几乎在所有的设计中都要用到紧固件。人们对于任何产品的满意程度不仅仅取决于其组成部件，而且还取决于其联接方式。紧固件为产品设计提供了以下特性：

- (1) Disassembly for inspection and repair;
- (2) Modular design where a product consists of a number of subassemblies. Modular design aids manufacturing as well as transportation.

(1)为检查和维修提供拆卸的方便；

(2)为由许多部件组成的模块化设计提供方便。采用模块化设计有助于生产制造和运输。

**There are three main classifications of fasteners, which are described as follows:**

紧固件可以分为以下三类：（练：我们班的人可分为以下三种）

**(1)Removable. This type permits the parts to be readily disconnected without damaging the fastener. An example is the ordinary nut-and-bolt fastener.**

(1)可拆式。采用这种紧固方式连接的零件很容易被拆开，而且不会对紧固件造成损伤。例如普通的螺栓螺母连接。



(2) **Semipermanent**. For this type, the parts can be disconnected, but some damage usually occurs to the fastener. One such example is **a cotter pin**.

(2)半永久式。采用此类紧固件连接的零件虽然能被拆开，但通常会对所用的紧固件造成损伤，如开口销。

(3) **Permanent**. When this type of fastener is used, **it is intended that** the parts will never be disassembled. Examples are **riveted and welded joints**.

(3)永久式。采用这种紧固件就表明所连接的零件不会被分开，如铆接和焊接。



**The following factors should be taken into account when selecting fasteners for a given application:**

对于一个特定的应用，在选择紧固件时应考虑以下几个方面：（练：为了节水，在选择洗衣机时需要考虑以下几点）

**(1) Primary function;**

(1)基本功能；

**(2) Appearance;**

(2)外观；

**(3) A large number of small size fasteners versus a small number of large size fasteners (an example is bolts);**

(3)对于采用大量的小型紧固件还是采用少量的大型紧固件的确定(螺栓可以作为一个例子)；

**(4) Operating conditions such as vibration, loads and temperature;**

(4)诸如载荷、振动和温度等工作条件；

(5) Frequency of disassembly;

(5) 装拆频率;

(6) Adjustability in the location of parts;

(6) 零件位置的可调性;

(7) Types of materials to be joined;

(7) 被连接零件的材料种类;

(8) Consequences of failure or loosening of the fastener.

(8) 紧固件失效或者松脱造成的后果。

The importance of fasteners can be realized when referring to any complex product. **In the case of** the automobile, there are **literally** thousands of parts which **are fastened together** to produce the total product. The failure or loosening of a single fastener could **result in** a simple nuisance ['nju:sns] such as a door rattle or in a serious situation such as a wheel coming off. Such possibilities must be taken into account **in the selection of the type of fastener for the specific application.**

通过任何一个复杂的产品，都可以认识到紧固件在其中的重要性。以汽车为例，它是由数千个零件联接在一起而成为一辆整车的。一个紧固件的失效或松脱可能会带来像车门嘎嘎响这类小麻烦，也可能造成像车轮脱落这种严重的后果。因此，在为一个特定的用途选择紧固件时，应该考虑到上述各种可能性。

Springs are **mechanical members** which are designed to give a relatively large amount of elastic deflection **under the action of an externally applied load**. Hooke's Law, which states that deflection is **proportional to<sup>[2]</sup> load**, is the basis of behavior of springs. However, some springs are designed to **produce a nonlinear relationship between load and deflection**.

弹簧是一种能够在外载荷作用下，产生相当大的弹性变形的机械零件。描述变形与载荷成正比的虎克定律表明了弹簧的基本性能。然而，也有一些弹簧在其设计时所确定的载荷与变形之间的关系就是非线性的。

The following is a list of the important purposes and applications of springs:

(1) Control of motion in machines. This category represents the majority of spring applications such as operating forces in clutches and brakes. Also, springs are used to maintain contact between two members such as a cam and its follower.

弹簧的主要用途如下所述:

(1) 控制机构运动。这类应用占弹簧用途的主要部分, 如在离合器和制动器中起操纵力的作用。弹簧也被用来保持凸轮与从动件接触。

**(2) Reduction of transmitted forces as a result of impact or shock loading.**

**Applications here include automotive suspension system springs and bumper springs.**

(2)缓冲和减振。这类应用包括汽车悬架系统弹簧和缓冲弹簧。

### **(3) Storage of energy.**

**Applications in this category are found in clocks, movie cameras and lawn mowers. Many parking meters[4] use spring mechanisms which perform the timing function.**

(3) 储存能量。这类弹簧应用于钟表、摄影机和割草机中。在许多汽车停车计时器中采用弹簧机构来实现计时功能。

- **(4) Measurement of force. Scales used to weigh people is a very common application for this category.**
- (4)测量力的大小。用来称体重的秤就是这类应用中最常见的一种。



Most springs are made of steel, although silicon bronze, brass and beryllium copper are also used. Springs are **universally made** by companies which **specialize in the manufacture of springs**. The helical coil spring is the most popular type of spring; **torsion bars and leaf springs** are also widely used.

大部分弹簧是采用钢来制造的，但也有一些弹簧采用硅青铜、黄铜和铜铍合金制造。弹簧通常由专业生产弹簧的厂家制造。圆柱螺旋弹簧是最常用的弹簧，扭杆和板簧也有广泛的应用。

If the wire diameter (assuming a helical coil spring) is less than 8 mm, the spring will normally be cold-wound from hard-drawn or oil-tempered wire[5]. For larger diameters, springs are formed using hot-rolled bar.

对于圆柱螺旋弹簧，如果弹簧丝直径小于8 mm，通常采用冷拔钢丝或者油回（火）钢丝通过冷卷法制成。如果弹簧丝直径较大，采用热轧钢筋卷制弹簧。

It is good practice to consult with a spring manufacturing company when selecting a spring design, especially if high loads or temperatures are to be encountered, or if stress reversals occur or corrosion resistance is required. To properly select a spring, a complete study of the spring requirements, including space limitations, must be undertaken. Many different types of special springs are available to satisfy unusual requirements or applications.

选择弹簧，尤其是在遇到重载、高温、需要承受交变应力或者需要具有抗腐蚀性的时候，应该向弹簧制造厂家进行咨询。为了正确地选择弹簧，应该对弹簧的各种使用要求，包括空间限制进行全面地研究。有许多不同种类的专用弹簧可以满足一些特殊的要求或用途。

# Lesson 14 Physical Properties of Materials

Terminology

Text tour

# ***Terminology***

## **Melting point**

The temperature at which a solid becomes a liquid **at standard atmospheric pressure**

熔点：在标准大气压力之下固体熔化成液体的温度

## Specific heat

**The ratio of the amount of heat required to raise the temperature of a unit mass of a substance by one unit of temperature to the amount of heat required to raise the temperature of a similar mass of a reference material, usually water, by the same amount.**

**比热：** 将一单位质量的物质的温度提高一单位所需的热量与将一具有相似质量的对照材料，通常为水，提高相同单位的温度所需的热量之比

- **Specific gravity**
- **The ratio of the mass of a solid or liquid to the mass of an equal**
- **volume of distilled water at 40C**
- **比重：**一种固体或液体的质量与温度为40C 的同体积的蒸馏水的质量之比

## ***Text tour***

One of the important considerations in material selection is their physical properties (that is, density, melting point, specific heat, thermal conductivity, thermal expansion, and corrosion resistance). Physical properties can **have several important influences on manufacturing and the service life of components**. For example, high-speed machine tools require lightweight components to **reduce inertial forces** and, thus, **keep machines from excessive vibration**.<sup>[1]</sup>

1. **inertial force**意为“惯性力”。全段译为：  
材料选择中要考虑的重要方面是它们的物理性能（即密度、熔点、比热、导热系数、热膨胀和抗腐蚀性等）。物理性能对制造和组件的工作寿命有几个重要影响。例如，高速机床需要采用重量轻的部件以减少惯性力，使机床不会产生过大的振动。



**1. Density** The density of a material is its **mass per unit volume**. Another term is **specific gravity**, which expresses a material's density **in relation to** that of water, and thus, it has no units. **Weight saving** is important particularly for aircraft and aerospace structures, for automotive bodies and components, and for other products where **energy consumption and power limitations** are major concerns.

**2. consumer product** 意为“用于消费的产品，消费品”。全句可译为：

**1.密度** 材料的密度是单位体积的质量。另一个词是比重，用来表示相对于水的密度，因此，比重没有单位。对于飞机和航天器构件、汽车车身和部件以及其它主要考虑**能量消耗和动力限制**的产品来说，减轻重量是特别重要的。

**Substitution of materials for the sake of weight saving and economy is a major factor in the design both of advanced equipment and machinery and of consumer products, such as automobiles.[2]**

在设计先进的设备与机器和设计诸如汽车等消费品的过程中，采用新的替代材料来减轻重量和降低成本是一个应该着重考虑的问题。

2. Melting Point The melting point of a metal depends on the energy required to separate its atoms. The melting temperature of a metal alloy can **have a wide range** (depending on its composition) and is unlike that of a pure metal, which **has a definite melting point**. The temperature range within which a component or structure is designed to function is **an important consideration in the selection of materials**.

参考译文：2.熔点 金属的熔点取决于分离原子所需的能量。合金的熔化温度可以是一个宽的范围（取决于它的组成），不像纯金属那样有一个固定熔点。元件或结构的工作温度范围在材料选择时应该重点考虑。

The melting point of a metal has a number of indirect effects on manufacturing operations.

Because the recrystallization temperature of a metal is related to its melting point, operations such as annealing and heat treating and hot working require a knowledge of the melting points of the materials involved.

金属熔点对制造加工有许多间接影响。因为金属的再结晶温度与熔点相关，退火和热处理以及热加工这些操作需要有关材料熔点的知识。

**3. Specific Heat :** A material's specific heat is the energy required to raise the temperature of a unit mass by one degree. Alloying element **have a relatively minor effect on the specific heat of metals.** The temperature rise in a workpiece **resulting from machining operations** is a function of the work done and of the specific heat of the workpiece material.<sup>[3]</sup>

**3.比热：** **work done** 意为“所做的功”。全句可译为：材料的比热是单位质量的材料温度升高一度所需的能量。合金元素对金属比热的影响相对较小。在机械加工过程中，工件温度的升高是所做的功和工件材料比热的函数。

Temperature rise in a workpiece, if excessive, can decrease product quality by adversely affecting its surface roughness and dimensional accuracy, can cause excessive tool wear, and can result in undesirable metallurgical changes in the material.

工件的温升过高会因对表面粗糙度和尺寸精度的不利影响而降低产品质量，会导致刀具过度磨损，也能引起材料金相的不良变化。

## 4. Thermal Conductivity :

Thermal conductivity

**indicates** the rate at which heat flows within and through a material. Metals generally have high thermal conductivity, while ceramics and plastics have poor conductivity.

**4.导热系数** 导热系数指热量在材料中流经的速率。金属通常导热系数高，而陶瓷和塑料的导热性较差。

When heat is generated by plastic deformation or due to friction, the heat should be conducted away at a rate high enough to prevent a severe rise in temperature. The main difficulty experienced in machining titanium, for example, is caused by its very low thermal conductivity. Low thermal conductivity can also result in high thermal gradients and, in this way, cause inhomogeneous deformation of work pieces in metalworking processes.<sup>[4]</sup>

4. in this way意为“这样, 可见, 因此”。当热由塑性变形或摩擦产生时, 热应该以足够高的速率传导开去以防止急剧升温。举例来说, 在加工钛金属时遇到的主要困难就是由它非常低的导热系数产生的。低导热率可以产生高的温度梯度, 因此, 在金属加工过程中会引起工件的不均匀变形。



5. **Thermal Expansion**: The thermal expansion of materials can **have several significant effects**, particularly **the relative expansion or contraction** of different materials in assemblies such as **electronic and computer components**, glass-to-metal seals, and moving parts in machinery that require certain clearances for proper functioning. The use of ceramic components in cast-iron engines, for example, also requires consideration of their relative expansions.

5.热膨胀 材料的热膨胀有几个重要的影响，特别是在装配件中不同材料的相对膨胀和收缩，如电子和计算机元件，玻璃-金属密封件 (GTMS) 和那些为了正常工作要求一定间歇的机构的运动零件。例如，在铸铁引擎中应用陶瓷元件也要求考虑它们的相对膨胀。

Shrink fits **utilize** thermal expansion and contraction. For example, a part, such as a flange, **is to be installed over a shaft**. It first is heated and then **slipped over a shaft** which is at room temperature. When allowed to cool, the part shrinks and the assembly effectively **becomes an integral component**.

冷缩配合利用热膨胀和收缩。例如，一个像法兰那样的零件，被安装到轴上。它首先被加热然后套在处于室温的轴上。当允许冷却时零件收缩，装配件有效地变成一个整体元件。

6. Corrosion Resistance :Metals, ceramics, and plastics all **are subject to forms of corrosion**. The word corrosion itself usually **refers to the deterioration of** metals and ceramics, while similar phenomena in plastics generally are called degradation. Corrosion leads not only to **surface deterioration of components and structures** but also **reduces their strength and structural integrity**.

6.抗腐蚀性 金属、陶瓷和塑料都受到腐蚀的作用。腐蚀这个词常常指金属和陶瓷的退化，塑料的相似现象通常叫做降解。腐蚀不单会导致元件和结构的表面退化，而且降低它们的强度和结构完整性。

Corrosion resistance is **an important aspect of material selection for applications** in the chemical, food, and petroleum industries, as well as in manufacturing operations. In addition to various possible chemical reactions from the elements and compounds present, environmental corrosion of components and structures is **a major concern, particularly at elevated temperatures.**

抗腐蚀性在化学制品、食品、石油工业和制造加工应用中是选材料的重要方面。除了各种当前可能的元素的化学反应产生化合物之外，组件和结构的环境腐蚀是关注的重点，特别是在高温情况下。

Resistance to corrosion depends on the composition of the material and **on the particular environment**. Corrosive media may be chemicals (acids, alkalis ['ælkəlaiz], and salts), the environment (**oxygen, moisture, pollution, and acid rain**), and water (fresh or salt water).<sup>[5]</sup>

5. **fresh water**意为“淡水, 清水”。全句可译为:

抗腐蚀性取决于材料的成分和特定的环境。腐蚀媒介可以是化学品(酸、碱和盐), 环境(氧、潮湿、污染和酸雨)和水(清水或盐水)。

**Nonferrous metals, stainless steels, and nonmetallic materials, generally have high corrosion resistance. Steels and cast irons usually have poor resistance and must be protected by various coatings and surface treatments.**

有色金属、不锈钢和非金属材料通常有高抗腐蚀性。钢和铸铁通常抗腐蚀性差, 必须有各种涂层和表面处理保护。

The usefulness of some level of oxidation [ɒksi'deɪʃən] is exhibited in the corrosion resistance of aluminum, titanium, and stainless steel. Aluminum develops a thin (a few atomic layers), strong, and adherent hard-oxide film ( $\text{Al}_2\text{O}_3$ ) that better protects the surface from further environmental corrosion.

一些氧化的用途表现在铝、钛和不锈钢的抗腐蚀性上。铝产生一层薄的（只有几层原子）、牢固的附着氧化膜( $\text{Al}_2\text{O}_3$ ) 以保护表面不进一步的腐蚀。

Titanium develops a film of titanium [tai'teinjəm] oxide ( $\text{TiO}_2$ ). A similar phenomenon occurs in stainless steels, which (because of the chromium present in the alloy) **develop a protective film on their surfaces.** When the protective film is **scratched and exposes the metal underneath**, a new oxide film begins to form.

钛产生一层氧化钛( $\text{TiO}_2$ )膜。不锈钢也有相似的现象，（因为合金中有铬）表面产生一层保护膜。当保护膜擦损并露出金属里层时，一层新的氧化膜又开始形成了。

# Lesson 29 Tolerances and Surface Roughness

Terminology

Text tour



# ***Terminology***

## Basic size

**The theoretical size**, from which limits or deviations are calculated

**基本尺寸**：理论尺寸，是计算极限尺寸和偏差的起始尺寸。

## Deviation

The difference between the hole or shaft size and the basic size

**偏差**：孔的尺寸或者轴的尺寸减去基本尺寸所得的差值。

## Reamer 铰刀

International tolerance (IT) grade

A series of tolerances that vary with basic size to provide a uniform level of accuracy within a given grade

国际公差（IT）等级：一系列随基本尺寸变化，并在规定等级内提供相同精度的公差。



## ***Text tour***

Today's technology requires that parts **be specified with increasingly exact dimensions.** Many parts made by different companies **at widely separated locations** must be interchangeable, which **requires precise size specifications** and production.

现代技术对零件尺寸精度的要求越来越严格。而且，目前许多零件是由散布在各地的不同厂家生产的，因此必须对这些零件的尺寸和生产做出严格的规定，以保证它们的具有互换性。

The technique of **dimensioning parts** within a required range of variation to ensure **interchangeability** is called tolerancing. Each dimension is allowed a certain degree of variation within a specified zone, or tolerance. For example, a part's dimension might **be expressed as**  $20 \pm 0.50$ , which **allows a tolerance** (variation in size) of 1.00 mm.

给零件标注尺寸使其在一个规定的区间内变动，以保证它们具有互换性的技术称为公差技术。允许每个尺寸在规定范围内具有的一定的变动量，称为公差。例如，一个零件的尺寸可以被表示成 $20 \pm 0.5$ ，其公差（尺寸变动量）为1.00 mm。

A tolerance should be as large as possible without interfering with the function of the part to minimize production costs.

Manufacturing costs increase as tolerances become smaller.

在不影响零件性能的情况下，应当给尺寸尽可能大的公差，以把生产成本降至最低。制造成本会随着公差的降低而升高。

There are three methods of specifying tolerances on dimensions: Unilateral, bilateral, and limit forms. When plus-or-minus tolerancing is used, it is applied to a theoretical dimension called the basic dimension. When dimensions can vary in only one direction from the basic dimension (either larger or smaller) tolerancing is unilateral. Tolerancing that permits variation in both directions from the basic dimension (larger and smaller) is bilateral.

有三种表示尺寸公差的方式：单向，双向和极限方式。当采用正负公差时，就将公差加到被称为基本尺寸的理论尺寸上去。当只允许尺寸有向基本尺寸的单一方向(或者变大，或者变小)的变动时，就是单向公差。在尺寸可以在基本尺寸的两个方向(变大或者变小)都可以变动时，公差就是双向的。

Tolerances may also be given in limit form, **with dimensions representing** the largest and smallest sizes for a feature.

Some tolerancing terminology and definitions are given below.

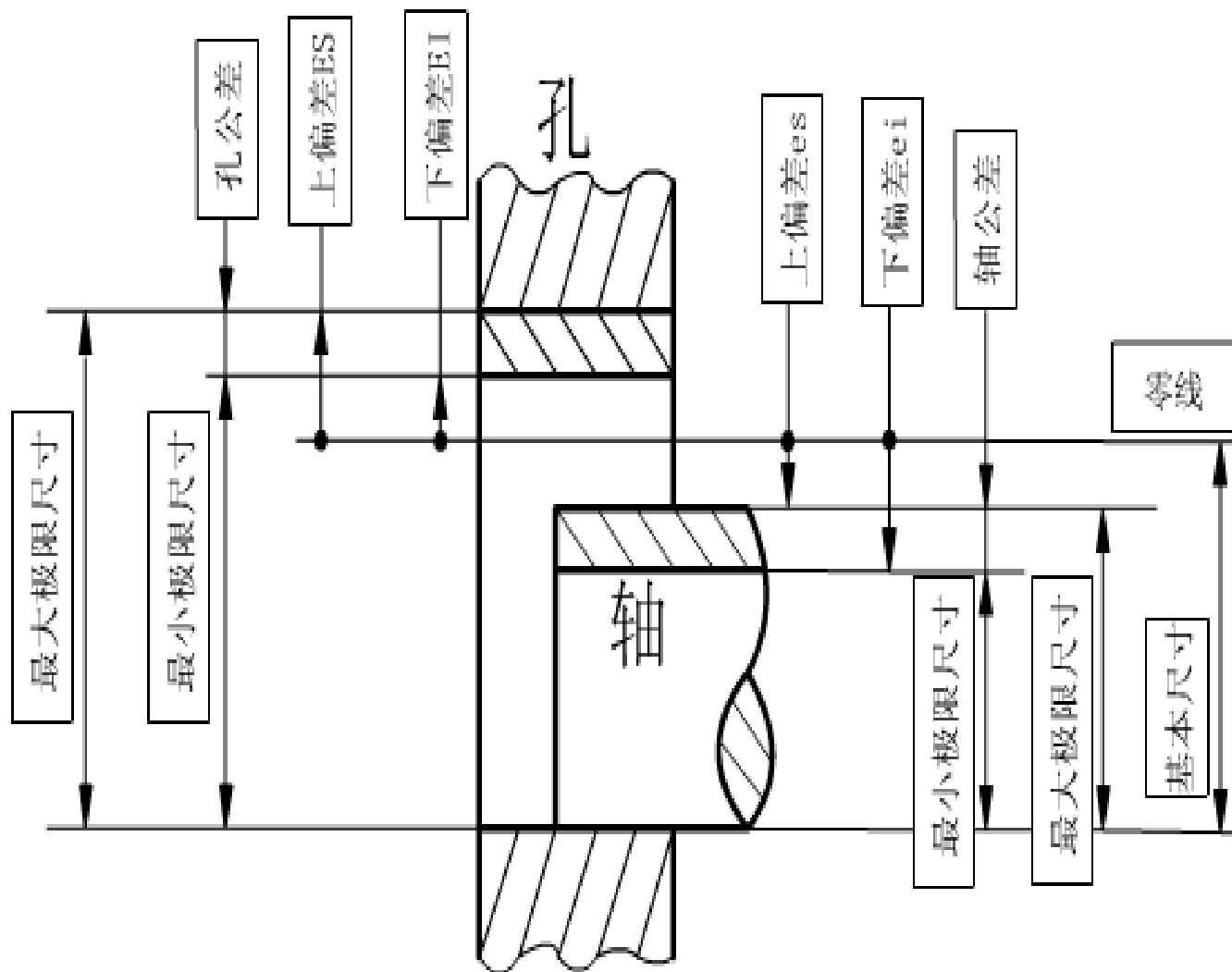
公差也可以用极限形式给出，表示零件外形的最大和最小尺寸。一些与公差有关的术语和定义如下所述。

**Tolerance:** **the difference between** the limits prescribed for **a single feature.**

**Basic size:** the theoretical size, from which limits or deviations are calculated

公差：为某个单一要素所规定的上限与下限之间的差值。

基本尺寸：理论尺寸，是计算极限尺寸和偏差的起始尺寸。





**Deviation:** the difference between the hole or shaft size and the basic size.

偏差：孔的尺寸或者轴的尺寸减去基本尺寸所得的差值。

**Upper deviation:** the difference between the maximum permissible size of a part and its basic size.

上偏差：零件最大极限尺寸减去其基本尺寸所得的差值。

**Lower deviation:** the difference between the minimum permissible size of a part and its basic size.

下偏差：零件最小极限尺寸减去其基本尺寸所得的差值。

**Actual size:** the measured size of the finished part.

实际尺寸：加工后零件的实测尺寸。

**Fit:** the tightness between two assembled parts. The three types of fit are: clearance, interference and transition.

**配合：** 两个装配在一起的零件之间的松紧程度。可以把配合分为三类：间隙配合，过盈配合，过渡配合。

**Clearance fit:** the clearance between two assembled **mating parts**.

**间隙配合：** 两个装配在一起配件之间留有间隙的配合。

**Interference fit:** results in an interference between the two assembled parts-the shaft is larger than the hole, requiring a force or press fit, an effect similar to welding the two parts.

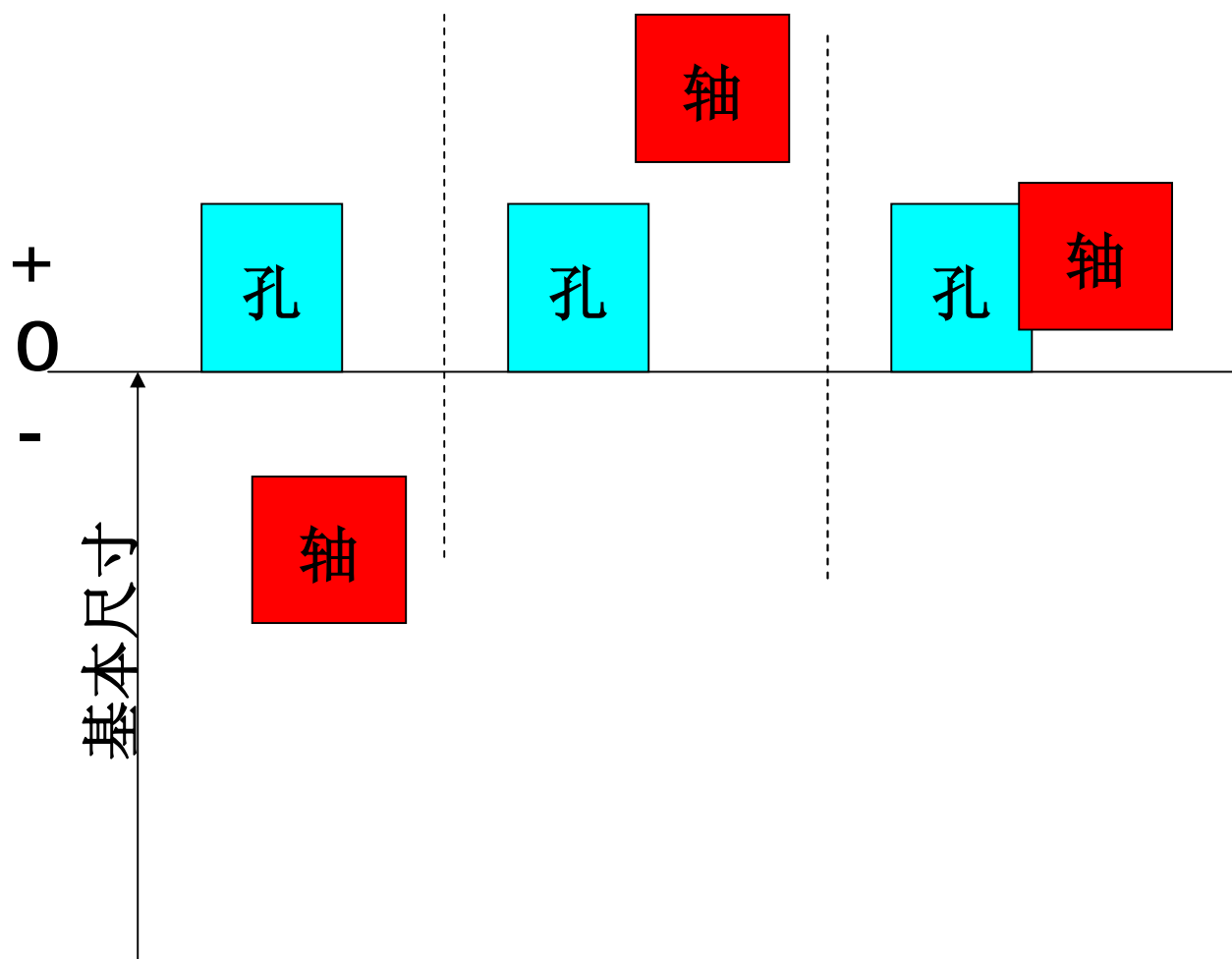
**过盈配合：** 两个装配在一起的零件之间有过盈的配合——轴大于孔，需要用力或压力进行配合，具有类似于将两个零件焊接在一起的效果。

**Transition fits:** may result in either an interference or a clearance between the assembled parts-the shaft may be either smaller or larger than the hole and still be **within the prescribed tolerances.**

过渡配合：在两个装配在一起的零件之间或者存在着过盈，或者存在着间隙的配合——轴可以小于或大于孔，但仍在规定的公差内。

**Selective assembly:** a method of selecting and assembling parts by trial and error[1] and by hand, allowing parts to be made **with greater tolerances at less cost** as a compromise between a **high manufacturing accuracy and ease of assembly.**

选择装配：通过手工试配来选择并装配零件的方法。通过这种方法，可以装配在较低的成本下制造出来的公差较大的零件，它可作为高的制造精度和易于装配的零件之间的一种折中方法。



## 间隙配合、过盈配合和过渡配合

The basic hole system <sup>[2]</sup> utilizes the smallest hole size as the basic diameter for calculating tolerances and allowances. The basic hole system is efficient when standard drills, reamers, and machine tools are available to give precise hole sizes. The smallest hole size is the basic diameter because a hole can be enlarged by machining but not reduced in size.

基孔制：采用最小的孔的尺寸作为计算公差和加工余量基本尺寸。当采用标准的钻头、铰刀和机床对孔进行精加工时，基孔制系统是非常有效的。采用最小的孔的尺寸作为基本尺寸是因为孔的尺寸可以通过机械加工变大，但不能减小。

The basic shaft system[3] is applicable when shafts are available in highly precise standard sizes. The largest diameter of the shaft is the basic diameter for applying tolerances and allowances. The largest shaft size is used as the basic diameter because shafts can be machined to smaller size but not enlarged.

当轴可以按照非常的高精度的标准尺寸提供时，采用基轴制是适用的。计算公差和余量时，采用轴的最大直径作为基本尺寸。这是因为轴可以通过加工变成较小的尺寸，但其尺寸不能增大。

International tolerance (IT)  
grade: a series of tolerances  
that vary with basic size to  
provide a uniform level of  
accuracy within a given grade.  
There are 20 IT grades: IT01,  
IT0, IT1, ..., IT18.

国际公差(IT)等级：一系列随  
基本尺寸变化，且在规定的等级  
内提供均匀精度的公差。共有  
20个IT等级：IT01，IT0，  
IT1，...，IT18。

**Tolerance symbols:** notes giving the specifications of tolerances and fits; the basic size is a number, followed by the fundamental deviation letter and the IT number, which combined give the tolerance zone; uppercase letters indicate the fundamental deviations for holes, and lowercase letters indicate fundamental deviations for shafts.

**公差符号：**符号给出了公差与配合的技术要求，基本尺寸是一个数字，后面跟着表示基本偏差的字母和表示IT等级的数字。它们共同决定了公差带的大小和位置。大写字母代表孔的基本偏差，小写字母代表轴的基本偏差。



Because the **surface texture** (or **surface finish**) of a part affects its function, it must be precisely specified. Surface texture is the variation in a surface, including **roughness, waviness, lay and flaws**.

由于表面形貌(即表面光洁程度)会影响零件的性能，因此对其大小必须精确地加以规定，表面形貌是表面上的差异，包括粗糙度，波度，加工纹理方向和缺陷。

**Roughness: the finest of the irregularities** in the surface caused by the manufacturing process used to smooth the surface. **Roughness height** is measured in micrometers ( $\mu\text{m}$ ) or microinches ( $\mu\text{in}$ ).

粗糙度：由用来使工件表面光滑的加工工艺所造成的最细微的表面不平度。表面粗糙度的高度采用微米或微英寸进行测量。

**Waviness:** a widely spaced variation that exceeds the roughness width cutoff measured in inches or millimeters; roughness may be regarded as a surface variation superimposed on a wavy surface

**波度：** 是超过粗糙度宽度界限的大间隔偏差，采用英寸或毫米测量。可将粗糙度看作叠加在波度表面上的表面不平度。

Lay: the direction of the surface pattern caused by the production method used.

加工纹理方向：由所采用的加工方法所产生的表面刀痕图案的方向。

**Flaws:** defects occurring infrequently or at widely varying intervals on a surface, including cracks, blow holes, checks, scratches, and the like; the effect of flaws is usually omitted in roughness height measurements.

**缺陷：**不经常出现或者在很大区间内才会出现的表面瑕疵，其包括裂纹，气孔，微细裂纹，划痕等。缺陷的影响通常在粗糙度的高度测量中被忽略。

# Lesson 35 Coordinate Measuring Machine

Terminology

Text tour

# ***Terminology***

Coordinate measuring machine  
(CMM) 三坐标测量机

Linear motor 直线电动机



Digitize

To put (data, for example) into digital form

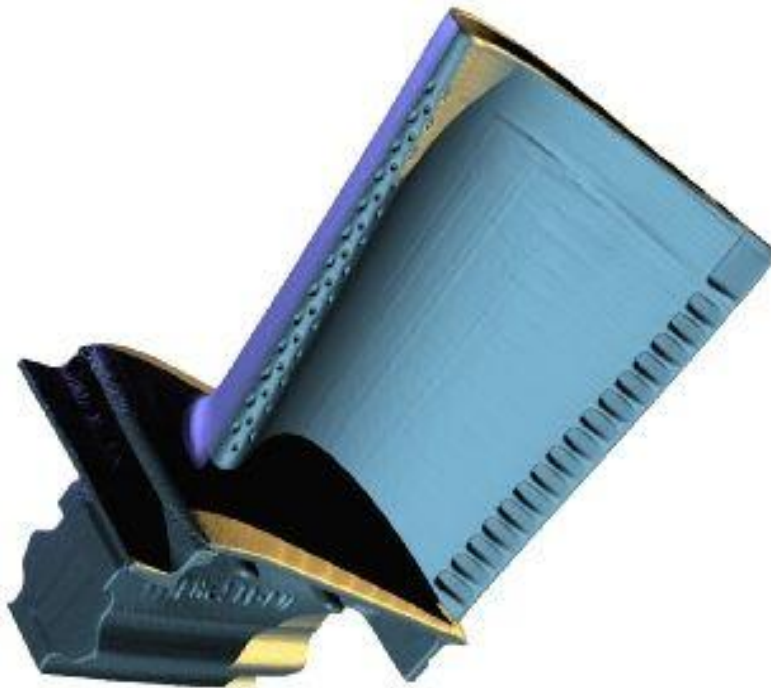
将（例如数据）数字化

Turbine blade 涡轮机叶片

User-friendly

Easy to use or learn to use

用户界面友好的，用户容易掌握使用的：容易（学会）使用的



## ***Text tour***

**A coordinate measuring machine (CMM) is typically used to generate 3-D points from the surface of a part. It's digitizing a part in three dimensions. However, it is often used to make 2-D measurements such as measuring the center and radius of a circle in a plane, or even one-dimensional measurements such as determining the distance between two points. 1. configure 意为“为特定设备或用途而进行的设计”。**

三坐标测量机CMM特别用于生成零件表面的三维点。它在三个维度上对零件进行数字化。然而，它常用于做二维测量如在平面内测量圆心和半径，或者甚至是像测定两点间距离这样的一维测量。



**Typically, CMMs are configured to measure in Cartesian coordinates.<sup>[1]</sup>**  
**There are also CMMs that measure in cylindrical or spherical coordinates. They can measure any part surface they can reach.**

通常，三坐标测量机是专门为在直角坐标系（笛卡尔坐标系）内进行测量而设计的。也测量圆柱坐标和球面坐标。它们能测量能到达的任何零件表面。

CMMs typically generate points in two ways: point-to-point mode, where the CMM touches the part and generates a single point of data every time contacting with the part, or scanning, where the CMM moves over a part, generating data as it moves. Scanning generates significantly more data than contacting, but is typically not as accurate.

三坐标测量机通常有两种生成点的方式：点对点模式，三坐标测量机触碰零件并在每次接触零件的地方生成一个单点的数据；扫描模式，三坐标测量机在零件上移动，同时生成数据。扫描比接触生成更多的数据，但通常不够准确。

CMMs are manual or automatic. In manual mode, the CMM is moved by the user. An automatic CMM is typically actuated by electric drives (using ballscrews or linear motors).<sup>[2]</sup>

2. **electric drive** 意为“电气传动，又称‘电力拖动’。生产过程中，以电动机作为原动机来带动生产机械，并按所给定的规律运动的电气设备”。全句可译为：

三坐标测量机可以是手动或自动的。手动情况下，三坐标测量机由操作者移动。一个自动化的三坐标测量机通常采用电气传动的方式（通过滚珠丝杠或采用直线电动机）。

**As shown in Figure 1, articulated arm CMMs look very much like six-degree-of-freedom robots, and are almost always manually driven. Hybrid CMMs are a cross between articulated arm systems and traditional CMMs. They may have servo assist for making measurements.**



如图1所示，关节臂式三坐标测量机看起来很像六自由度机器人，它几乎总是手动的。混合三坐标测量机介于关节臂式三坐标测量机和传统三坐标测量机之间。它们在测量时可以有伺服机构协助。

While the CMM hardware generates the coordinate data, the software bundled with the CMM (or in many instances sold separately) analyzes the data and presents the results to the user in a form that permits an understanding of part quality, and conformance to specified geometry.

当三坐标测量机的硬件生成坐标数据时，三坐标测量机的捆绑软件（或很多时候是单卖的）分析数据并以能理解零件质量的形式向操作者输出结果，并符合特定的几何学。

**New user-friendly software that allows the CMM and probe to be accurately, quickly, and easily calibrated has also made the CMM more accurate and easier to use.[3]**

**3. user-friendly**意为“用户界面友好的，用户容易掌握使用的”。  
全句可译为：

新的用户界面友好的软件可以对三坐标测量机及其测量头进行精确、快速和容易的校准工作，这也使得三坐标测量机更为精确和更容易使用。

**The most important advancement in CMM technology over the past several years is that significant errors can be corrected mathematically via software. As a result, looser tolerances can be used on the system hardware, and the resulting errors (as long as they are highly repeatable) are eliminated in software.[4]**

**4. looser tolerance 意为“比较大的公差”。全句可译为：**

过去几年里CMM技术最重要的进步是相当数量的错误可以通过软件进行数学修正。结果是，系统硬件的公差可以比较大，只要可重复性很高，其所产生的误差可应通过软件予以消除。

This results in lower manufacturing costs, while retaining or even improving the capabilities of the CMM. Other major design innovations in the past were linear air bearings and linear scales for improved repeatability and accuracy.

当保持甚至提高三坐标测量机性能时，这能导致较低的制造成本。过去其它主要的创新是为提高重复定位精度和准确度设计的直线空气轴承和光栅尺。



Examples of geometries that are difficult to measure include very deep holes, where a probe must be inserted down the length of the hole. If the hole diameter is small, such as cooling holes on turbine blades, the task becomes even more formidable.

难于测量的几何学实例包括探针必须伸到孔底部的深孔。如果孔径很小，如涡轮叶片的冷却孔，这个任务就更艰难。

**A controlled environment is important for efficient CMM operation. CMMs can operate well on the shop floor if they are equipped with thermal compensation capabilities that correct for temperature changes from standard temperature (20°C).<sup>[5]</sup> In any case, the CMM should be kept in a relatively clean environment and located in a space that is isolated from vibration.**

**5. thermal compensation**意为“热补偿”。全句可译为：

一个受控的环境对三坐标测量机的有效工作是重要的。如果三坐标测量机具有热补偿能力，能够在偏离标准温度(20°C)时，对由于温度变化带来的影响进行修正，三坐标测量机就可以很好地在车间内工作。无论如何，三坐标测量机应该在相对清洁的环境中工作并与振动源相隔绝。

**A stationary bridge-type CMM is shown in Figure 2, and the accuracy of this kind of CMM is usually better than that of a mobile articulated arm CMM.**



图2所示是一种固定桥式三坐标测量机，这种测量机的精度一般要比移动式的关节臂式测量机高。

**Figure 2 Bridge-type CMM**

However, recent advances in the articulated arm area, have yielded significant advances in the capabilities of the articulated arm.

然而，关节臂式测量机近来的发展使其在性能上有了明显的进步。

But for many operations, the accuracy of articulated arm CMMs is sufficient for a variety of processes.

但对很多工作而言，关节臂式测量机的精度是足够的。

The advantage of articulated arm CMMs is that they generally have a larger work volume than bridge CMMs, and can reach areas that are not easy to access with typical CMMs. Thus, if quoted accuracies for articulated arm CMMs are sufficient for a particular application, it should be seriously considered as an alternative. Also, articulated arm CMMs are more portable. Typically, they can be set up for measurement quickly.

关节臂式测量机的优点是它们比桥式三坐标测量机的工作范围更大，并能达到典型的三坐标测量机不能到达的地方。这样，如果对特定的应用来说关节臂式测量机的精度满足要求，它应该作为一种要认真考虑的选择。而且关节臂式测量机更为轻便。通常它们能很快被安置好以开展测量。

The size range of a CMM can span about four orders of magnitude with respect to part size. There are a variety of enormous CMMs that are used for measuring entire car bodies, the bodies of earth moving equipment, and even large aircraft elements (e. g. , wings that are 10-m long). There are other CMMs that measure parts that have features on the order of 1 mm. This capability can offer significant advances in micromanufacturing.

三坐标测量机的尺寸范围能相对于零件尺寸跨越四个数量级。有若干庞大的三坐标测量机用于测量整个汽车车身、推土设备的机身，甚至大的航空器构件（例如10米长的机翼）。其它的三坐标测量机测量拥有1毫米量级特征的零件。这种能力能产生微制造领域的重大进展。

In the future, higher-speed measurements facilitated by linear drives and more advanced controls, in conjunction with thermal compensation, will be making further inroads in the CMM area. Other big changes may be expected in the software for CMMs as it becomes more user-friendly, and flexible. This will allow for much easier integration of the CMM into automated production facilities.

未来由线性驱动助推的高速测量和更多先进控制方法，连同热补偿，将在三坐标测量机领域产生进一步的影响。其它大的变化可能在三坐标测量机的专用软件中出现，如更便于使用和柔性。这将使三坐标测量机更容易集成到自动生产设备中去。

# Lesson 36 Lathes

Terminology

Text tour



# ***Terminology***

## **Stop**

**A part in a machine that stops or regulates movement**

撞块，挡块：用于使机器停止运动或调节运动位置的限位零件。

## **Carriage**

Carriage is a major element in lathe mechanism, which provides the necessary longitudinal motion to the cutting tool to generate the necessary surfaces.

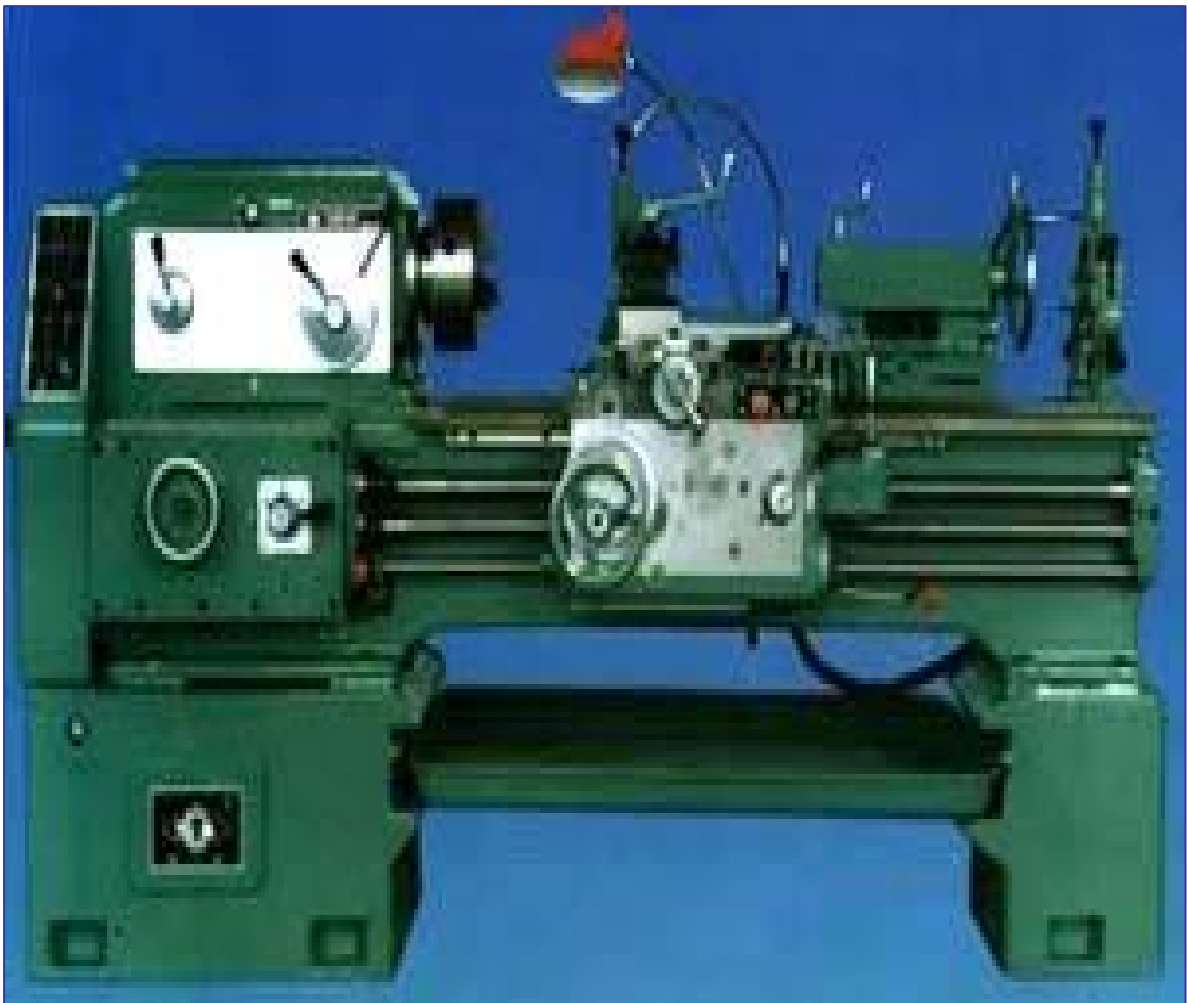
溜板：车床中的一个主要部件，它为刀具提供必要的纵向移动以生成所需要的加工表面。

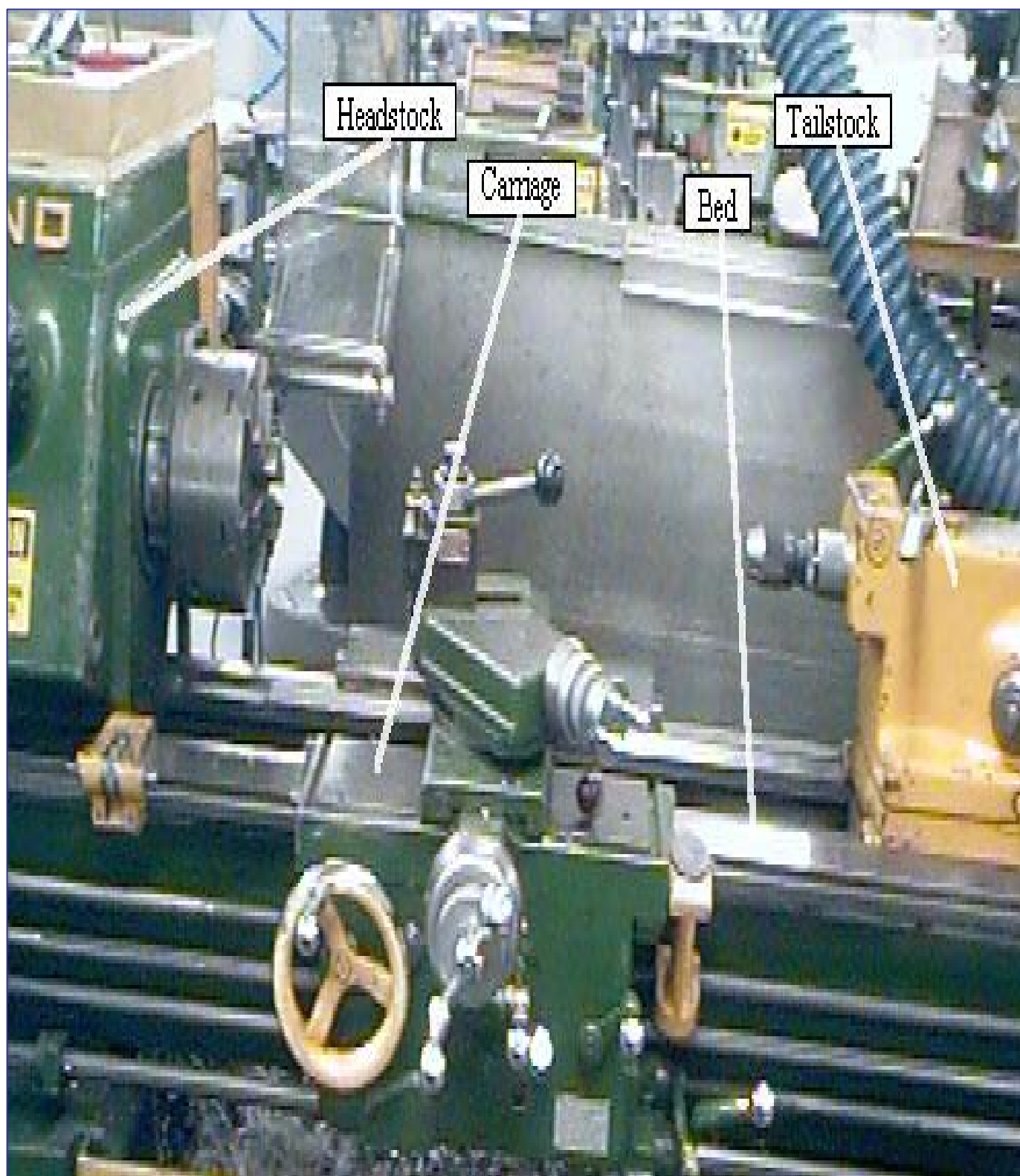
# Work

A material or piece of material being processed in a machine during manufacture

工件：制造过程中被机器加工的材料。

Engine lathe 普通车床

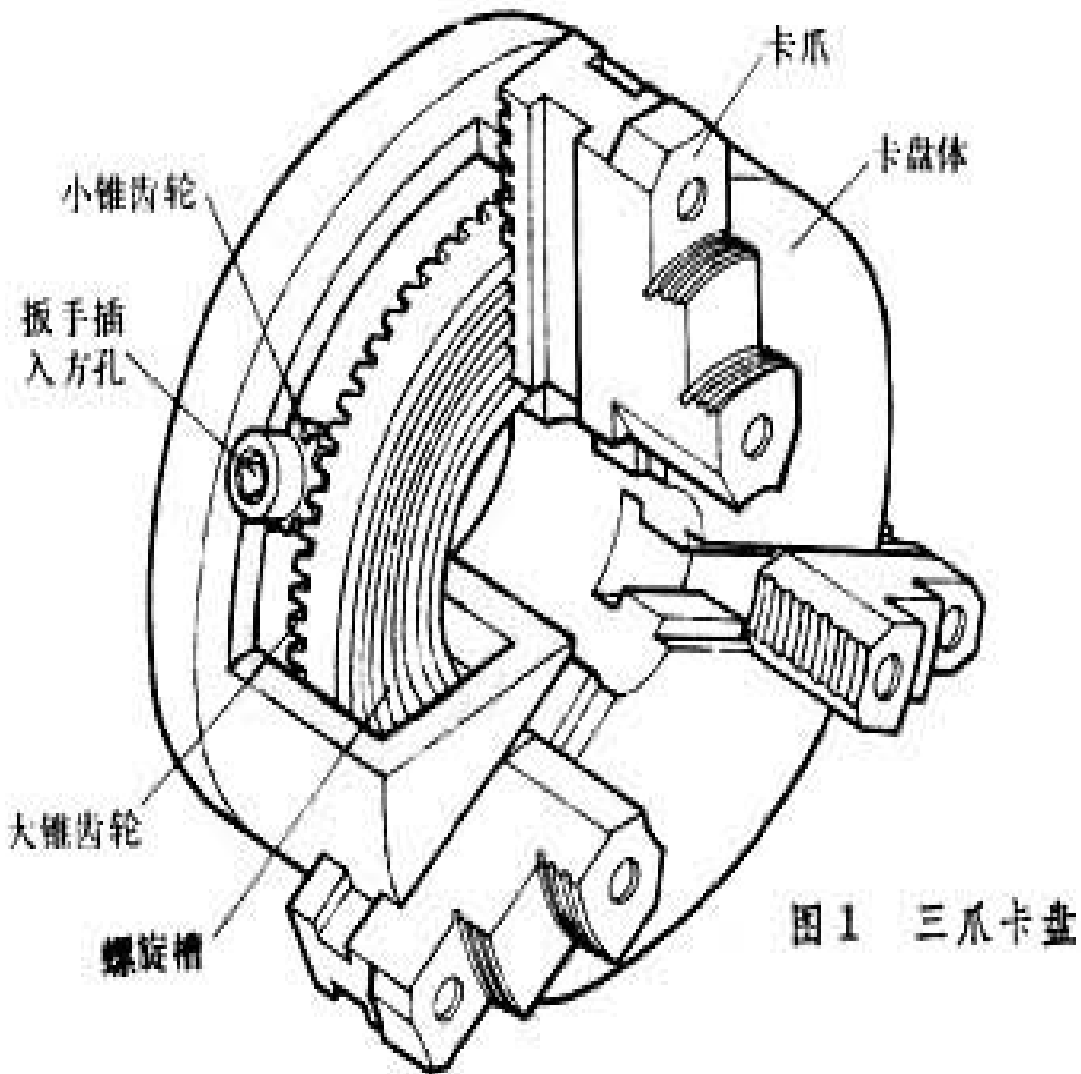




# Chuck

**A clamp that holds a tool or the material being worked in a machine such as a lathe.**

卡盘：在诸如车床等机床上用来夹持刀具或工件的装置



# Collet 弹簧夹头



Machining center  
加工中心

## ***Text tour***

### **Engine Lathes普通车床**

Engine lathes, of course, are general-purpose machines used in production and maintenance shops all over the world. Sizes range from small bench models to huge heavy duty pieces of equipment. Many of the larger lathes come equipped with attachments not commonly found in the ordinary shop, such as automatic stops for the carriage.

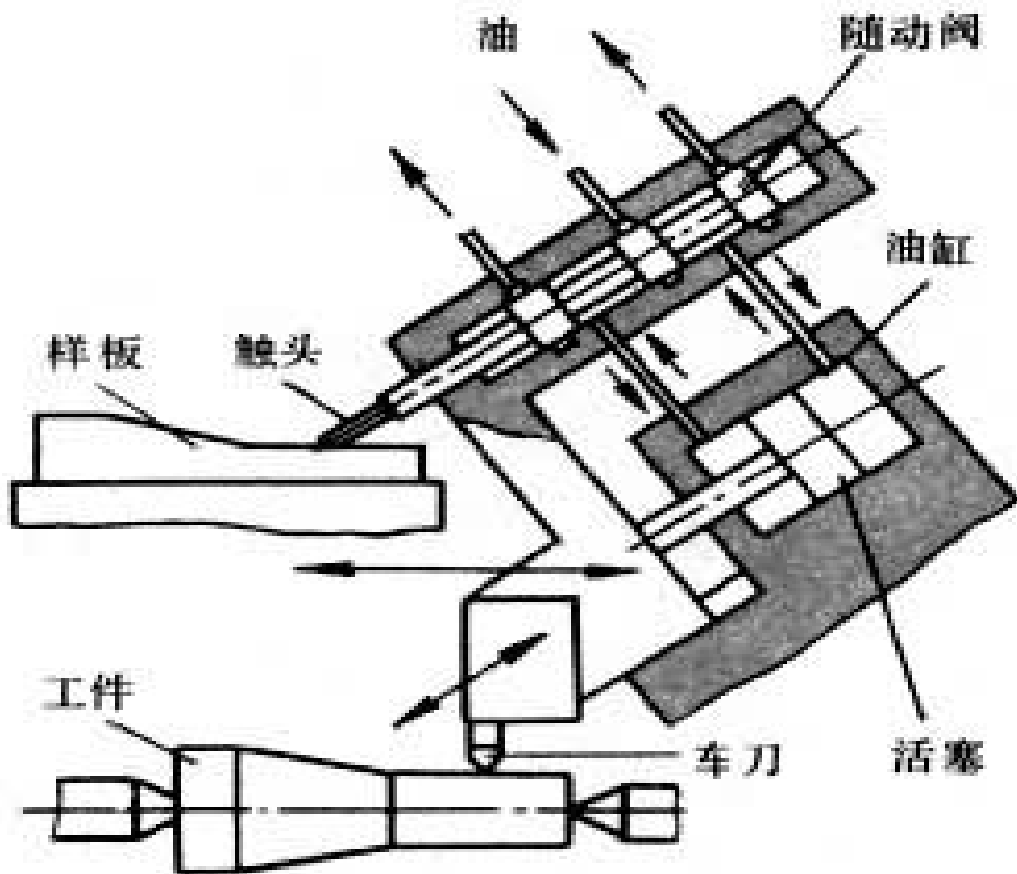
普通车床是全世界的生产车间和维修车间里广泛使用的通用机床。它的尺寸范围很广，从小型的台式车床到巨大的重型车床。许多大型的车床配备有在普通车间中通常看不到的附件，例如，溜板的自动挡块。

# Tracer or Duplicating Lathes 靠模车床或仿形车床

The tracer or duplicating lathe is designed to produce irregularly shaped parts automatically. The basic operation of this lathe is as follows.

靠模车床或仿形车床被设计用来对形状不规则的零件进行自动加工。这种车床的基本操作如下：

**A template of either a flat or three-dimensional shape is placed in a holder. A guide or pointer then moves along this shape and its movement controls that of the cutting tool.**



在夹持装置上安装平面或立体形状的样板，然后，导向触头或指针沿着它的外形移动，从而控制切削刀具的运动。



The duplication may include a square or tapered shoulder, grooves, tapers, and contours. Work such as motor shafts, spindles, pistons, rods, car axles, turbine shafts, and a variety of other objects can be turned using this type of lathe.

仿形加工可以包括方形或锥形轴肩、各种槽、锥体和轮廓。像电动机的轴、主轴、活塞、杆件、汽车轴、汽轮机轴和其他很多种类的工件都可以采用这种车床来进行切削加工。

## Turret Lathes转塔车床

**When machining a complex workpiece on a general-purpose lathe, a great deal of time is spent changing and adjusting the several tools that are needed to complete the work. One of the first adaptations of the engine lathe which made it more suitable to mass production was the addition of multi-tool turret in place of the tailstock. Although most turrets have six stations, some have as many as eight.**

在通用车床上加工一个复杂的工件时，在更换和调整加工时所用的一些刀具上要花费很多时间。对普通车床的早期改装工作之一是增加一个可以安装多把刀具的转塔来代替尾架，使它能够更好地适应大批量生产的需要。虽然大多数转塔有六个刀位，但有些转塔有八个刀位。

High-production turret lathes are very complicated machines with a wide variety of power accessories. The principal feature of all turret lathes, however, is that the tools can perform a consecutive serials of operations in proper sequence. Once the tools have been set and adjusted, little skill is required to turn out duplicate parts.

高生产率的转塔车床是安装有许多动力附件的非常复杂的机器。然而，所有转塔车床的主要特点是刀具能按适当顺序完成一系列的加工工序。一旦这些刀具被安装调整好后，只需要很低的技术就可以车削加工出很多相同的零件。

## Automatic Screw Machines 自动螺丝车床

Screw machines are similar in construction to turret lathes, except that their heads are designed to hold and feed long bars of stock. Otherwise, there is little difference between them. Both are designed for multiple tooling, and both have adaptations for identical work. Originally, the turret lathe was designed as a chucking lathe <sup>[3]</sup> for machining small castings, forgings, and irregularly shaped workpieces.

螺丝车床在结构上与转塔车床类似，不同之处是螺丝车床的主轴头部能被设计用来夹持和送进长棒料。除此之外，它们之间几乎没有什么差别。这两种车床都用于多刀具切削，都适合加工同样的工件。最初，为转塔车床设计的用途和卡盘车床的用途一样，也是用来加工小型铸件、锻件和形状不规则的零件。

The first screw machines were designed to feed bar stock and wire used in making small screw parts. Today, however, the turret lathe is frequently used with a collet attachment, and the automatic screw machine can be equipped with a chuck to hold castings.

早期的螺丝车床通过棒料和线材的送进，制造小的螺丝零件。时至今日，转塔车床上经常使用夹头附件，而自动螺丝车床上则可通过安装卡盘用来夹持铸件。

The single-spindle automatic screw machine, as its name implies, machines work on only one bar of stock at a time. A bar 16 to 20 feet long is fed through the headstock spindle and is held firmly by a collet. The machining operations are done by cutting tools mounted on the turret and on the cross slide. When the machine is in operation, the spindle and the stock are rotated at selected speeds for different operations. If required, rapid reversal of spindle direction is also possible.

单轴自动螺丝车床，顾名思义，一次仅能加工一根棒料。一根**16至20**英尺长的棒料可以通过主轴箱中的主轴孔送进，并用弹性夹头将其夹紧。机械加工工序是由装在转塔和横刀架上的刀具完成的。当机床工作时，主轴和棒料按照为每道工序所选择的转速旋转。如果需要时也可以使主轴快速反转。

In the single-spindle automatic screw machine, a specific length of stock is automatically fed through the spindle to a machining area. At this point, the turret and cross slide<sup>[4]</sup> move into position and automatically perform whatever operations are required. After the machined piece is cut off, stock is again fed into the machining area and the entire cycle is repeated.

在单轴自动螺丝车床上，棒料的一段规定好的长度穿过主轴自动送到加工区。在这里，转塔和横向刀架进入加工位置并自动完成所需的任何加工工作。当加工好的零件被切断后，棒料再次被送入加工区，并重复整个循环。

Multiple-spindle automatic screw machines have from four to eight spindles located around a spindle carrier.<sup>[5]</sup> Long bars of stock, supported at the rear of the machine, pass through these hollow spindles and are gripped by collets. With the single spindle machine, the turret indexes around the spindle.

多轴自动螺丝车床在主轴鼓周围装有4到8根主轴。在机床尾部支撑着的长棒料穿过这些空心的主轴，通过夹头进行夹紧。在单轴车床上，转塔围绕主轴转位。



When one tool on the turret is working, the others are not. With a multiple spindle machine, however, the spindle itself indexes. Thus the bars of stock are carried to the various end working and side working tools. Each tool operates in only one position, but all tools operate simultaneously. Therefore, four to eight workpieces can be machined at the same time.

当转塔上的一个刀具工作时，其他的刀具不工作。然而，在多轴自动车床上，主轴自己转位。因此，几根棒料被转位到各个不同的端面加工和侧面加工的刀具位置处。每把刀具仅在一个位置工作，但是所有的刀具都能同时工作。因此，能够在同一时间内加工4到8个工件。

## **Vertical Turret Lathes 立式转塔车床**

**A vertical turret lathe is basically a turret lathe that has been stood on its headstock end. It is designed to perform a variety of turning operations. It consists of a turret, a revolving table, and a side head with a square turret for holding additional tools. Operations performed by any of the tools mounted on the turret or side head can be controlled through the use of stops.**

立式转塔车床基本上就是将其从床头箱一端向下而竖立起来的一台转塔车床。它被设计用来完成各种各样的切削工作。它由一个转塔，一个旋转工作台和一个侧面溜板组成的。在侧面溜板上装有可以再安装几把刀具的正方形刀架。由安装在转塔或侧面溜板上的任何刀具完成的加工工序都可通过使用挡块来加以控制。

## Machining Centers加工中心

Many of today's more sophisticated lathes are called machining centers since they are capable of performing, in addition to the normal turning operations, certain milling and drilling operations. Basically, a machining center can be thought of as being a combination turret lathe and milling machine. Additional features are sometimes included by manufacturers to increase the versatility of their machines.

当前，许多技术更为先进的车床叫做加工中心。因为，它们除了完成常规的车削工作之外，还可以完成某些铣削、钻削工作。加工中心基本上可以认为是转塔车床和铣床的组合体。有时，制造厂商为了增加机床的多用性，还会增加一些其它的性能。

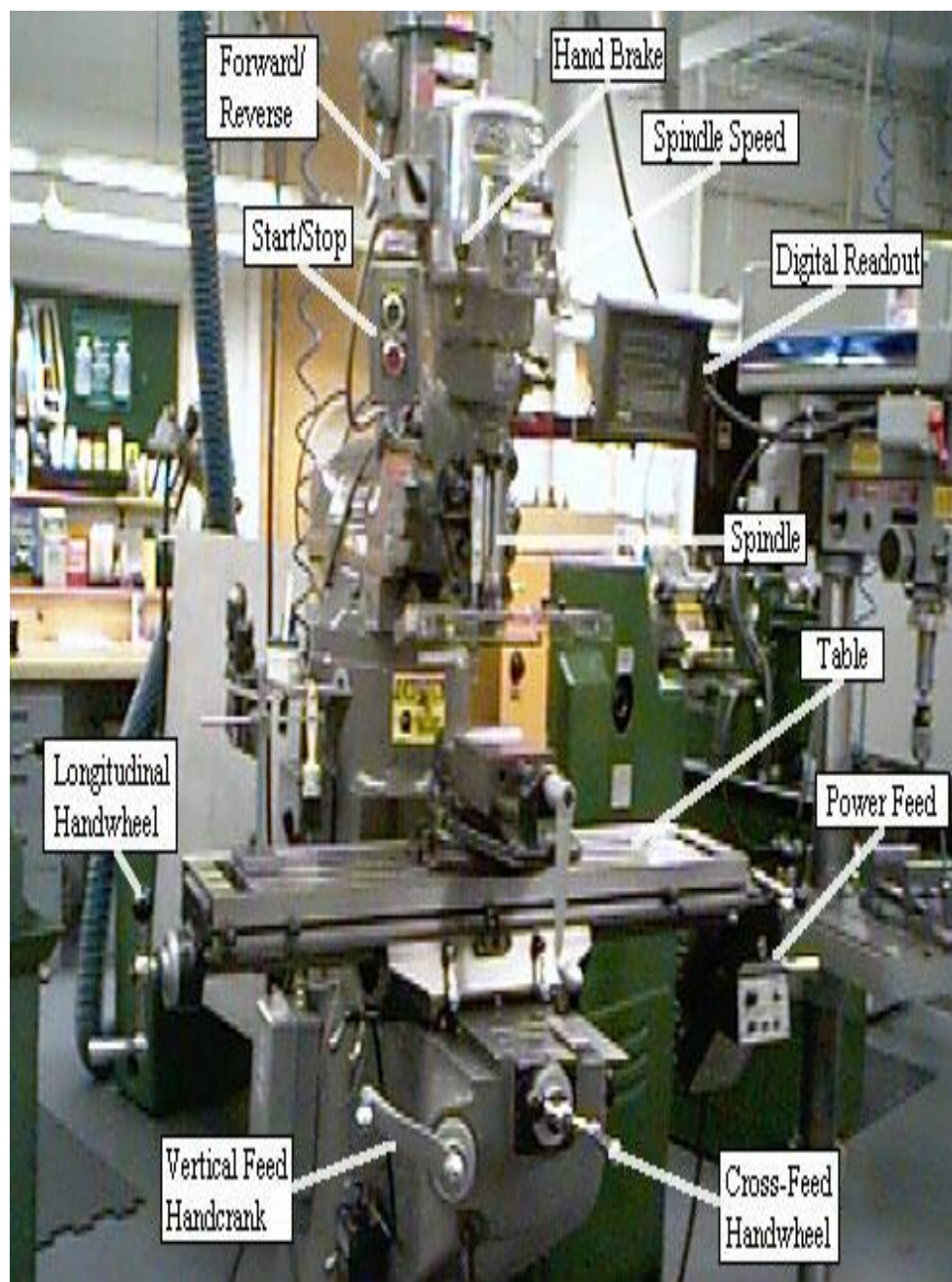
# Lesson 37 Milling Machines and Grinding Machines

Terminology

Text tour

# ***Terminology***

## **Milling machine 铣床**





**Surface grinder**  
**平面磨床**



**Centerless grinder**  
**无心磨床**



# Boring machine 镗床



## ***Text tour***

**Milling machines may be classified in three groups: the bed type, the column and knee type, and special milling machines.<sup>[1]</sup>**

**1. the bed type, the column and knee type** 意为“床身式和升降台式”。  
全句可译为：

铣床可以被分为三种类型：床身式铣床，升降台式铣床和专用铣床。



**The bed-type milling machine is used for production manufacturing. The general characteristics of this type of machine are that the height of the table is fixed and the adjustments for height are made with the spindles.[2]**

**2. height of the table** 这里指“工作台的高度”。全句可译为：

床身式铣床用于生产加工。这种机床的一般特性是工作台的高度是固定的，高度的调整是通过主轴进行的。

**In construction, these machines are very rigid, permitting greater metal removal. Since adjustments are rather time consuming, it takes longer to set them up than it takes to set up the knee and column type of machine.**

结构上，这些机床刚性很大，可以进行大余量的金属切削。因为调整需要消耗相当的时间，它们的准备时间比升降台式铣床更长。

The planer type of milling machine is a bed type machine which is usually very large.<sup>[3]</sup>

3. planer type of milling machine 意为“龙门式铣床”。全句可译为：

龙门式铣床通常是一种尺寸很大的床身式铣床。

The table moves under an arch very much as the table of a planer. The cutter heads are mounted above and at the sides of the table.<sup>[4]</sup>

4. cutter head 意为“刀盘，刀架”。全句可译为：

工作台在拱门下运动，很象龙门刨床的工作台。刀盘安装在工作台的上方和侧面。

The column and knee type of milling machine is the most commonly used because of its flexibility. Because of the ease with which it can be set up and its versatility [ˌvɜːsə'tiləti] , it is more adaptable for quick single-piece setups. If more complicated setups are desirable, this is also possible.

因为有柔性，升降台式铣床是最常用的。因为它设置起来很容易并且是多功能的（万能），更适合快速的整体设置。如果想要更复杂的设置，也是可能的。

In general, there are two types of column and knee milling machines: the horizontal and vertical milling machines. The difference between the horizontal and vertical milling machine is the position of the spindle in relation to the machine table. The spindle is mounted vertically on the vertical miller and horizontally on the horizontal miller.

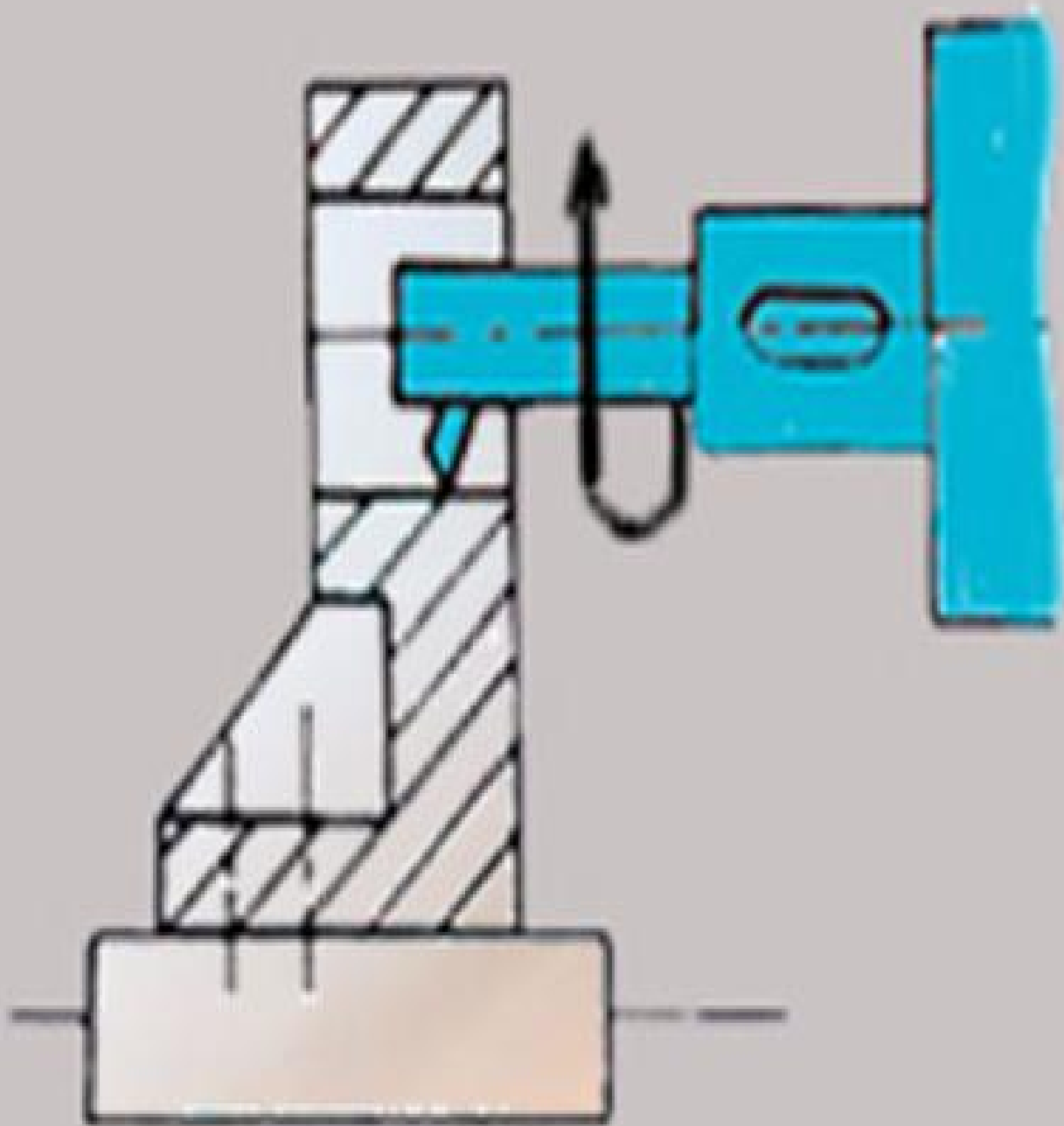
通常有两种升降台式铣床：卧式和立式铣床。卧式、立式铣床的区别在于主轴相对于工作台的位置。主轴在立式铣床上垂直安装而在卧式铣床上水平安装。

There are also several special-purpose machines such as thread millers, tracer-controlled (profilers) milling machines, rotary millers, and many others each designed to do a very special job.<sup>[5]</sup>

5. **tracer-controlled (profilers) milling machine** 意为“仿形控制铣床（靠模铣床）”。全句可译为：还有几种专用的铣床，例如螺纹铣床，仿形控制铣床（靠模铣床），回转铣床和许多其它被设计用来完成特殊工作的铣床。

**The horizontal boring mill is usually a large machine designed with a retractable spindle mounted in the headstock of the machine. The headstock can be moved in a vertical direction. A bushing mounted in a block in the tailstock is caused to move up and down, always in alignment with the headstock spindle.**

卧式镗床通常是一台大机器，在机器的床头箱（主轴箱）中安有一根伸缩自如的主轴。主轴箱可在垂直方向上移动。衬套安装在尾架的一个块中使得能上下移动，总是与床头箱的主轴同轴。



Thus a long boring bar, capable of mounting cutters, can be supported at both ends. The boring bar receives its power from the spindle. It should be noted that milling cutters, drills, and so on, can be mounted directly in the spindle without using the boring bar or the tailstock.

这样一根能安装刀具的镗杆能在两端被支撑。镗杆从主轴获得动力。应该指出铣刀、钻头 etc 能不用镗杆或尾架而直接安装在主轴上。



Special milling machines for continuous milling are also manufactured. The rotary miller, which uses a vertical spindle and a power-actuated rotary table, provides an opportunity for continuous milling. Many pieces of work may be mounted in a circle. Since the rotation of the table is slow, the operator has the chance to remove the finished workpiece and load an unfinished workpiece.

连续铣削的专用铣床也生产出来了。使用立式主轴和回转工作台的回转铣床提供了持续铣削的机会。许多件工件可安装在一个圆周上。因为工作台的旋转速度慢，操作者有机会取下加工好的工件并装夹待加工工件。

There are many types of grinding machines. The two most widely used are the cylindrical and surface grinders.<sup>[6]</sup> Other grinding operations include those using vertical spindles, internal and centerless grinders, and jigs.

6. cylindrical and surface grinders  
意为“外圆和平面磨床”。全句可译为：

磨床的种类很多。两种最常用的磨床是外圆磨床和平面磨床。其它磨削加工包含那些有立式主轴的，内圆磨床、无心磨床，以及夹具。

**The cylindrical grinder is equipped with a headstock and tailstock between which the work is mounted and rotated as a grinding wheel in contact with the work removes metal from its circumference (see Fig. 1).**

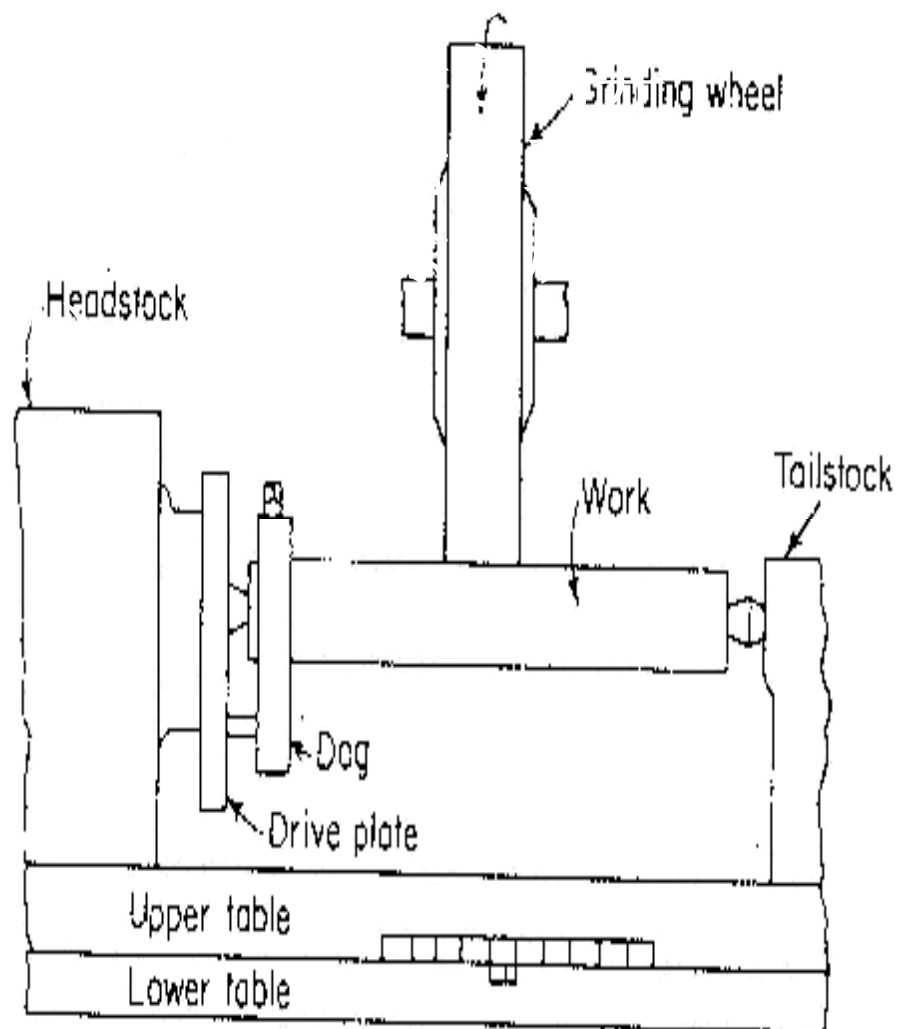


Figure 1 Sketch of a cylindrical grinder

The operation is somewhat similar to that of a lathe. The grinding wheel replaces the tool bit, and the thousands of little abrasive particles in it may be thought of as little tool bits. They in fact produce little chips during the cutting operation.

操作与车床多少有点相似。砂轮替代了刀具，砂轮上数千个小磨料颗粒可以被当做车刀。它们实际上在切削加工中产生小的切屑。

The headstock center may or may not revolve with the work. The tailstock center is always dead.<sup>[7]</sup>

7. tail stock center 意为“尾架顶尖”。  
全句可译为：

床头箱的顶尖可以随工件一起旋转或者不转。尾架上总是采用死顶尖。

Operating a cylindrical grinder with both centers dead eliminates any possible eccentricity [eksen'trisiti] which may result from the live center runout. Precision grinding is done between two dead centers.

用带有两个死顶尖的外圆磨床进行加工消除了活顶尖的跳动误差带来的可能的偏心。在两个死顶尖之间可以进行精密磨削。

Feeding the grinding wheel into the work may be done automatically or by hand in increments as low as 0.0001 in. per pass.

砂轮可以以每次操作最少0.0001英寸的增量自动或手动地向工件进给。

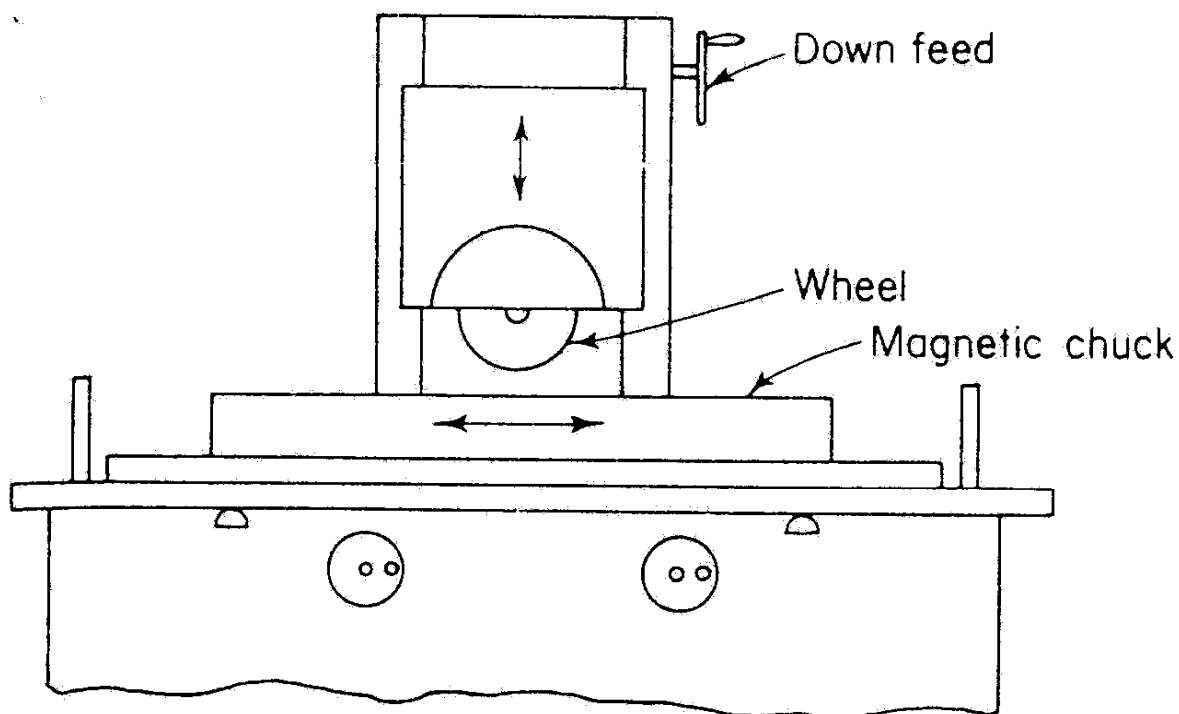
The range of infeed of the wheel into the work is from about 0.002 in. per pass for roughing to about 0.0005 in. for finishing.

Hydraulically controlled infeed grinders are also available with mechanisms for automatic table retraction when the grinding operation is complete.

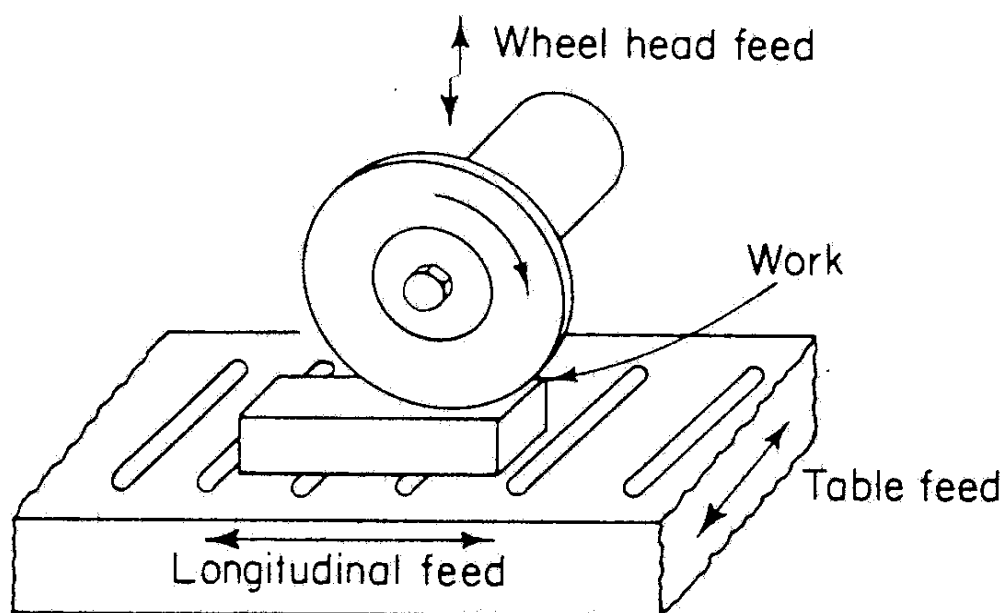
砂轮向工件横向进给量的范围从粗加工的每次0.002英寸到精加工的每次0.0005英寸。液压控制进给的磨床在磨削完成后也用机构实现工作台的自动回缩。

The surface grinder is used for grinding flat surfaces (see Fig.2 (a)). The table mounts a magnetic chuck used for holding the work during the grinding operation. The table **oscillates** ['ɒsileit] under the wheel, as shown in Fig. 2(b). With each pass the table feeds transversely. This feed may be accomplished automatically or by hand. The automatic control may be with hydraulic power or a mechanical indexing mechanism.

平面磨床用于磨削平面(见图2(a))。工作台安装了一个磁性吸盘用于在磨削时吸附住工件。工作台在砂轮下摆动，如图2(b)所示。随着每次磨削工作台进行横向进给。这个进给可以自动或手动完成。自动控制可由液压动力或一个机械分度机构支持。



(a)



(b)



**As the table moves longitudinally [ˌlɒndʒiˈtjuːdɪnəli] the direction is reversed with trip dogs.[8]**

8. **trip dog** 意为“行程挡块”。全句可译为：在工作台的纵向移动中，当它碰到行程挡块时就会改变运动方向。

**A unique grinder is the centerless grinder of which there are several types: the cylindrical grinders for grinding circular external surfaces, internal centerless grinders for grinding internal circular surfaces, and centerless thread grinders. These grinders may be used to grind cylinders, tapers, spheres, threads, and so on.**

一种独特的磨床是无心磨床，有这样几种类型：磨外圆表面的外圆磨床，磨内圆表面的内圆无心磨床以及无心螺纹磨床。这些磨床可以用来磨削圆柱面、锥面、球面、螺纹等。

In all case at least three points of contact with the work are employed. The work is supported by a blade, or roller; a regulating wheel which has a higher coefficient of friction than the grinding wheel is the second support point.<sup>[9]</sup> The grinding wheel is the third support point. This is shown in Figure 3.

9. **regulating wheel** 意为“（无心磨床的）导轮”。全句可译为：

所有情况下至少要用三个点与工件接触。工件被支承在托板或辊子上，一个具有比砂轮摩擦系数更高导轮是第二个支承点。砂轮是第三个支承点。如图3所示。

# Lesson 38 Drilling Operations

Terminology

Text tour

# ***Terminology***

## **Twist drill**

**A drill having deep helical grooves along the shank from the point**

麻花钻：从顶端开始沿着钻杆有较深的螺旋槽的钻头



## **Trepanning drill 套料钻，环孔钻**

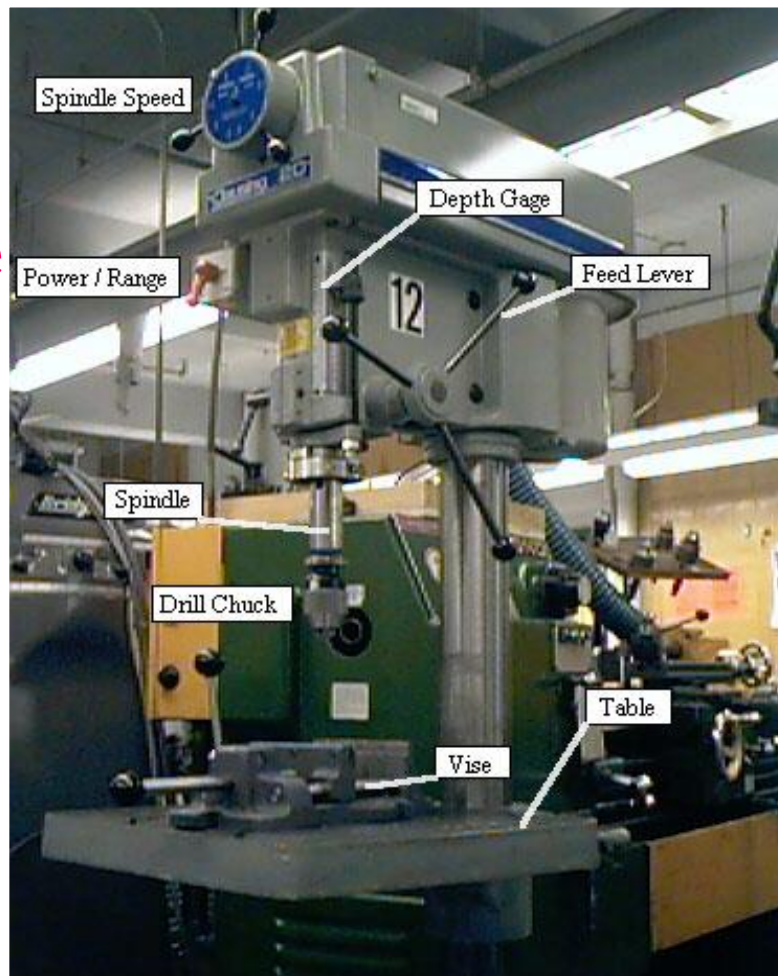


# Feed

**Feed is defined as the relative movement per revolution, per tooth or per stroke of the cutting tool in a direction usually normal to the cutting speed direction.**

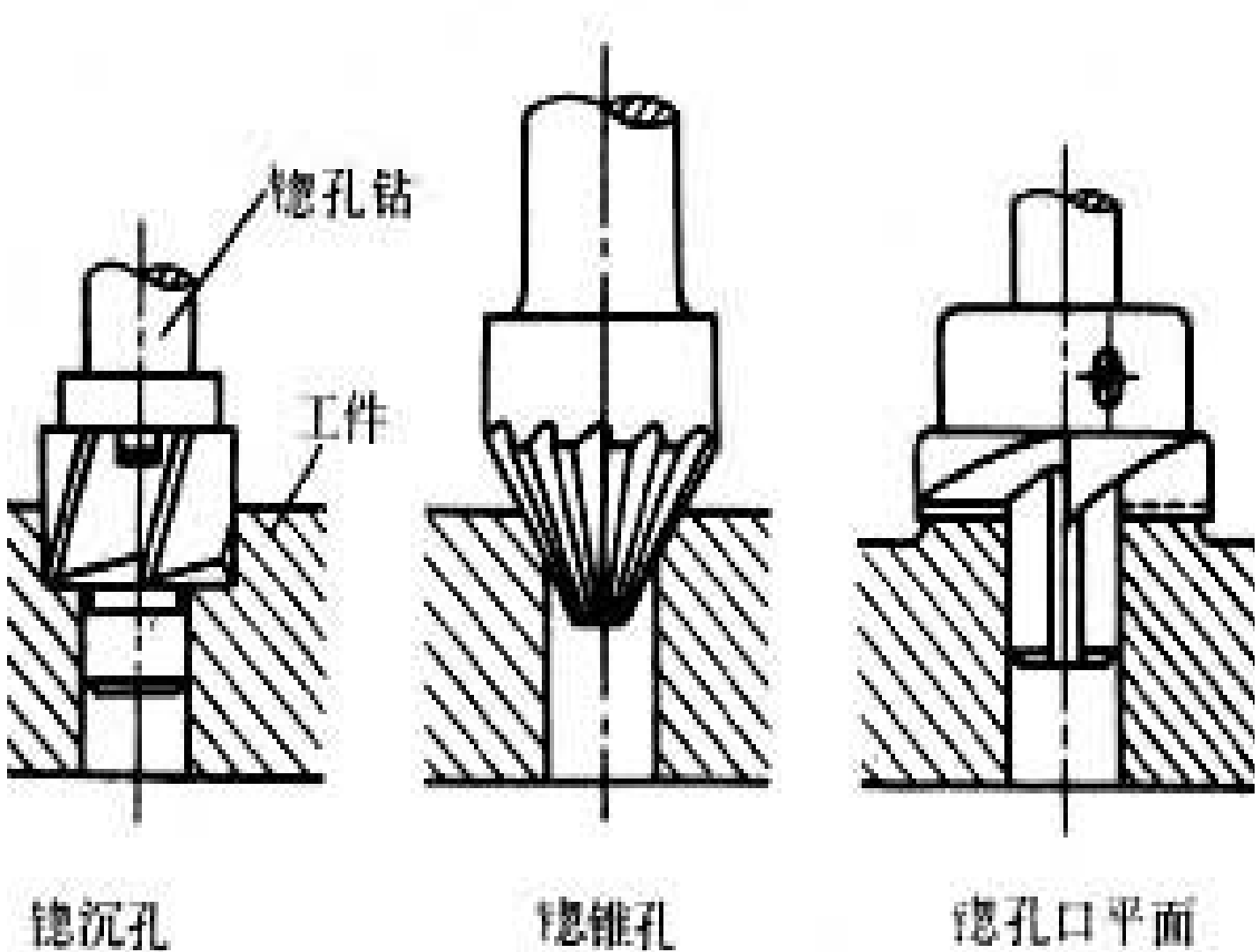
进给量被定义为刀具每转、每齿或每行程通常在与切削速度垂直的方向上的相对运动量。

## Drilling machine 钻床



# Counterboring, Countersinking, Spot facing

镗沉头孔，镗锥孔，镗孔口平面



## Vise 也作 vice

**1. A clamping device of metal, usually consisting of two jaws closed or opened by a screw and lever, used in metalworking to hold a piece in position.**

虎钳：由金属制成的钳夹工具，通常有两个钳口，利用螺杆和手柄使两钳口作相对移动来夹持工件的工具。

**2. To hold or compress in or as if in a vise**  
钳住，夹紧



## Radial drill 摇臂钻床





# ***Text tour***

**Drilling involves producing through or blind holes in a workpiece by forcing a tool, which rotates around its axis, against the workpiece.[1]**

1. **through or blind holes** 意为“通孔或盲孔”。全句可译为：

钻孔是将一个绕本身轴线转动的刀具压到一个工件上加工出通孔或盲孔。

**Consequently, the range of cutting from that axis of rotation is equal to the radius of the required hole. In practice, two symmetrical cutting edges that rotate about the same axis are employed.[2]**

2. **cutting edge** 意为“切削刃”。全句可译为：

所以，从回转轴线开始的切削范围等于待加工孔的半径。在实践中，通常采用绕同一轴线转动的两个对称切削刃。

Drilling operations can be carried out by using either hand drills or drilling machines. The latter differ in size and construction.

Nevertheless, the tool always rotates around its axis while the workpiece is kept firmly fixed.

This is contrary to drilling on a lathe.

钻孔能用手钻或钻床进行。后者在加工尺寸和构造上有所不同。然而，刀具总是绕着轴线旋转同时工件被夹紧。这与在车床上钻孔相反。

# Cutting Tools for Drilling Operations

## 钻孔刀具

In drilling operations, a cylindrical cutting tool, called a drill, is employed. The drill can have either one or more cutting edges and corresponding flutes, which can be straight or helical. The function of the flutes is to provide outlet passages for the chips generated during the drilling operation and also to allow lubricants and coolants to reach the cutting edges and the surface being machined. Following is a survey of the commonly used drills.

钻孔中要用到一把圆柱形的刀具，叫钻头。钻头有一个或两个切削刃以及对应的直的或螺旋形的容屑槽。容屑槽的功能是提供在钻孔中产生的切屑的排出通道并让润滑剂和冷却液到达切削刃，其表面是经过加工的。以下是常用钻头的情况。

## Twist Drill:

The twist drill is the most common type of drill. It has two cutting edges and two helical flutes that continue over the length of the drill body. The drill also consists of a neck and a shank that can be either straight or tapered.

## 麻花钻

麻花钻是最常用的钻头类型。它有两个切削刃和两个延伸到整个钻头刀杆长度的螺旋容屑槽。钻头还包含一个颈部和一个直的或锥形的柄部。

In the latter case, the shank is fitted by the wedge action into the tapered socket of the spindle and has a tang, which goes into a slot in the spindle socket, thus acting as a solid means for transmitting rotation.<sup>[3]</sup> On the other hand, straight shank drills are held in a drill chuck that is, in turn, fitted into the spindle socket in the same way as tapered shank drills.

3. tapered socket of the spindle 意为“主轴锥孔”。全句可译为：

对于后一种情况，钻柄通过斜楔作用与主轴的锥孔相配合并使钻柄上的扁尾进入到主轴锥孔的槽内，作为传递转动的一个实体工具。另一方面，直柄钻头装在钻夹头中，钻夹头反过来以锥柄钻头一样的方式装在主轴孔中。

**Twist drills** are usually made of high-speed steel, although carbide-tipped drills are also available. The sizes of twist drills used in industrial practice range from 0.25 mm up to 80mm.

虽然硬质合金钻头也在用，但**麻花钻**通常用高速钢制造。工业实践中麻花钻的尺寸范围从0.25mm一直到80mm。

**Core Drills** A core drill consists of the chamfer, body, neck, and shank. This type of drill may have either three or four flutes and an equal number of margins, which ensure superior guidance, thus resulting in high machining accuracy.<sup>[4]</sup>

4. machining accuracy 意为“机械加工精度”。全句可译为：

**扩孔钻** 扩孔钻由倒角、刀杆、刀颈和刀柄组成。这种类型的钻头可以有三个到四个容屑槽和相同数量的刃带，它们可以保证良好的导向性，因此具有较高的机械加工精度。

**A core drill** has flat end. The chamfer can have three or four cutting edges, or lips, and the lip angle may vary between  $90^{\circ}$  and  $120^{\circ}$ . Core drills are employed for enlarging previously made holes and not for originating holes. This type of drill is characterized by greater productivity, high machining accuracy, and superior quality of the drilled surfaces.

**扩孔钻**是平头的。倒角部分有三到四个切削刃或钻缘，钻缘角可以在 $90^{\circ}$ 到 $120^{\circ}$ 之间变化。扩孔钻用于扩大已钻好的孔而不是钻孔。这种钻头的特点是生产率较高，加工精度高，具有较好的加工表面质量。

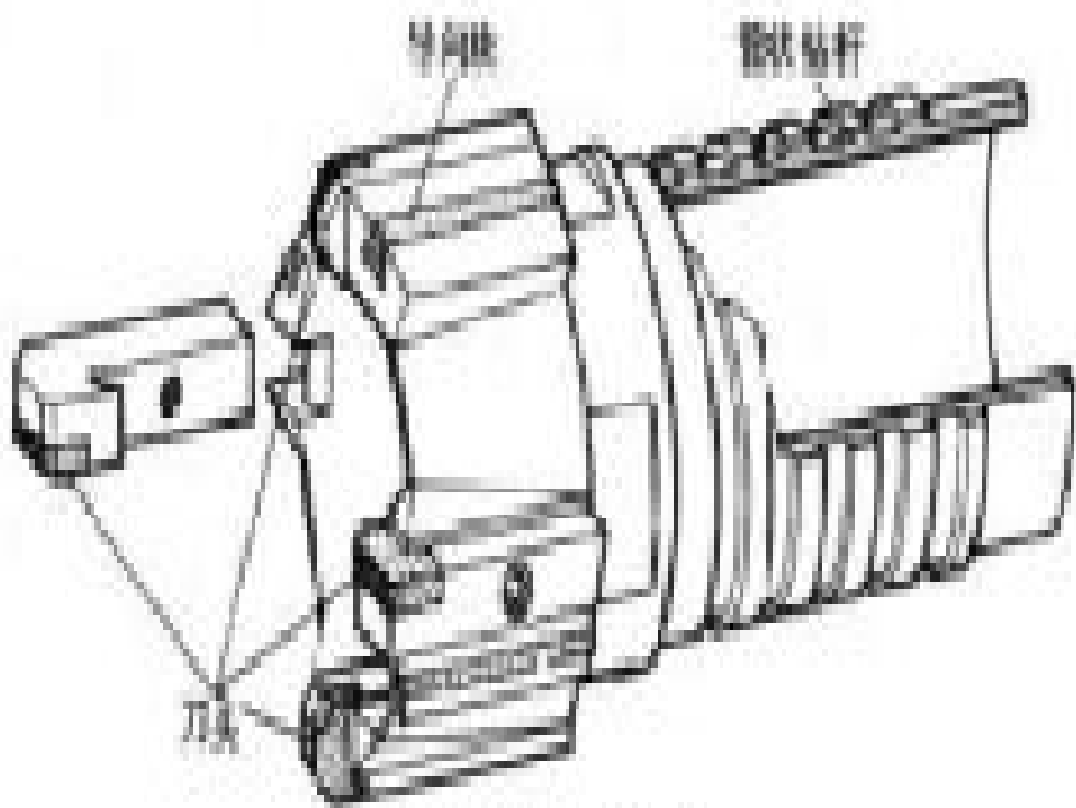


**Gun Drills** Gun drills are used for drilling deep holes. All gun drills are straight-fluted, and each has a single cutting edge. A hole in the body acts as a conduit to transmit coolant under considerable pressure to the tip of the drill.

**枪钻** 枪钻用于钻深孔。所有的枪钻都是直柄的，而且都只有一个切削刃。刀杆内部有孔作为通道将具有相当压力的冷却液送到钻头尖端。

There are two kinds of gun drills, namely, the center cut gun drill used for drilling blind holes and the trepanning drill. The latter has a cylindrical groove at its center, thus generating a solid core, which guides the tool as it proceeds during the drilling operation.

有两种枪钻，即用于钻盲孔的中心切削枪钻和套料钻。后者在其中心有圆柱形槽，因此产生一个实体芯部，能在钻孔过程中引导刀具前进。



多齿外排屑套料钻



**Spade Drills** Spade drills are used for drilling large holes of 90 mm or more. The design results in a marked saving in cost of the tool as well as a tangible reduction in its weight, which facilitates its handling. Moreover, this type of drill is easy to grind.

**扁钻** 扁钻用于加工90毫米及以上的大孔。这种设计导致刀具成本的显著节约以及重量的切实减轻，使其操作起来更便利。而且，这种钻头容易磨削。

# Other Types of Drilling Operations

## 钻孔的其它类型

**In addition to conventional drilling, there are other operations that are involved in the production of holes in the industrial practice. Following is a brief description of each of these operations.**

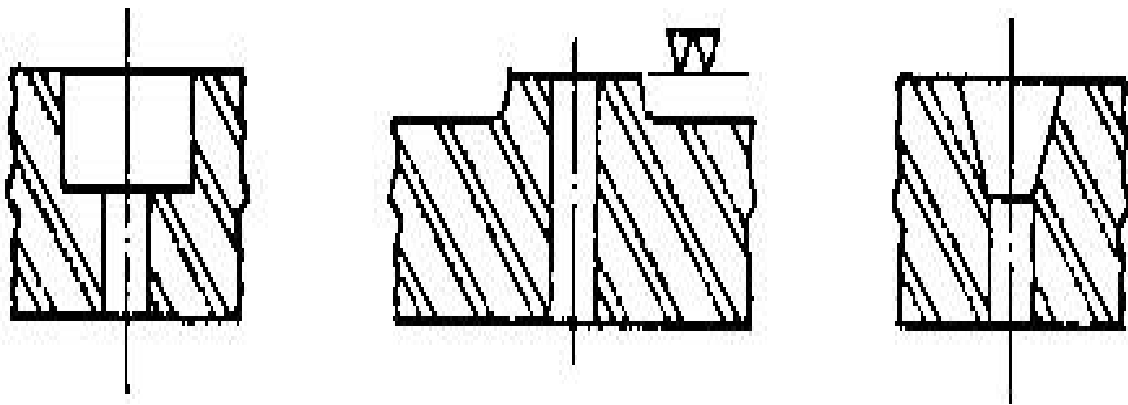
除了常规钻孔以外，有其他加工工序涉及到工业实践中的孔加工。以下是这些工序的简短描述。

**Boring** Boring involves enlarging a hole that has already been drilled. It is similar to internal turning and can, therefore, be performed on a lathe. There are also some specialized machine tools for carrying out boring operations. Those include the vertical boring machine, the jig boring machine, and the horizontal boring machine.

**镗孔** 镗孔包括对已经被钻出的孔的扩大。类似于车内圆，因此能在车床上进行。也有一些进行镗孔加工的专用机床。包括立式镗床、坐标镗床和卧式镗床。

**Counterboring** As a result of counterboring, only one end of a drilled hole is enlarged. This is illustrated in Figure 1 (a). This enlarged hole provides a space in which to set a bolt head or a nut so it would be entirely below the surface of the part.

**镗圆柱沉孔** 镗圆柱沉孔时钻好的孔只有一端被扩大。如插图1(a)中所示。孔被扩大的部分提供了安装螺栓头或螺母的空间，因此它应该整个低于零件表面。



(a) Counterboring

(b) Spot facing

(c) Countersinking

Figure 1 Operations related to drilling. [5]

5. 图中剖面线是美国国家标准协会规定的关于钢的剖面线符号。

**Spot Facing** Spot facing operation is performed to finish off a small surface area around the opening of a hole. As can be seen in Figure 1 (b), this process involves removing a minimal depth of cut and is usually performed on castings or forgings.

**镗凸台** 镗凸台用于在孔的开口周围加工出一个小平面区域。如图1(b)所示，其工艺包含去除一个最小的切削深度，常用于铸件和锻件。



**Countersinking** As shown in Figure 1 (c), countersinking is done to enable accommodating the conical ['kɒnikəl] seat of a flathead screw so that the screw does not appear above the surface of the part.

**铰锥孔** 如图1(c)所示，铰出的锥孔能容纳平头螺钉的锥形垫，以使螺钉不会露出零件表面。

**Reaming** Reaming is actually a "sizing" process, by which an already drilled hole is slightly enlarged to the desired size. As a result of a reaming operation, a hole has a very smooth surface. The cutting tool used in this operation is known as the reamer.

**铰孔** 铰孔实际上是一个矫正工艺，通过它可以将已钻好的孔轻微扩大到需要的尺寸。铰孔加工可以得到具有非常光滑表面的孔。用于铰孔的刀具被称为铰刀。

# Classification of Drilling Machines

## 钻床的分类

Drilling operations can be carried out by employing either portable small machines or appropriate machine tools. The latter differ in shape and size, although they have common features. For instance, they all involve one or more twist drills, each rotating around its own axis while the workpiece is kept firmly fixed.

钻削加工可以用便携式的小机器或适当的机床来进行。尽管它们有相同的特征，后者在形状和尺寸上有不同。例如，它们都包含一个或更多的麻花钻，当工件被牢固地夹紧时绕着自身的轴线旋转。

This is contrary to the drilling operation on a lathe, where the workpiece is held in and rotates with the chuck.<sup>[6]</sup> Following is a survey of the commonly used types of drilling machines.

6. **drilling operation** 意为“钻孔工序，钻孔操作”。全句可译为：

这与在车床上进行的钻孔操作正好相反，在车床上，工件被夹紧在夹具内并随其转动。以下是常用类型钻床的情况。

**Bench-type Drilling Machines** Bench-type drilling machines are general-purpose, small machine tools that are usually placed on benches. This type of drilling machine includes an electric motor as the source of motion, which is transmitted via pulleys and belts to the spindle, where the tool is mounted.

**台式钻床** 台式钻床是通用的小型机床，通常放置在工作台上。这种钻床用电机作为动力源，通过皮带轮和带将动力传输到装有刀具的主轴上。

The feed is manually generated by lowering a lever handle, which is designed to lower (or raise) the spindle.

7. **lever handle** 意为“杠杆手柄”。全句可译为：

进给是通过用手向下搬动手柄而实现的，这个手柄是被设计用来使主轴向下（或向上）运动的。

The workpiece is mounted on the machine table, although a special vise is sometimes used to hold the workpiece. The maximum height of a workpiece to be machined is limited by the maximum gap between the spindle and the machine table.

工件安装在机床工作台上，有时也用一个专用台钳来夹持工件。被加工工件的最大高度受到主轴和工作台之间最大间隙的限制。

# Upright Drilling Machines

Depending upon the size, upright drilling machine tools can be used for light, medium, and even relatively heavy jobs. It is basically similar to bench-type machines, the main difference being a longer cylindrical column fixed to the base.<sup>[8]</sup>

8. cylindrical column fixed to the base 意为“固定在底座上的圆形立柱”。全句可译为：

立式钻床 根据尺寸，立式钻床能用于加工轻的、中等的甚至是相对重型的工件。它与台式钻床基本类似，主要的区别之处在于一根较长的固定在底座上的圆形立柱。

Along that column is an additional, sliding table for fixing the workpiece which can be locked in position at any desired height. The power required for this type is more than that for the bench-type drilling machines, since this type is employed in performing medium-duty jobs.

沿着立柱是一个附加的安装工件的滑动工作台，它能在任何需要的高度锁定位置。这种钻床所需的功率比台式钻床要大，因为它用于做中等负荷的工作。



There are also large drilling machines of the upright type. In this case, the machine has a box column and a higher power to deal with large jobs. Moreover, gear boxes are employed to provide different rotational spindle speeds as well as the axial feed motion, which can be preset at any desired rate.

也有大的立式钻床。这种情况下，机床有一个箱型立柱和更大的功率去加工大型工件。而且，用了变速箱来提供不同的主轴转速和预设好的任何速率的轴向进给运动。

# Multispindle Drilling Machines

Multispindle drilling machines have sturdy construction and require high power; each is capable of drilling many holes **simultaneously** [saiməl'teiniəsli]. The positions of the different tools (spindles) can be adjusted as desired. Also, the whole head (which carries the spindles and the tools) can sometimes be tilted, as required.

多轴钻床 多轴钻床有坚固的构造和需要的大功率；两者都使其能同时加工多个孔。不同刀具（主轴）的位置都能按需要调整。而且整个床头箱（携带着主轴和刀具）有时可按需要倾斜。

This type of drilling machine is used mainly for mass production in jobs having many holes, such as cylinder blocks.

这种钻床主要用于有多个孔的工件的大量生产，如气缸缸体。

**Radial Drill** A radial drill is particularly suitable for drilling holes in large and heavy workpieces that are inconvenient to mount on the table of an upright drilling machine. A radial drilling machine has a main column, which is fixed to the base.

摇臂钻 摇臂钻特别适于在大型和重型工件上钻孔，这些工件不便于安装在立式钻床的工作台上。摇臂钻有一根固定在基础上的杆柱。

**The cantilever guide arm, which carries the drilling head, can be raised or lowered along the column and clamped at any desired position.**<sup>[9]</sup>

9. **cantilever guide arm** 意为“摇臂”。全句可译为：

装有钻床主轴箱的摇臂可以沿着立柱上下移动，并且可以固定在任何合适的位置上。

**The drilling head slides along the arm and provides rotary motion and axial feed motion. Again, the cantilever guide arm can be swung, thus enabling the tool to be moved in all directions according to a cylindrical coordinate system.**

钻头主轴箱沿摇臂滑动，提供回转运动和轴向进给运动。摇臂能够摆动，因此使刀具能移到柱面坐标系的任何位置。

# Lesson 44 Nontraditional Manufacturing Processes

Terminology

Text tour

# ***Terminology***

## **Burr**

**A rough edge or area remaining on material, such as metal, after it has been cast, cut, or drilled.**

**毛刺：**铸造、切削或钻孔后留在材料(如金属)上的粗糙的边或表面

## **Saw**

**Any of various tools, either hand-operated or power-driven, having a thin metal blade or disk with a sharp, usually toothed edge, used for cutting wood, metal, or other hard materials.**

**锯：**任一种手动或机动的工具名，可以是薄金属片或圆盘，通常具有锋利尖齿，用于切割木材、金属或其它坚硬物质。



# Plasma

An electrically neutral, highly ionized ['aiənaɪzd] gas composed of ions, electrons, and neutral particles. It is a phase of matter distinct from solids, liquids, and normal gases.

**等离子体：**由离子、电子和中性粒子组成的电中性的、高度离子化的气体，它是与固体、液体和正常气体相区别的一种物质状态。



## ***Text tour***

The human race has distinguished itself from all other forms of life by using tools and intelligence to create items that serve to make life easier and more enjoyable. Through the centuries, both the tools and the energy sources to power these tools have evolved to meet the increasing sophistication and complexity of mankind's ideas.

人类通过使用工具和智能来制造使其生活变得更加容易和更舒适的物品这种方法，把他们自己与其他种类的生命区别开来。许多世纪以来，工具和为工具提供动力能源的种类都在不断地发展，以满足人类日益完善和越来越复杂的想法。

In their earliest forms, tools primarily consisted of stone instruments. Considering the relative simplicity of the items being made and the materials being shaped, stone was adequate. When iron tools were invented, durable metals and more sophisticated articles could be produced.

在最早的时期，工具主要是由石器构成的。考虑到所制造的物品相对简单的形状和被加工的材料，石头作为工具是适用的。当铁制工具被发明出来以后，耐用的金属和更精致的物品能够被制造出来。

**The twentieth century has seen the creation of products made from the most durable and, consequently, the most difficult-to-machine materials in history. In an effort to meet the manufacturing challenges created by these materials, tools have now evolved to include materials such as alloy steel, carbide, diamond, and ceramics.**

在20世纪中，已经有了一些由有史以来最耐用，同时也是最难加工的材料制造的产品。为了迎接这些材料给制造业带来的挑战，工具材料已经发展到包括合金钢、硬质合金、金刚石和陶瓷。

A similar evolution has taken place with the methods used to power our tools. Initially, tools were powered by muscles; either human or animal. However as the powers of water, wind, steam, and electricity were harnessed, mankind was able to further extended manufacturing capabilities with new machines, greater accuracy, and faster machining rates.

给我们的工具提供动力的方法也发生了类似的进步。最初，是由人或动物的肌肉为工具提供动力；随后，水力、风力、蒸汽和电力得到了利用，人类通过采用新型机器、更高的精度和更快的加工速度来进一步提高制造能力。

Every time new tools, tool materials, and power sources are utilized, the efficiency and capabilities of manufacturers are greatly enhanced. However as old problems are solved, new problems and challenges arise so that the manufacturers of today are faced with tough questions such as the following:

每当采用新的工具、新的材料和新的能源时，制造效率和制造能力都会得到很大的提高。然而，当旧的问题解决之后，就会有新的问题和挑战出现。例如，现今制造业面对着下面一些问题：

How do you drill a 2 mm diameter hole 670 mm deep without experiencing taper or runout? Is there a way to efficiently deburr passageways inside complex castings and guarantee 100 % that no burrs were missed? Is there a welding process that can eliminate the thermal damage now occurring to my product?

如何去钻一个直径为2 mm，长度为670 mm的孔，而不产生锥度和偏斜？用什么办法能够有效地去除形状复杂的铸件内部的通道中的毛刺，而且保证去除率达到100%？是否有一种焊接工艺，它能够避免目前在产品中出现的热损伤？

Since the 1940s, a revolution in manufacturing has been taking place that once again allows manufacturers to meet the demands imposed by increasingly sophisticated designs and durable, but in many cases nearly unmachinable, materials.

从20世纪40年代以来，制造业中发生的大变革一次又一次地促使制造厂家去满足日益复杂的和耐用的，但是在许多情况下几乎接近无法加工的材料所带来的各种要求。

This manufacturing revolution is now, as it has been in the past, centered on the use of new tools and new forms of energy. The result has been the introduction of new manufacturing processes used for material removal, forming, and joining, known today as nontraditional manufacturing processes.

这种制造业的大变革不论现在还是过去都是集中在采用新型工具和新型能源上。这样做的结果是产生了用来去除材料、成型、连接的新型加工工艺。这些工艺目前被称为特种加工工艺。



The conventional manufacturing processes in use today for material removal primarily rely on electric motors and hard tool materials to perform tasks such as sawing, drilling, and broaching. Conventional forming operations are performed with the energy from electric motors, hydraulics, and gravity. Likewise, material joining is conventionally accomplished with thermal energy sources such as burning gases and electric arcs.

在目前所采用的常规制造工艺中，材料的去除是依赖于电动机和硬的刀具材料进行的，诸如锯断、钻孔和拉削。常规的成型加工是利用电动机、液压和重力所提供的能量进行的。同样，材料连接的常规做法是采用诸如燃烧的气体 and 电弧等热能进行的。

In contrast, nontraditional manufacturing processes harness energy sources considered unconventional by yesterday's standards. Material removal can now be accomplished with electrochemical reactions, high-temperature plasmas, and high-velocity jets of liquids and abrasives.

与之相比，特种加工工艺采用按照以前的标准来说不是常规的能源。现在材料的去除可以利用电化学反应、高温等离子、高速液体和磨料射流。

Materials that in the past have been extremely difficult to form, are now formed with magnetic fields, explosives, and the shock waves from powerful electric sparks. Material-joining capabilities have been expanded with the use of high-frequency sound waves and beams of electrons.

过去非常难于成型加工的材料，现在可以利用大功率的电火花所产生的磁场、爆炸和冲击波进行成型加工。采用高频声波和电子束可使材料的连接能力有很大的提高。

In the past 50 years, over 20 different nontraditional manufacturing processes have been invented and successfully implemented into production. The reason there are such a large number of nontraditional processes is the same reason there are such a large number of conventional processes; each process has its own characteristic attributes and limitations, hence no one process is best for all manufacturing situations.

在过去的50年间，人们发明了20多种特种加工工艺，并且将其成功地应用于生产之中。这么多特种加工工艺存在的原因与许多种常规加工工艺存在的原因是一样的。每一种工艺都有它自己的特点和局限性。因而，不存在一种对任何制造环境来说都是最好的工艺方法。

For example, nontraditional process are sometimes applied to increase productivity either by reducing the number of overall manufacturing operations required to produce a product or by performing operations faster than the previously used method.

例如，有时特种加工工艺或者通过减少生产某个产品所需要的加工工序的数量，或者通过采用比以前使用的方法更快的工序来提高生产率。

In other cases, nontraditional processes are used to reduce the number of rejects experienced by the old manufacturing method by increasing repeatability, reducing in-process breakage of fragile workpieces, or by minimizing detrimental effects on workpiece properties.

在另外的场合中，采用特种加工工艺可以通过增加重复精度，减少易损坏工件在加工过程中的损伤，或者减少对工件性能的有害影响来减少采用原来的加工工艺所产生的废品的数量。

Because of the aforementioned attributes, nontraditional manufacturing processes have experienced steady growth since their introduction. An increasing growth rate for these processes in the future is assured for the following reasons:

由于前面所提到的这些特点，特种加工工艺从其诞生时起就开始了稳定的发展。由于下列原因，可以肯定这些工艺将来会有更快的增长速度。

1. Currently, nontraditional processes possess virtually unlimited capabilities when compared with conventional processes, except for volumetric material removal rates. Great advances have been made in the past few years in increasing the removal rates of some of these processes, and there is no reason to believe that this trend will not continue into the future.

1. 目前，同常规工艺相比，除了材料的体积去除率外，特种加工工艺几乎具有不受限制的能力。在过去几年中，某些特种加工工艺在提高材料去除率方面有了很大的进展，而且有理由相信这种趋势在将来也会继续下去。



2. Approximately one half of the nontraditional manufacturing processes are available with computer control of the process parameters. The use of computers lends simplicity to processes that people may be unfamiliar with, and thereby accelerates acceptance. Additionally, computer control assures reliability and repeatability <sup>[5]</sup>, which also accelerates acceptance and implementation.

2. 大约半数的特种加工工艺目前采用计算机控制加工参数。使用计算机可使人们所不熟悉的加工过程变得简单，因而加大了人们对这种技术的接受程度。此外，计算机控制可以保证可靠性和重复性，这也加大了人们对这种技术的接受程度及其应用范围。

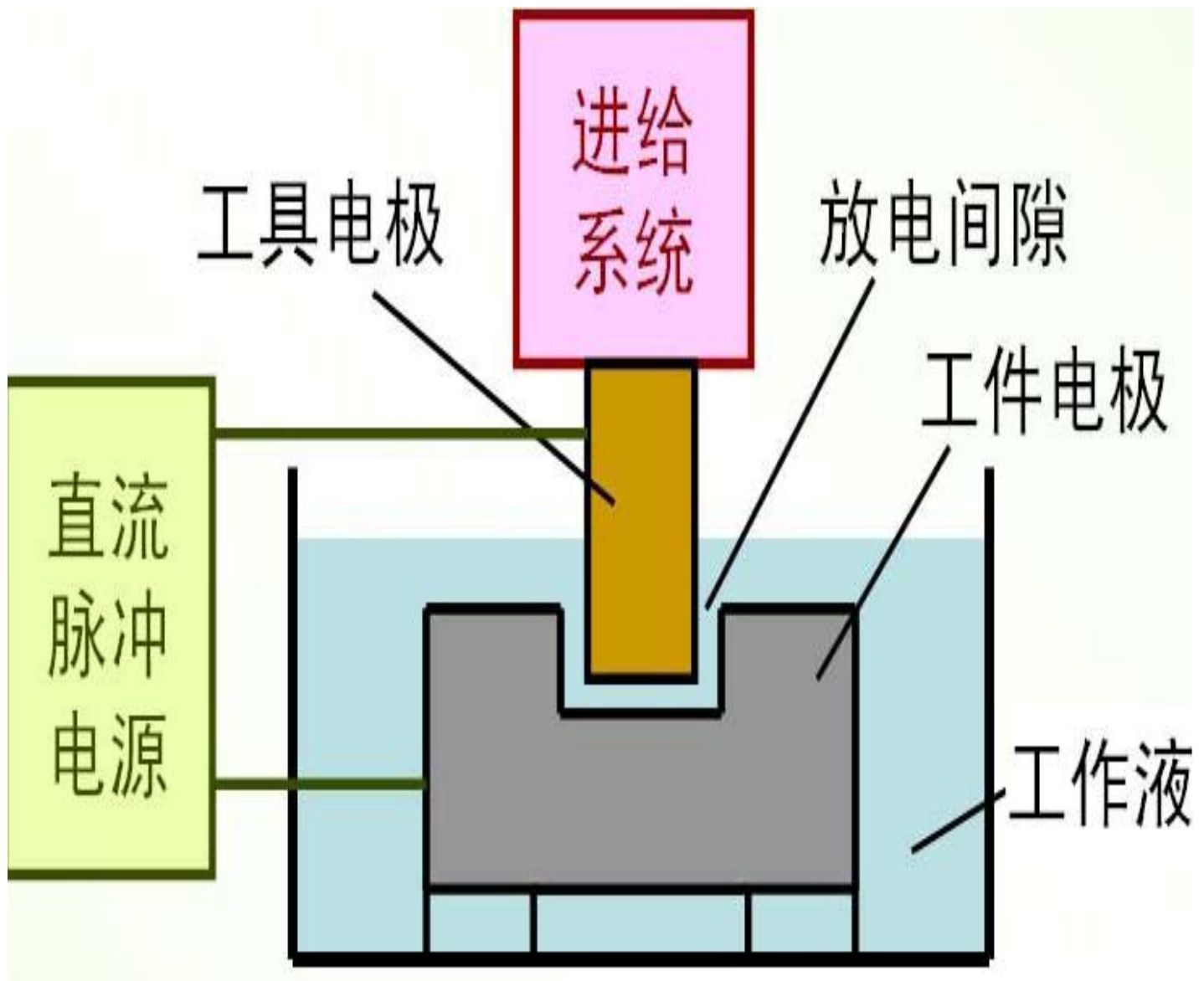
3. Most nontraditional processes are capable of being adaptively-controlled through the use of vision systems, laser gages, and other in-process inspection techniques. If, for example, the in-process inspection system determines that the size of holes being produced in a product are becoming smaller, the size can be modified without changing hard tools, such as drills.

3. 大多数特种加工工艺可以通过视觉系统，激光测量仪表和其他过程检测(在线检测On-line detection)技术来实行自适应控制。例如，过程检测结果表明，产品中正在加工的孔的尺寸在变小，可以在不更换硬的加工工具(如钻头)的情况下，修正孔的尺寸。

**4. The implementation of nontraditional manufacturing processes will continue to increase as manufacturing engineers, product designers, and metallurgical engineers become increasingly aware of the unique capabilities and benefits that nontraditional manufacturing processes provide.**

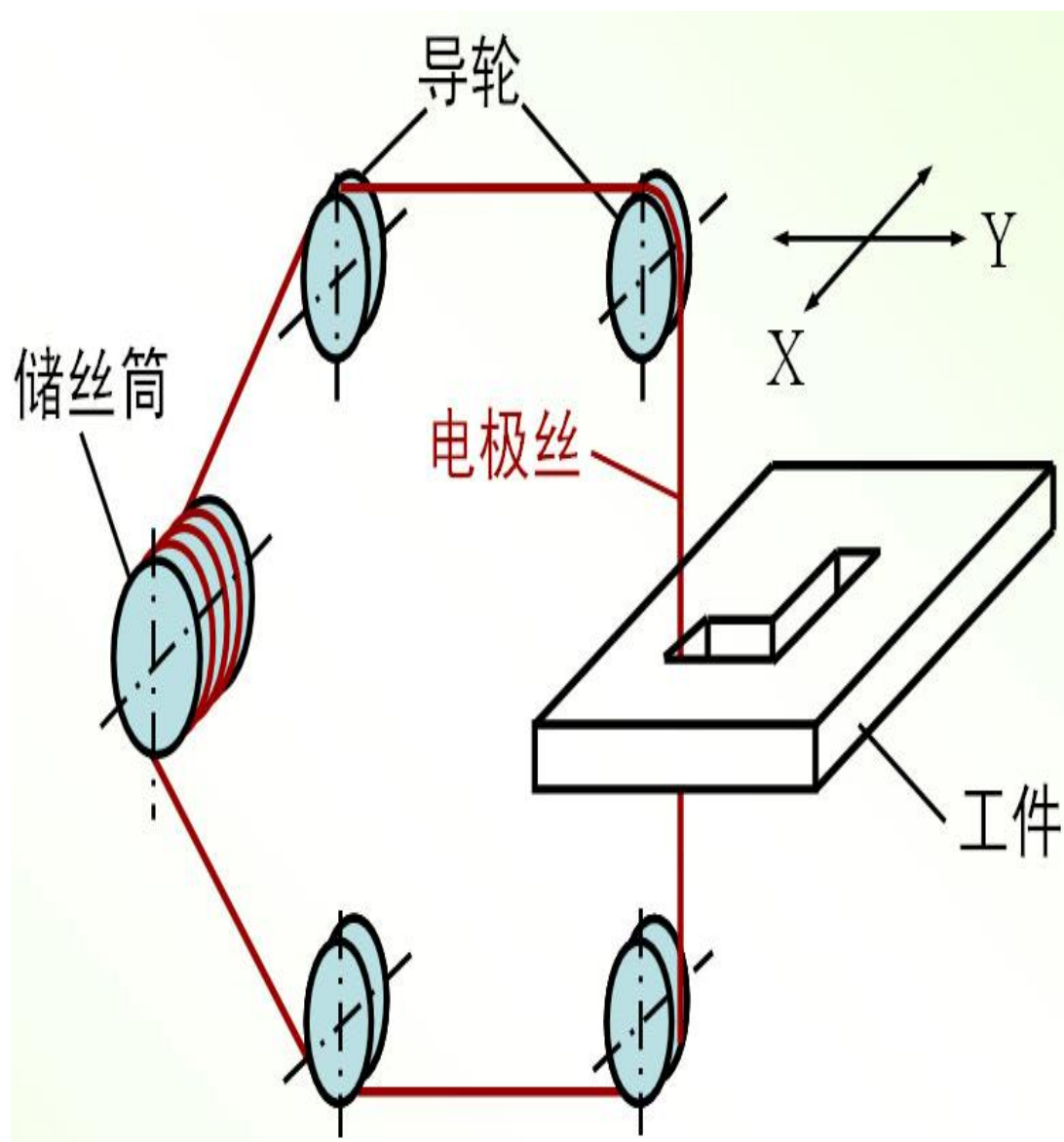
4. 随着制造工程师，产品设计人员和冶金工程师们对特种加工工艺所具有的独特能力和优越性的了解的增加，特种加工工艺的应用范围将会不断增加。

# 部分特种加工方法

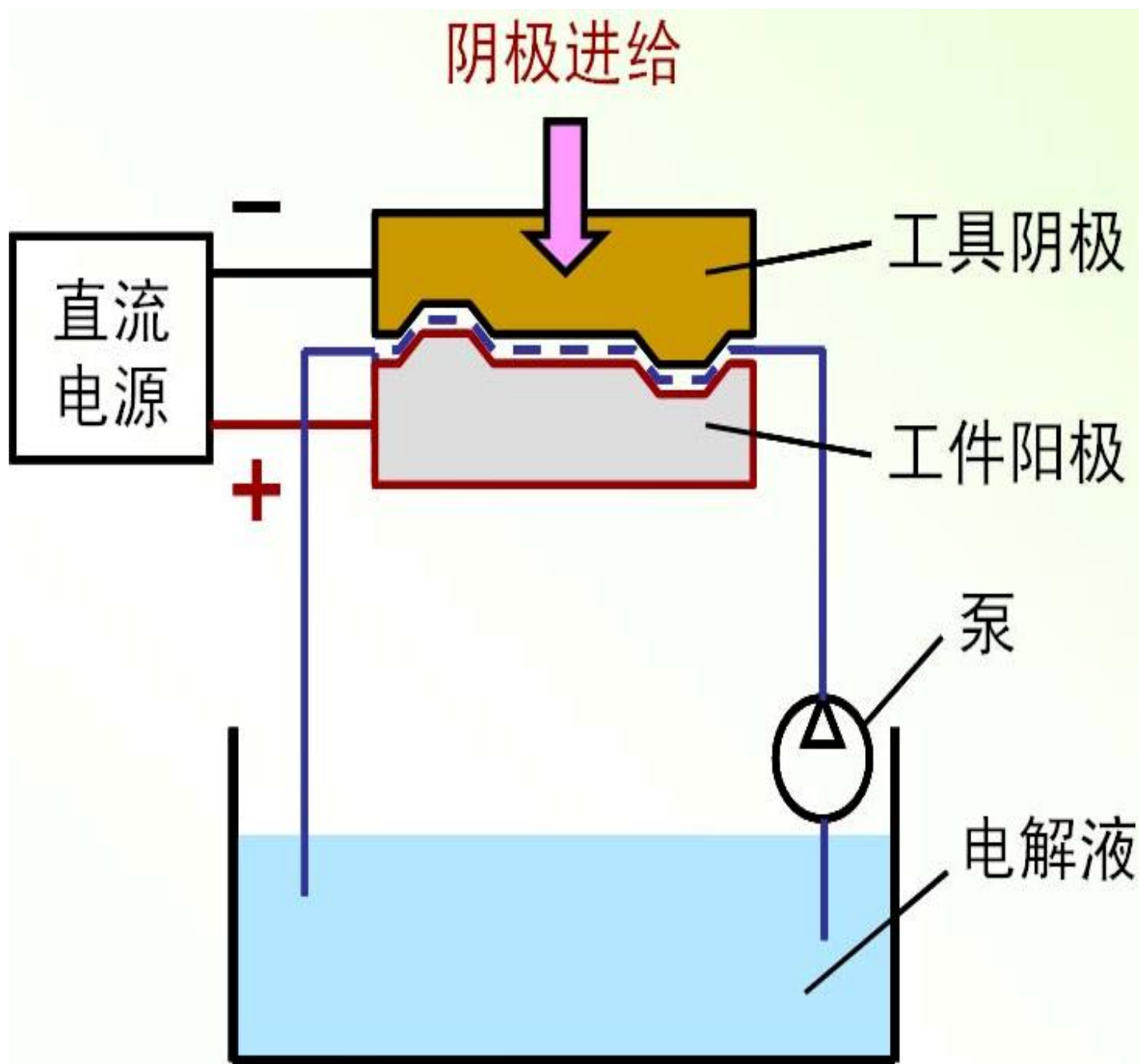


电火花加工(**Electrical Discharge Machining, EDM**)原理

利用工具电极和工件电极间瞬时火花放电所产生的高温，熔蚀工件材料来获得工件成形

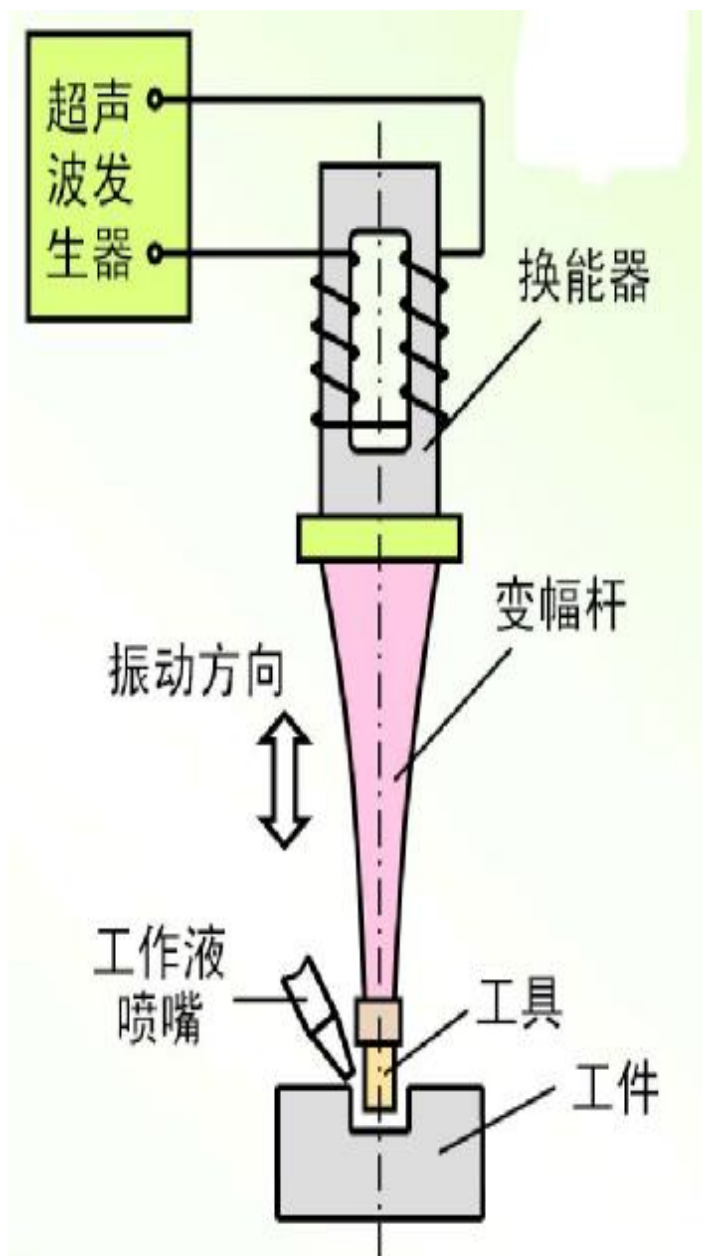


## 电火花线切割加工



电解加工（electrochemical machining, ECM）  
原理图

利用金属在电解液中产生阳极溶解的原理，去除  
工件材料的特种加工。



## 超声波加工(ultrasonic machining, USM)原理示意图

利用超声频振动的工具端面冲击工作液中的悬浮磨粒,由磨粒对工件表面撞击抛磨来实现对工件加工的一种方法

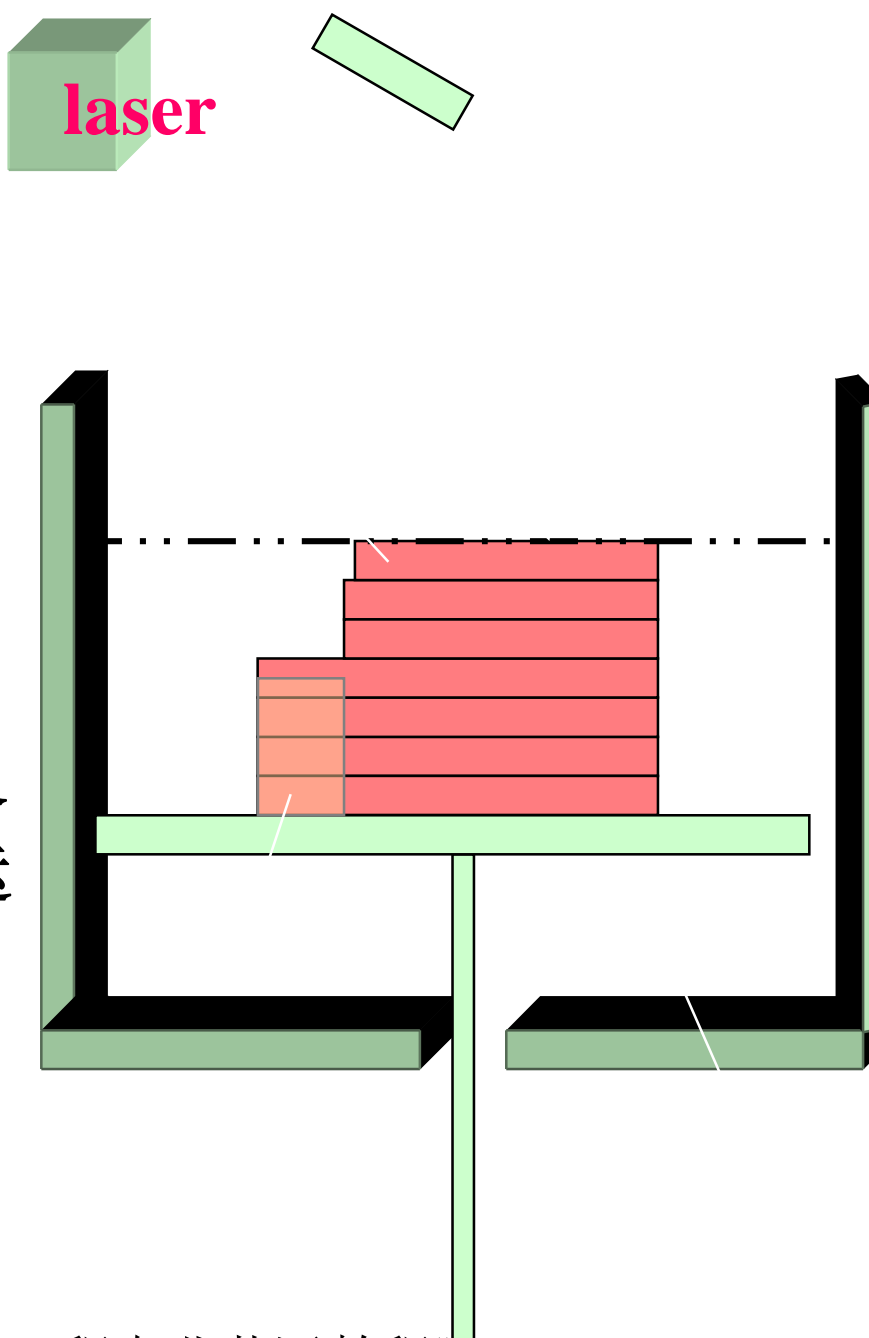


特 种 加 工 方 法		能量来源及形式	作用原理	英文缩写
电火花加工	电火花成形加工	电能、热能	熔化、气化	EDM
	电火花线切割加工	电能、热能	熔化、气化	WEDM
电化学加工	电解加工	电化学能	金属离子阳极溶解	ECM(ELM)
	电解磨削	电化学、机械能	阳极溶解、磨削	EGM(ECG)
	电解研磨	电化学、机械能	阳极溶解、研磨	ECH
	电铸	电化学能	金属离子阴极沉积	EFM
	涂镀	电化学能	金属离子阴极沉积	EPM
激光加工	激光切割、打孔	光能、热能	熔化、气化	LBM
	激光打标记	光能、热能	熔化、气化	LBM
	激光处理、表面改性	光能、热能	熔化、相变	LBT
电子束加工	切割、打孔、焊接	电能、热能	熔化、气化	EBM
离子束加工	蚀刻、镀膜、注入	电能、动能	原子撞击	IBM
等离子弧加工	切割(喷镀)	电能、热能	熔化、气化(涂覆)	PAM
超声加工	切割、打孔、雕刻	声能、机械能	磨料高频撞击	USM
化学加工	化学铣削	化学能	腐蚀	CHM
	化学抛光	化学能	腐蚀	CHP
	光刻	光、化学能	光化学腐蚀	PCM



## A. SL成形原理

光固化造型首先由CAD系统对准备制造的零件进行三维实体造型设计，再由专门的计算机切片软件CAD系统对三维模型分割成若干薄层平面数据模型。薄层厚度越小，零件的制造精度越高，但制作的时间也越长，所以要综合考虑后选取薄层的厚度。随后CAM软件再根据各薄层的平面X—Y运动指令，结合提升机构Z坐标方向的间歇下降运动，形成整个零件的数控加工指令。



## **1) Material.**

**It is photopolymer (感光性树脂) that is a kind of acrylate (丙烯酸酯).**

## **2) Support.**

因为原型是在液体中生成的，则在生成过程中，在零件上面的未支撑的部分可能下沉或漂移。因此，原型需要一些预先设计好的支撑体。这些支撑体可能是梁柱型、桥型或框架型等。

## **3) Model accuracy and performance.**

精度大约是原型整体尺寸的0.1%，但是不能超过0.5%。层的厚度在0.004和0.03英寸之间。感光性树脂制造的原型是易碎的，不能承受高压测试。甚至，材料的收缩也会导致原型的变形。

## **4) Capacity.**

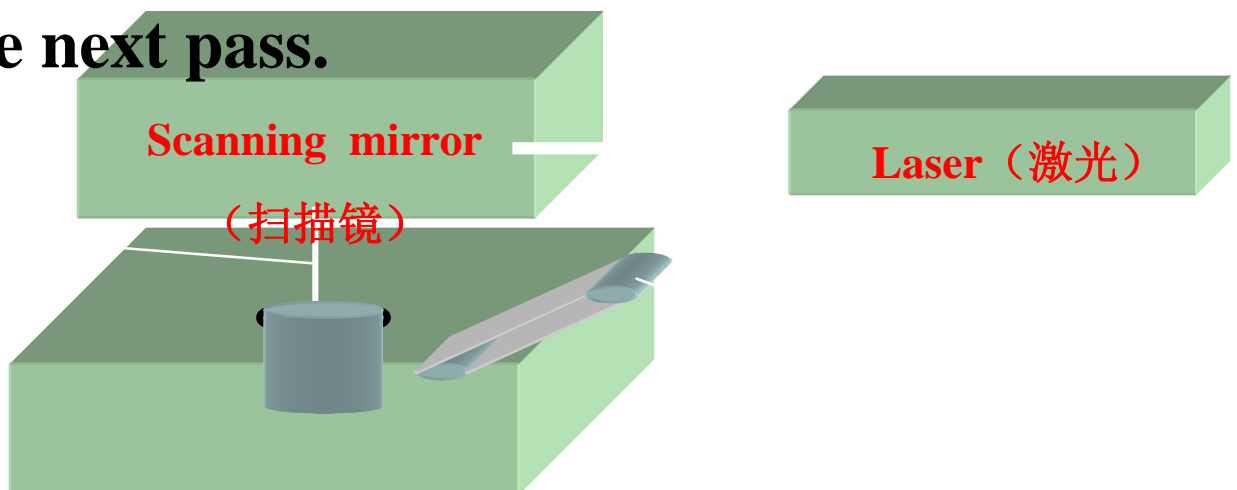
盛液体树脂的容器的大小决定了能制作的原型的尺寸。目前来说，该尺寸越来越大。

## **5) Recycling.**

感光性树脂是热固性材料，不能再熔化以再利用。

## A. Theory of SLS

SLS uses a carbon dioxide laser to sinter successive layers of powder instead of liquid. In SLS processes, a thin layer of powder is applied by a counter-rotating roller mechanism onto the work place. The powder material is preheated to a temperature slightly below its melting point. The laser beam traces the cross-section on the powder surface to heat up the powder to the sintering temperature so that the powder scanned by the laser is bonded. The powder that is not scanned by the laser will remain in place to serve as the support to the next layer of powder, which aids in reducing distortion. When a layer of the cross-section is completed, the roller levels another layer of powder over the sintered one for the next pass.



1) Material. SLS uses a wide range of materials for model production including polycarbonate, PVC (polyvinyl chloride), ABS (acrylonitrile-butadiene-styrene), nylon, resin, polyster, polypropane, polyurethane and investment casting wax.

SLS 使用一大类材料生产模型。这些材料包括：聚碳酸酯、PVC（聚氯乙烯）、ABS（丙烯腈-丁二烯-苯乙烯）、尼龙、树脂、聚丙烯、聚亚安酯等。

2) Support.

SLS系统不需要预先设计的支撑体。在每一层上的没有被烧结的粉末就作为下一层的支撑体

3) Model accuracy and performance.

平均精确度可达 $\pm 0.005$ 到 $\pm 0.015$ 英寸。层的厚度在0.003和0.02英寸之间。由于烧结和冷却，产品可能收缩和变形。这两种因素可以通过选择合适的粉末部分地消除，如粉末微粒要细、高于粉末软化点的气流温度等。

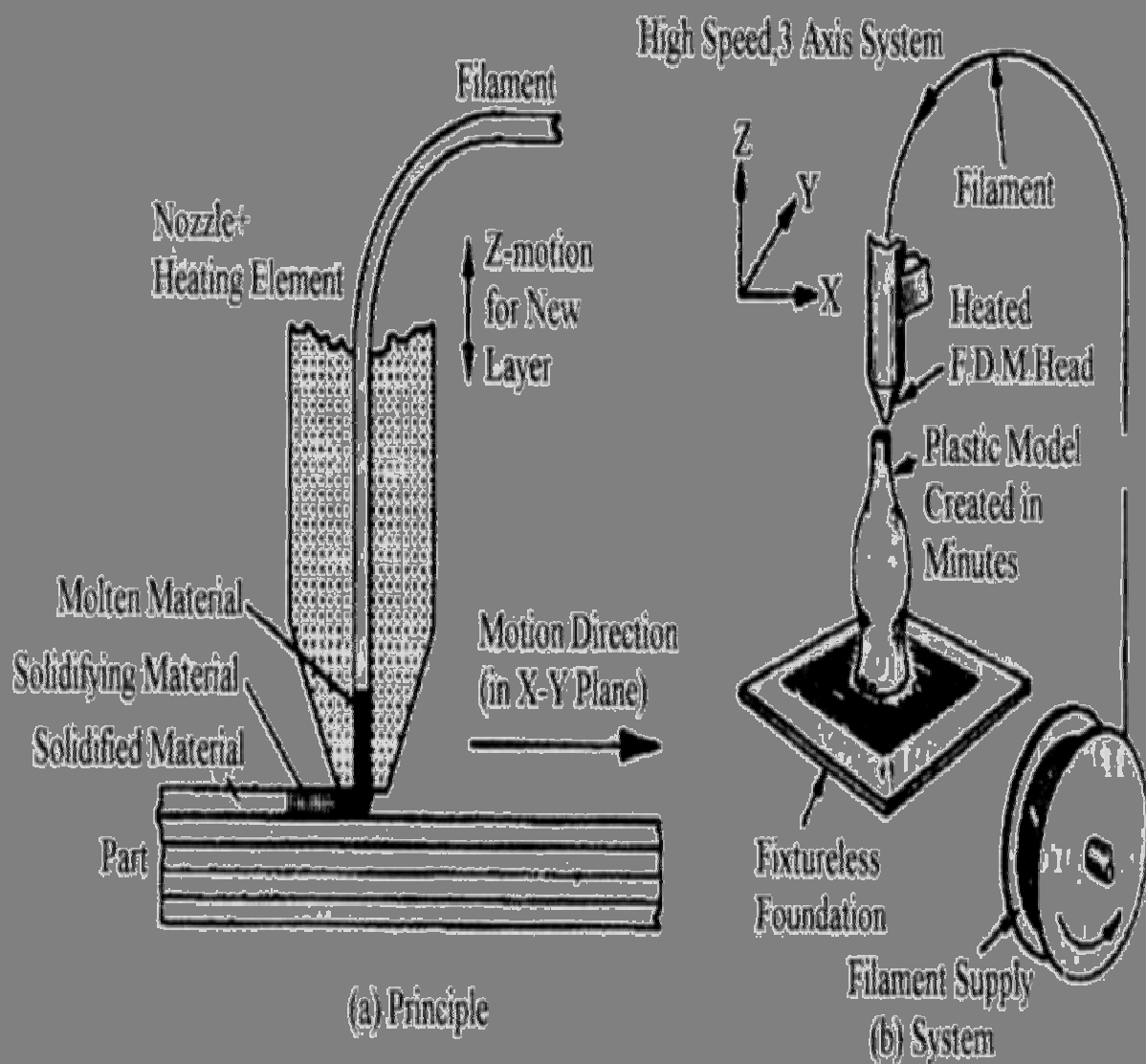
4) Capacity.

最大的零件尺寸是12英寸的直径和15英寸深

5) Recycling.

原型能被研细成粉末后再利用。

### (3) Fused Deposition Modelling: FDM (熔融沉积造型)



Working Principle of FDM.

熔融堆积制造加工原理

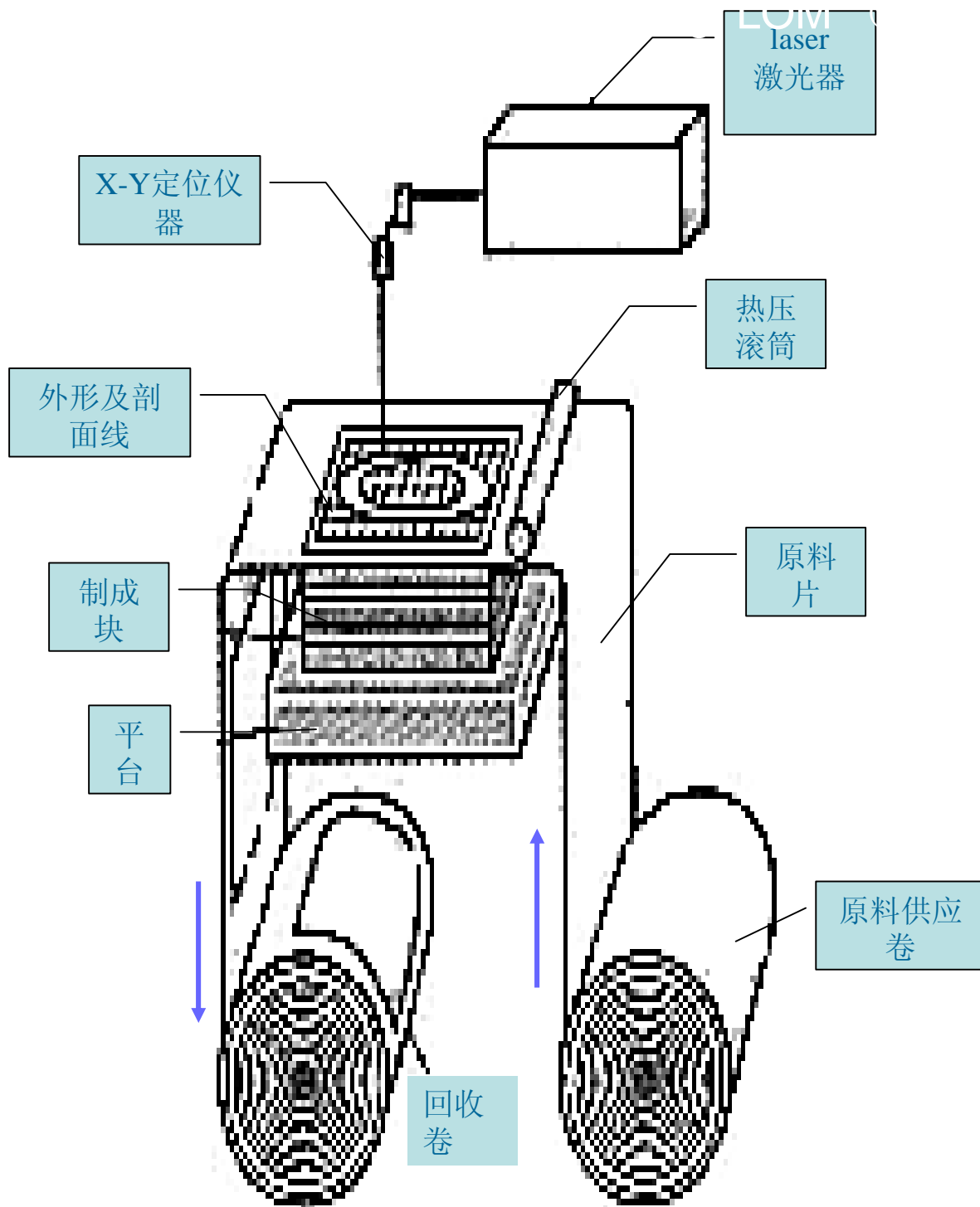
A spool of thermoplastic filament feeds into a heated FDM extrusion head. The movement of the FDM head is controlled by computer. Inside the flying extrusion head, the filament is melted into liquid (above the melting temperature) by a resistant heater. The head traces an exact outline of each cross-section layer of the part. As the head moves horizontally in X and Y axes, the thermoplastic material is extruded out of a nozzle by a precision pump. The material solidifies in 1/10 second as it is directed on to the workplace. After one layer is finished, the extrusion head moves up a programmed distance in Z direction for building the layer. Each layer is bonded to the previous layer through thermal heating.

1) Material. FDM technology allows a variety of modeling materials and colors for model building. Available materials are wax-filled plastic adhesive material, proprietary nylon, and investment casting wax. All the materials are non-toxic and can be in different colors.

FDM使用的成形材料有铸造石蜡、尼龙（聚脂塑料）、**ABS**（丙烯腈-丁二烯-苯乙烯）塑料及**MABS**，可实现塑料零件无注塑成形制造。所有的材料都是无毒的，而且是可以有不同的颜色。

- 2) Support. In many cases, the FDM process does not need support to produce part. For overhanging parts, a support may still be required to reduce part distortion.
- SLS系统不需要预先设计的支撑体。但是对于有悬臂的零件，还是需要支撑体以减少零件变形。
- 3) Model accuracy and performance.
- 综合公差可达 $\pm 0.005$ 英寸。层的厚度在0.001和0.05英寸之间，壁厚在0.01到0.25英寸之间。用FDM工艺生产的原型最大有1.2%的收缩变形。
- 4) Capacity.
- 最大的零件尺寸是12英寸 $\times$ 12英寸 $\times$ 12英寸。





LOM工艺成形原理图

## **A. Theory of LOM**

**The LOM processes produce parts from bonded paper plastic, metal or composite sheet stock. LOM machines bond a layer of sheet material to a stack of previously formed laminations, and then laser beam follows the contour of the part cross-section generated by CAD to cut it to the required shape. The layers can be glued or welded together and the excess material of every sheet is either removed by vacuum suction or remains as next layer's support.**

## B. Features of LOM

1) Material. Virtually any foil (sheet material) can be applied: paper, metals, plastics, fibers, synthetic materials, glass or composites.

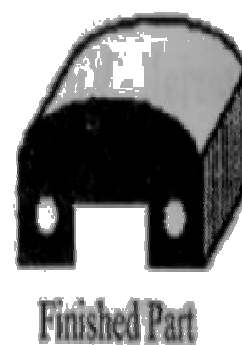
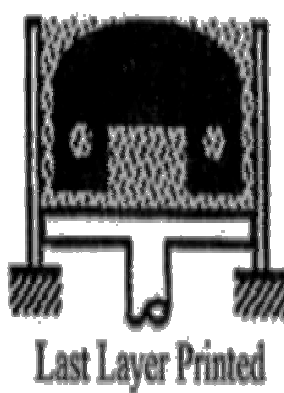
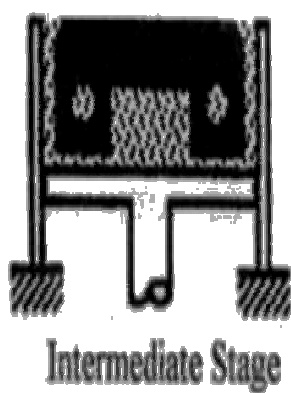
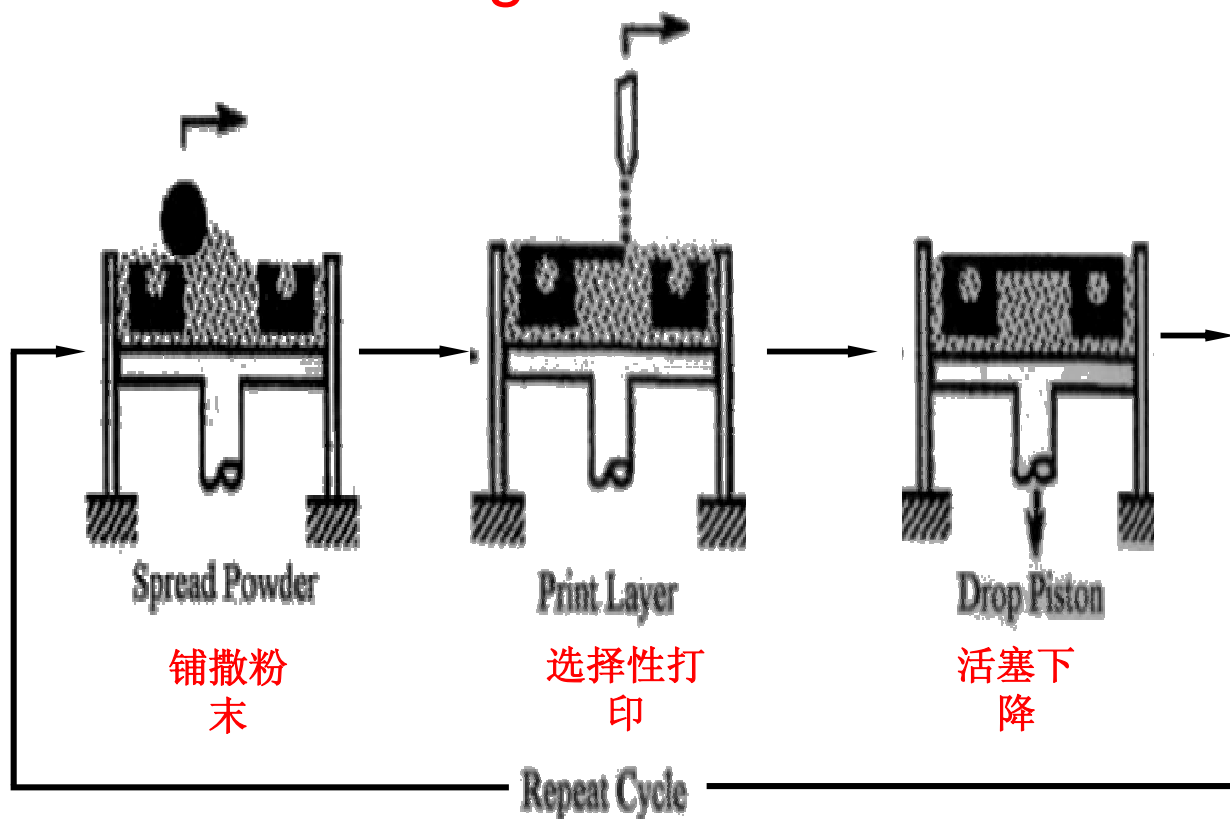
事实上，任何薄片都能使用：纸、金属、塑料、光纤、合成材料、玻璃和其他合成物。

2) Support. The LOM process uses solid-state materials and therefore usually does not need predesigned support structure.

LOM工艺使用固态的材料，因此系统通常也不需要预先设计的支撑体。

- 3) Model accuracy and performance.
- 原型构造的精度可达 $\pm 0.005$ 英寸。由于使用薄片材料，原型也不会收缩和扭曲变形。连续的层的厚度在0.002和0.02英寸之间。制作模型的原材料没有感光树脂材料脆。
- 4) Capacity.
- LOM加工使用二氧化碳激光束。能构造的原型的尺寸是15英寸 $\times$ 10英寸 $\times$ 15英寸。因为只有需要加工的轮廓才需要加工速度快。

## (5) Three-dimensional Printing: 3D Printing (三维打印)



**In the 3-D Printing is sliced into 2-D cross-section layers in computer. A layer of powder is spread on the top of the piston, the powder bed, in a cylinder, and then an inkjet printing head projects droplets of binder material onto the powder at the place where the solidification is required according to the information from the computer model. After one layer is completed, the piston drops a predefined distance and a new layer of powder is spread out and selectively glued. When the whole part is completed, heat treatment is required to enhance the bonding of the glued powder, and then the unbonded powder is removed.**

1) Material. The 3-D Printing process can use aluminum oxide and alumina-silica ceramic powders. The binder material is amorphous or colloidal silicon carbide (SiC).

三维打印工艺使用氧化铝和铝硅陶瓷粉末为原型材料，粘结材料是无定形的或胶状的碳化硅（SiC）。

2) Support. With the 3-D Printing technique, the design of support structure for the part is not needed, since the unbonded powder of each layer remains to form a natural support during the layering process.

利用三维打印技术，原型零件的支撑结构体的设计是不必要的。这是因为在层叠过程中，每一层未粘结的金属粉末形成一个自然的支撑体。

- 3) Model accuracy and performance.
- 原型的层的厚度是178微米，最小的特征尺寸是0.017英寸。
- 4) Capacity.
- 三维打印工艺能用于生产功能性零件和工具的原型。现在最大零件的尺寸是12英寸×12英寸×24英寸。



# Lesson 62 The Computer and Manufacturing

Terminology

Text tour

# ***Terminology***

## **Conceive**

### **1. To form or develop in the mind; devise**

构思：在脑海中设计或构思；  
设计

### **2. To form or hold an idea**

构想出：构想出或持有一种想法

Tedious

Tiresome by reason of length,

slowness, or dullness, boring

单调乏味的：由于时间长、缓慢  
或呆滞而令人厌倦的，  
令人厌烦的。

Optimum

1. The point at which the condition,  
degree, or amount of

something is the most favorable

最佳效果：事物的条件、程度或  
数量的最合适点

2. Most favorable or advantageous,  
best

最好的：最适合或最有利的；最  
好的

## ***Text tour***

The computer is bringing manufacturing into the Information Age. This new tool, long a familiar one in business and management operations, is moving into the factory, and its advent is changing manufacturing as certainly as the steam engine changed it more than 200 years ago.

计算机正在将制造业带入信息时代。计算机长期以来在商业和管理方面得到了广泛的应用，它正在作为一种新的工具进入到工厂中，而且它如同蒸汽机在200多年前使制造业发生改变那样，正在使制造业发生着变革。

The basic metalworking processes are not likely to change fundamentally, but their organization and control definitely will.

尽管基本的金属加工工艺不太可能发生根本性的改变，但是它们的组织形式和控制方式必将发生改变。

In one respect, manufacturing could be said to be coming full circle.

从某一方面可以说，制造业正在完成一个循环。

The first manufacturing was a cottage industry: the designer was also the manufacturer, conceiving and fabricating products one at a time. Eventually, the concept of the interchangeability of parts was developed, production was separated into specialized functions, and identical parts were produced thousands at a time.

最初的制造业是家庭手工业：设计者本身也是制造者，一次只构思与加工一个产品。后来，形成了零件的互换性这个概念，生产被依照专业功能分割开来，可以成批地生产数以千计的相同零件。

Today, although the designer and manufacturer may not become one again, the functions are being drawn close in the movement toward an integrated manufacturing system.

今天，尽管设计者与制造者不再可能是同一个人，但在向集成制造系统前进的途中，这两种功能已经越来越靠近了。

It is perhaps ironic that, at a time when the market demands a high degree of product diversification, the manufacturing enterprises have to increase productivity and reduce cost. Customers are demanding high quality and diversified products for less money.

可能具有讽刺意味的是，在市场需求高度多样化产品的同时，制造业必须提高生产率和降低成本。消费者要求用较少的钱去购买高质量和多样化的产品。

The computer is the key to meet these requirements. It is the only tool that can provide the quick reflexes, the flexibility and speed, to meet a diversified market. And it is the only tool that enables the detailed analysis and the accessibility of accurate data necessary for the integration of the manufacturing system.

计算机是满足这些要求的关键因素。它是能够提供快速反应能力、柔性和来满足多样化市场的唯一工具。而且，它是实现制造系统集成所需要的、能够进行详细分析和利用精确数据的唯一工具。



It may well be that, in the future, the computer may be essential to a company's survival. Many of today's businesses will fade away to be replaced by more productive combinations. Such more-productive combinations are superquality, superproductivity plants. The goal is to design and operate a plant that would produce 100% satisfactory parts with good productivity.

将来，计算机可能是一个企业生存的基本条件，许多现今的企业将被生产能力更高的企业组合所取代。这些生产能力更高的企业组合是一些具有非常高的质量、非常高的生产率的工厂。目标是设计和运行一个能以高生产率的方式生产100%合格产品的工厂。

A sophisticated, competitive world is requiring that manufacturing begin to settle for more, to become itself sophisticated. To meet competition, for example, a company will have to meet the somewhat conflicting demands for greater product diversification, higher quality, improved productivity, and low prices.

一个采用先进技术的、竞争的世界正在促使制造业开始做更多的工作，使其本身采用先进的技术。为了适应竞争，一个公司会满足一些在某种程度上相互矛盾的要求，诸如产品多样化、提高质量、增加生产率、降低价格。

The company that seeks to meet these demands will need a sophisticated tool, one that will allow it to respond quickly to customer needs while getting the most out of its manufacturing resources.

在努力满足这些要求的过程中，公司需要一个采用先进技术的工具，一个能够对顾客的需求做出快速反应，而且从制造资源中获得最大收益的工具。

The computer is that tool.  
计算机就是这个工具。

Becoming a "superquality, superproductivity" plant requires the integration of an extremely complex system. This can be accomplished only when all elements of manufacturing—design, fabrication and assembly, quality assurance, management, materials handling—are computer integrated.

成为一个具有“非常高的质量、非常高的生产率”的工厂，需要对一个非常复杂的系统进行集成。这只有通过采用计算机对机械制造的所有组成部分—设计、加工、装配、质量保证、管理和材料装卸及输送进行集成才能完成。

In product design, for example, interactive computer-aided-design (CAD) systems allow the drawing and analysis tasks to be performed in a fraction of the time previously required and with greater accuracy. And programs for prototype testing and evaluation further speed the design process.

例如，在产品设计期间，交互式的计算机辅助设计系统使得完成绘图和分析工作所需要的时间比原来减少了几倍，而且精确程度得到了很大的提高。此外，用于样机的试验与评价的计算机程序进一步加快了设计过程。

In manufacturing planning, computer-aided process planning permits the selection, from thousands of possible sequences and schedules, of the optimum process.

在制定制造计划时，计算机辅助编制工艺规程可以从数以千计的工序和加工过程中选择最好的加工方案。

On the shop floor, distributed intelligence in the form of microprocessors controlled machines, runs automated loading and unloading equipment, and collects data on current shop conditions.

在车间里，分布式智能以微处理器这种形式来控制机床、操纵自动装卸料设备和收集关于当前车间状态的信息。

But such isolated revolutions are not enough. What is needed is a totally automated system, linked by common software from front door to back.

但是这些各自独立的改革还远远不够。我们需要的是由一个通用软件从始端到终端进行控制的全部自动化的系统。

The benefits range throughout the system. Essentially, computer integration provides widely and instantaneously available, accurate information, improving communication between departments, permitting tighter control, and generally enhancing the overall quality and efficiency of the entire system.

一般来说，制造系统经过计算机集成后具有如下优点：可以利用更为广泛、及时而准确的信息，可以改进各部门之间的交流与沟通，实施更严格的控制，而且通常能够增强整个系统的全面质量和效率。



Improved communication can mean, for example, designs that are more producible. The NC programmer and the tool designer have a chance to influence the product designer, and vice versa.

例如，改进交流和沟通意味着会使设计具有更好的可制造性。数控编程人员和工艺装备设计人员有机会向产品设计人员提出意见，反之亦然。

Engineering changes, thus, can be reduced, and those that are required can be handled more efficiently. Not only does the computer permit them to be specified more quickly, but it also alerts subsequent users of the data to the fact that a change has been made.

因而可以减少技术方面的变更，而对于那些必要的变更，可以更有效地进行处理。计算机不仅能够更快地对变更之处做出详细说明，而且还能够把变更之后的数据告诉随后的使用者。

The instantaneous updating of production-control data permits better planning and more effective scheduling. Expensive equipment, therefore, is used more productively, and parts move more efficiently through production, reducing work-in-process costs.

利用及时更新的生产控制数据可以制订更好的工艺规程和更有效率的生产进度。因而，可以使昂贵的设备得到更好的利用，提高零件在生产过程中的运送效率，减少在制品的成本。

Product quality, too, can be improved. Not only are more-accurate designs produced, for example, but the use of design data by the quality-assurance department helps eliminate errors due to misunderstandings.

产品质量也可得到改进。例如，不仅可以提高设计精度，还可以使质量保证部门利用设计数据，避免由于误解而产生错误。

People are enabled to do their jobs better. By eliminating tedious calculations and paperwork-not to mention time wasted searching for information-the computer not only allows workers to be more productive but also frees them to do what only human beings can do: think creatively.

可使人们更好地完成他们的工作。通过避免冗长的计算和书写工作——这还不算查找资料所浪费的时间——计算机不仅使人们更有效地工作，而且还能把他们解放出来去做只有人类才能做的工作：创造性地思考。

Computer integration may also lure new people into manufacturing. People are attracted because they want to work in a modern, technologically sophisticated environment.

计算机集成制造还会吸引新的人才进入制造业。人才被吸引过来的原因是他们希望到一个现代化的、技术先进的环境中工作。

In manufacturing engineering, CAD/CAM decreases tool design NC-programming, and planning times while speeding the response rate, which will eventually permit in-house staff to perform work that is currently being contracted out.

在制造工程中，CAD/CAM减少了工艺装备设计、数控编程和编制工艺规程所需要的时间。而且，在同时加快了响应速度，这将会使目前委托其它公司来做的那部分工作最终由本公司内部人员来完成。

# Lesson 63 Computers in Design and Manufacturing

Terminology

Text tour



# ***Terminology***

## **Built in**

**Constructed as part of a larger unit; not detachable**

内装式的，嵌入的：作为一个大整体的一部分建造的，不可分的

## **Warehouse**

**1. A place in which goods or merchandise are stored, a storehouse**

仓库：商品或货物贮存之处；货栈

**2. A large, usually wholesale shop**

批发商店：大的，通常从事批发业务的商店

Just in time production (JIT)  
The principle of JIT is that supplies of raw materials, parts, and components are delivered to the manufacturer just in time to be used, and products are finished just in time to be delivered to the customer.

准时生产：在需要的时候将原材料、零件、部件送到生产厂家，在需要的时候将产品生产出来，并将其交给客户。

## ***Text tour***

Computers have been used in nearly every manufacturing job. Computers improve the efficiency, accuracy, and productivity of many manufacturing processes. Just like the other tools and machines, computers extend human capabilities and make some jobs easier. Every department in manufacturing has found a use for computers.

几乎所有制造工作中都用到了计算机。计算机提高了许多制造工艺的效率、精度和生产率。就像其它工具和机器一样，计算机扩展了人的能力，使一些工作更容易。制造业中每个部门中都能发现计算机的用处。

In the management department, supervisors and managers use computers to gather information about the progress of work in all the other departments.

在管理部门里，主管和经理用计算机来收集所有其它部门工作进度的信息。

In marketing, researchers, advertisers, and sales people use computers to get data on potential buyers, to study market research, and to create advertisements.<sup>[1]</sup>

1. in marketing 这里指“in marketing department”。全句可译为：

在销售部门，研究人员，广告制作人员，销售人员利用计算机来收集潜在客户的数据，进行市场研究和制作广告。

The real tool when using any computer is the software. Software is the set of coded instructions written to control the operations of the computers.<sup>[2]</sup>

2. **coded instruction**意为“编码指令”。全句可译为：

用计算机时真正的工具是软件。软件是用于控制计算机运行的编码指令。

Without software, a computer would be a useless machine. The list of written instructions in software is called program. Many software programs are available for every department in manufacturing, but the most important uses of computers have been in the engineering and production departments.

没有软件，计算机会变得毫无用处。软件中写好的指令的清单叫程序。许多软件程序用于制造业的每个部门，但计算机最重要的应用是在工程和生产部门。

**CAD.** Drafters use CAD systems to make technical drawings of the product to be manufactured. In the past, drafters worked with T-squares, scales, triangles, and pencils to create these drawings by hand on paper.

**CAD** 绘图员用CAD系统来制作加工工件的工程图纸。在过去，他们是在纸上利用丁字尺、比例尺、三角板和铅笔用手绘制这些图纸。

Today more and more drafters use CAD systems to perform drafting operations. Doing drawing by hand requires a great deal of time. Each line, letter, and shape on a drawing must be created by the drafter. The drafter must have great skill to draw these features exactly the same every time.

今天越来越多的绘图员用CAD系统来绘图。手工绘图要花大量的时间。图纸上的每根线，每个字母和形状都必须由绘图员去画。绘图员必须有很好的技能去画这些特征，让它们每次画出来都是一样的。

In CAD, most of these jobs are done by the computer. CAD software programs are written so that a drafter needs only to identify the type of line, letter, or shape required; the computer then draws the feature perfectly on a computer screen.

而在CAD中，绝大多数这些工作是由计算机完成的。CAD软件程序写好后绘图员只需要确定所要的线、字母和形状的类型；计算机就会在屏幕上完美地绘出这些特征。

Most CAD systems also include a drawing library of commonly used symbols and shapes to allow faster drawing.<sup>[3]</sup>

3. **drawing library** 意为“图形库”。全句可译为：大部分CAD系统中还包括一个含有常用符号和形状的图形库，来实现快速绘图。



Another advantage of CAD is ease in revising drawings. In the past, when a product was changed or improved the drawings (on paper) had to be completely redrawn or traced. Today, CAD systems allow the drafter to redraw only those parts and features that have been revised.

CAD的另一个优点是修改图纸很容易。在过去，当产品被改变或改进后，图纸（在纸上的）不得不完全重画或描图。今天，CAD系统让绘图员只去重画那些被修改了的零件和特征。

CAD can also be used to simulate product testing procedures. In the past, when a product was designed by an engineer, scale models and full-sized prototypes were often made and tested for durability, strength, and performance.<sup>[4]</sup>

4. scale models and full-sized prototypes 意为“比例模型和实际尺寸样机”。全句可译为：

CAD也能用于仿真产品测试过程。在过去，当一种产品被工程师设计出来后，通常需要制作比例模型和实际尺寸样机来对其耐用性，强度和性能进行测定。

This process involved making dozens of different models and prototypes until the engineers found the combination of materials, parts, and design they wanted. CAD systems have simulation programs built in so that product design models can be built, tested, and changed on a computer screen in a small portion of the time needed to make real models.<sup>[5]</sup>

5. **simulation program** 意为“仿真程序，模拟程序”。全句可译为：

这个过程包括制造成打的不同模型和原型直至工程师找到他们想要的材料、零件和设计的组合。**CAD**系统内部装有仿真程序，可以在计算机屏幕上建造产品设计模型，并对其进行试验和修改，所用的时间仅仅是建造实物模型的一小部分。

Engineers can change materials and parts on the product and simulate the stresses, strains, and wear the product must take when used. The procedure of testing products this way on a computer is called **finite element analysis**.

工程师能改变产品的材料和零件并模拟产品使用时会遇到的应力、应变和磨损。在计算机上的这种测试产品的过程叫做**有限元分析**。

Designing and testing products this way takes less time, saves the company money that used to be spent on the models and prototypes, and improves the quality of manufactured products.

这种设计和测试产品的方法费时较少，节省了公司花在模型和产品原型上的钱，并提高了所制造产品的质量。

The use of computers in processing materials is called computer-aided manufacturing or CAM. CAM involves controlling tools and machines with computers. In the past, all manufacturing machines were operated and controlled directly by human operators. Then numerical control (NC) machining was introduced.

计算机在材料加工上的应用叫计算机辅助制造或**CAM**。**CAM**包含用计算机控制工具和机器。在过去，所有的制造机器都直接由人控制。接着数字控制（**NC**）加工被采用

With NC, operators code the machine operations onto a punched tape. The punched tape is then used to control the machines. Recently CAM has been replacing NC. Instead of coding operations onto a punched tape, CAM operators write software programs for computers that are used to control machines.

用NC时，操作者在穿孔纸带上给机器操作编码。用穿孔纸带来控制机器。近来CAM已经替代了NC。

CAM工作者编写计算机软件程序来控制机器，替代了在穿孔纸带上编码。

**CAD/CAM.** The next step in computerizing manufacturing operations was to tie the engineering department to the production department using CAD/CAM systems. With CAD/CAM, a drafter in the engineering department draws the plans for a product on a CAD system, and the design information is then sent directly to machines in the production department where the product is made.

**CAD/CAM** 制造作业计算机化的下一步是用**CAD/CAM**系统把工程（设计）部门和生产部门捆绑到一起。用**CAD/CAM**，工程部门的绘图人员在**CAD**系统上绘制一个产品的平面图，然后设计信息直接传输到生产产品的制造部门的机器里。

## Computer integrated manufacturing (CIM). 计算机集成制造 (CIM)

After the engineering and production departments were connected with CAD/CAM, computers were used to integrate (tie together) all the departments. In CIM, the management, engineering, production, finance, marketing, and human resources departments are all linked by computer. Information about the progress in any department can be seen at once in any other department. Company-wide planning can be done with CIM.

在用CAD/CAM把工程和生产部门连接起来以后，计算机又用于集成（捆绑在一起）所有部门。在CIM中，管理、工程、生产、财务、市场营销和人力资源部门都通过计算机连接起来。任何部门中的进展信息能立即在其他任何部门看到。用CIM能实现公司范围的规划。



The human resources department can prepare workers for specific jobs; the finance department can plan to buy materials to match the production schedule; marketing can plan advertising to match the finished-product dates, engineering and production communicate with CAD/CAM, and management can direct the whole company by following the progress of each department.

人力资源部门可以为特殊工作准备工人；财务部门能依据生产计划作购买物料的计划。市场营销部门能配合产品完工日期安排广告，工程和生产部门用**CAD/CAM**进行沟通，管理部门能跟踪每个部门的进展指挥整个公司。

With CIM, all separate departments can work toward the single goal of producing and selling a quality product for profit.<sup>[6]</sup>

6. quality product意为“合格产品”。全句可译为：

采用计算机集成制造，所有的各个部门都能为单一的目标而工作，即生产和销售合格的产品以获取利润。

Just in time (JIT).<sup>[7]</sup> Once a company has started working with CIM, it is not far from JIT manufacturing. With JIT, a manufacturing company can save money by carefully timing the different parts of the manufacturing process so that they all fit together "just in time".

7. just in time (JIT) 意为“准时生产，即在需要的时候，按需要的数量生产所需要的产品”。

准时生产(JIT) 一个公司一旦开始用上 CIM，离JIT制造就不远了。用JIT，制造公司能通过细致地安排制造工艺流程中不同零件的时间以让它们“刚好在那个时间”组装在一起来省钱。

For example, manufacturing companies have always ordered materials and supplies in large quantities long before they were needed. These materials and supplies were then stored in nearby warehouses and delivered to the plant when needed.

例如，制造公司总是以远超过他们所需的数量订购原料和供应品。这些原料和供应品接下来就存放在附近的仓库里并在需要时转交给工厂。

Renting a warehouse, storing supplies, and moving supplies from the warehouse can be expensive for a company.

Since CIM helps a company know just when it needs certain supplies or materials, the company can have delivered just in time at the manufacturing plant.

租用仓库，存放供应品和运送供应品使仓库对一个公司来说是昂贵的。因为**CIM**帮助公司确切地知道确定数量的供应品或原材料的需要时间，公司能准时地将其交付给制造厂。

This saves the company money that would have been spent to rent the warehouse. Similarly, the company will finish the products and deliver them to the market immediately, again saving the cost to store finished items in a warehouse.<sup>[8]</sup>

8. **finished item**意为“成品”。全句可译为：

这就节约了公司用来租用仓库的钱。类似地，公司将加工后的产品马上投放到市场中，这又节省了产品的库存成本。

## Flexible manufacturing.

Another important new use of computers is flexible manufacturing lets a company make many versions of the same product to meet specific consumer wants.

**柔性制造** 计算机的另一个重要的新应用是柔性制造，它使一个公司可以为相同产品制造多种版本以满足特定消费者的需要。

# Lesson 64 Computer-Aided Analysis of Mechanical Systems

Terminology

Text tour

# ***Terminology***

## **Simulator**

One that simulates, especially an apparatus that generates test conditions approximating actual or operational conditions

**模拟装置：** 一个进行模拟的装置，尤指产生与实际或操作条件接近的测试条件的装置

## **Terrain**

1. An area of land, ground

**地区, 地带**

2. The surface features of an area of land, topography

**地形地势：** 一个地域的表面特征, 地形



# Planar

**1. Of, relating to, or situated in a plane.**

平面的：平面的，与平面有关的或位于平面的

**2. A planar surface**  
平面

**3. Having a two-dimensional characteristic**

二维平面的：具有二维特性的

## ***Text tour***

The major goal of the engineering profession is to design and manufacture marketable products of high quality.<sup>[1]</sup>

1. **marketable products**意为“适销产品”。全句可译为：

工程技术这个职业的主要目标是设计和制造高质量的适销产品。

Today's industries are utilizing computers in every phase of the design, management, manufacture, and storage of their products. The process of design and manufacture, beginning with an idea and ending with a final product, is a closed-loop process.<sup>[2]</sup> Almost every link in the loop can benefit from the power of digital computers.

2. **closed-loop**意为“闭环”。全句可译为：

今天的工业在它们设计、管理、制造和储存产品的各个阶段都用到了计算机。设计和制造过程是一个从概念开始到最终产品为止的闭环过程。几乎环里的每个链都得益于数字计算机的能力。

**Factory automation** is one of the major objectives of modern industry. In factory automation, all branches of the factory communicate and exchange information through a central data base.

**工厂自动化**是现代工业的一个主要目标。在工厂自动化中，工厂所有分支机构的沟通和信息交换都通过一个中央数据库。

Various parts of the product are designed in the computer-aided design (CAD) branch, and then the design is sent to the computer-aided manufacturing (CAM) branch for parts manufacturing and final assembly.

产品的各种零件在计算机辅助设计（**CAD**）分支中设计，然后传送到计算机辅助制造（**CAM**）分支去加工零件和最终装配。

The computer-aided product design branch, better known as **computer-aided design (CAD)**, may consider the design of single parts or it may concern itself with the final product as an assembly of those parts.

计算机辅助产品设计分支，称为**计算机辅助设计（CAD）**，可以考虑单个零件的设计或关注作为这些零件的装配体的最终产品自身。

Computerized product design requires such capabilities as computer-aided analysis, computer-aided drafting, design sensitivity analysis, or optimization. The computer-aided analysis capability serves as part of the design process and is also used as a model simulator for the finished manufactured product.

计算机化的产品设计要有计算机辅助分析、计算机辅助绘图、设计灵敏度分析或优化等功能。计算机辅助分析作为设计过程的一个部分也用来作为产成品的模型仿真器。

Analysis may be considered especially appropriate for a product whose initial design has to be modified several times during the manufacturing process. Thus computer-aided analysis can be used as a substitute for laboratory or field tests in order to reduce the cost.<sup>[3]</sup>

3. **substitute for** 意为“替代，取代”。  
全句可译为：

分析特别适合一个在加工过程中其初始设计需要修改多次的产品。为了降低成本，可以用计算机辅助分析来替代在验室中的试验和现场试验。



The computer-aided manufacturing design branch is concerned with the design of the manufacturing process. This branch considers the manufacturability of newly designed parts and employs techniques to improve the manufacturing process, in addition to on-line control of the manufacturing process.

计算机辅助工艺设计分支进行制造工艺的设计。这个分支进行新设计零件的可制造性分析，并应用一些方法来改善加工工艺，还能进行制造过程的在线控制。

The computer-aided analysis process (CAA) allows the engineer to simulate the behavior of a product and modify its design prior to actual production.

计算机辅助分析（**CAA**）允许工程师模拟产品的行为并在实际生产前修改设计。

In contrast, prior to the introduction of CAA, the manufacturer had to construct and test a series of prototypes, a process which was not only time-consuming but also costly.

与之相反，**CAA**出现之前，制造商不得不建造并测试一系列的产品原型，这个过程不仅费时还花钱。

Most optimal design techniques require repetitive analysis processes. Although one of the major goals of an automated factory is computer-aided design, computer-aided analysis techniques must be developed first.

大多数优化设计方法需要重复分析过程。尽管自动化工厂的一个主要目标是计算机辅助设计，计算机辅助分析技术却必须先发展。

Computer-aided analysis techniques may be applied to the study of electrical and electronic circuits, structures, or mechanical systems.

计算机辅助分析技术可以应用到电气和电子电路，结构和机械系统的研究中。

Today, these programs, known as finite-element techniques, have become highly advanced and are used widely in various fields of engineering.

今天，这些被称为有限元方法的程序变得非常先进，并广泛用在工程的各个领域。

The development of **algorithms** ['ælgəriðəm] for analyzing electrical circuits began in the early days of electronic computer. Similar techniques were also employed to develop computer programs for structural analysis.

电路分析算法的发展开始于电子计算机的早期。类似的技术也用于结构分析计算机程序的开发。

It was not until the early 1970s that computational techniques found their way into the field of mechanical engineering.<sup>[4]</sup> One of the areas of mechanical engineering where computational techniques can be employed is **the analysis of multi-body mechanical systems**.

4. **find one's way** 意为“找到道路”。  
全句可译为：

直到二十世纪七十年代后期，计算技术才在机械工程领域得到了应用。能应用计算技术的机械工程领域之一是**多体机械系统的分析**。

The purpose of computer-aided analysis of mechanical systems is to develop basic methods for computer formulation and solution of the equations of motion.

机械系统计算机辅助分析的目的是为运动方程的计算机公式化和求解找到基本方法。

This requires systematic techniques for formulating the equations and numerical methods for solving them. A computer program for the analysis of mechanical systems can be either a special-purpose program or a general-purpose program.

这要求表示这些方程的系统技术和解方程的数值计算方法。作机械系统分析的计算机程序既可以是专用程序也可以是通用程序。

A special-purpose program is a rigidly structured computer code that deals with only one type of application.

专用程序是固定结构的计算机编码，只处理一种应用类型。

Such a program can be made computationally efficient and its storage requirement can be minimized, with the result that it will be suitable for implementation on small personal computers.

这种程序计算效率高而且存储空间需求最小化，因此可以在小型的个人计算机上使用。

The major drawback of a special-purpose program is its lack of flexibility for handling other types of applications.

专用程序的主要缺陷是缺乏处理其他应用类型的柔性。



A general-purpose program can be employed to analyze a variety of mechanical systems. For example, the planar motion of a four-bar linkage under applied loads and the spatial motion of a vehicle driven over a rough terrain can be simulated with the same general-purpose program.<sup>[5]</sup>

5. **four-bar linkage**意为“四连杆机构”，**rough terrain**意为“崎岖不平地区，地形条件恶劣地区”。

全句可译为：

通用程序能用来分析各种各样的机械系统。例如，一个四连杆机构在外加荷载作用下的平面运动和一辆在崎岖不平道路上行驶的汽车的空间运动都可以用同一个通用程序进行仿真。

The input data to such a program are provided by the user and must completely describe the mechanical system under consideration.

这种程序的输入数据由用户提供，数据必须完全描述所针对的机械系统。

The input must contain such information as number of bodies, connectivity between the bodies, force elements, and geometric and physical characteristics. The program then generates all of the governing equations of motion and solves them numerically.

输入必须包含这样一些信息如体数、体间连接性、力的要素以及几何特征与物理特性等。程序接着生成所有运动控制方程并对它们进行数值求解。

A general-purpose program, compared with a special-purpose program, is not computationally as efficient and requires more memory space, but it is flexible in use.

与专用程序相比较，通用程序计算效率不高而且要求更多的存储空间，但它使用更灵活。

The computational efficiency of a general-purpose program depends upon several factors, two of which are the choice of coordinates and the method of numerical solution. The choice of coordinates directly influences both the number of the equations of motion and their order of nonlinearity

[,nɒnlɪni'æərəti] .[6]

6. **order of nonlinearity**意为“非线性的阶数”。全句可译为：

通用程序的计算效率取决于几个因素，其中有两个是坐标和数值计算方法的选择。坐标的选择直接影响到运动方程的个数和方程非线性的阶数。

Furthermore, depending upon the form of these equations, one method of numerical solution may be preferable to another in terms of efficiency and accuracy.

此外，根据这些方程的形式，在效率和精度方面一种数值方法可能比另一种要好。

# Lesson 65 Computer Aided Process Planning

Terminology

Text tour

# ***Terminology***

## **Clerical**

Of or relating to clerks or office workers or their work.

办事员的，职员，文书的：职员、办公室人员或其工作的或与之相关的

## **Concomitant**

1. Occurring or existing concurrently  
伴随的：同时发生或共存的

2. One that occurs or exists concurrently with another

伴随物：与另一个同时发生或共存的事物

## Algorithm ['ælgəriðəm]

A step-by-step problem-solving procedure, especially an established computational procedure for solving a problem in a finite number of steps

算法，**规则系统**：一种循序渐进解决问题的过程，尤指一种为在有限步骤内解决问题而建立的计算过程



# ***Text tour***

According to **the *Tool & Manufacturing Engineers Handbook***, process planning is the systematic determination of the methods by which a product is to be manufactured economically and competitively. It essentially involves selection, calculation, and documentation. Processes, machines, tools, operations, and sequences must be selected. Such factors as feeds, speeds, tolerances, dimensions, and costs must be calculated.

根据《**工具与制造工程师手册**》，工艺设计就是系统地确定能够经济地和有竞争力地将产品制造出来的方法。它主要由选择、计算和建立工艺文件组成。对加工方法、机床、刀具、工序和顺序必须进行选择。对于一些参数如进给量、速度、公差、尺寸和成本等应该进行计算

Finally, documents in the form of setup instructions, work instructions, illustrated process sheets, and routings must be prepared. Process planning is an intermediate stage between designing and manufacturing the product. But how well does it bridge design and manufacturing?

最后，应该建立装备说明、加工说明、带工序简图的工艺过程卡片和加工路线等方面的工艺文件。工艺设计是产品设计和制造的中间环节。那么，它是如何将设计与制造连接起来的呢？

Most manufacturing engineers would agree that, if ten different planners were asked to develop a process plan for the same part, they would probably come up with ten different plans. Obviously, all these plans cannot reflect the most efficient manufacturing methods, and, in fact, there is no guarantee that any one of them will constitute the optimum method for manufacturing the part.

大部分制造工程师都会同意这个看法，即如果10个不同的工艺人员进行同一个零件的工艺设计，他们很可能得出10种不同的方案。显然，并不是所有这些方案都不能反映最适当的制造方法，而且，事实上也不能保证它们中的任何一个方案是由加工这个零件的最好的方法组成的。

What may be even more disturbing is that a process plan developed for a part during a current manufacturing program may be quite different from the plan developed for the same or similar part during a previous manufacturing program and it may never be used again for the same or similar part.

在目前的制造过程中的一个更为混乱的事情是，对于一个零件来说，现在所编制的工艺规程可能与以前在制造过程中所编制的同一个零件或者相似零件的工艺规程相差很多，而且这个工艺规程可能再也不会应用于同一个零件或者相似零件。

That represents a lot of wasted effort and produces a great many inconsistencies in routing, tooling, labor requirements, costing, and possibly even purchase requirements.

这说明很多工作都被浪费了，而且在工艺路线、工艺装备、对工人的要求和成本等方面都不一致，甚至对外购件的要求都不

Of course, process plans should not necessarily remain static. As lot sizes change and new technology, equipment, and processes become available, the most effective way to manufacture a particular part also changes, and those changes should be reflected in current process plans released to the shop.

当然工艺设计不应该是一成不变的。随着产品批量的变化和新技术、新设备、新的加工方法的出现，加工制造某个特定零件最适当的方法也会发生变化，而且这些变化应该在车间目前使用的加工工艺规程中反映出来。

A planner must manage and retrieve a great deal of data and many documents, including established standards, machinability data, machine specifications, tooling inventories, stock availability, and existing process plans. This is primarily an information-handling job, and the computer is an ideal companion.

工艺人员应该管理和检索大量的数据和很多文件，其中包括：已经建立的标准、可加工性数据、机器的规格、工艺装备的清单、原材料库存量和一些目前正在应用的工艺文件。这主要是一些信息处理工作，而计算机是完成这项工作的一个理想助手。

There is another advantage to using computers to help with process planning. Because the task involves many interrelated activities, determining the optimum plan requires many iterations.

在进行工艺设计时应用计算机还有一个优点。因为这项工作涉及许多相互关联的事情，在确定最优的方案时，需要进行许多次迭代。

Since computers can readily perform vast numbers of comparisons, many more alternative plans can be explored than would be possible manually.

由于计算机可以很容易地进行大量的比较工作，它比人工所能分析的可供选择的方案要多得多。



A third advantage in the use of computer-aided process planning is uniformity.

采用计算机辅助工艺设计的第三个优点是所设计的工艺规程具有一致性。

Several specific benefits can be expected from the adoption of compute-aided process planning techniques:

采用计算机辅助工艺设计可以获得以下11点好处。

- 1.Reduced clerical effort in preparation of instructions.  
1. 在准备工艺文件时，减少书写工作量。
2. Fewer calculation errors due to human error.  
2. 减少在进行人工计算时所产生的错误。
3. Fewer oversights in logic or instructions because of the prompting capability available with interactive computer programs.  
3. 由于交互式计算机程序的提示功能而减少在逻辑和说明方面的疏漏。
4. Immediate access to up-to-date information from a central database.  
4. 通过中央数据库可以直接利用最新的信息。

5. Consistent information, because every planner accesses the same database.

5. 由于每个工艺人员都利用相同的数据库，因此，可以保证信息的一致性。

6. Faster response to changes requested by engineers of other operating departments.

6. 对由其他部门的工程人员所提出的修改意见做出快速反应。

7. Automatic use of the latest revision of a part drawing.

7. 自动地利用最新版本的零件图纸。

8. More-detailed, more-uniform process-plan statements produced by word-processing techniques.

8. 采用文字处理技术，产生更详细、更一致的工艺文件。

9. More-effective use of inventories of tools, gages, and fixtures and a concomitant reduction in the variety of those items.

9. 更有效地利用库存的刀具、量具和夹具，减少这些物品的种类。

10. Better communication with shop personnel because plans can be more specifically tailored to a particular task and presented in unambiguous, proven language.

10. 由于能使工艺规程适合于某项特定的工作，而且用清楚的、有理有据的语言表达出来，因此，可与车间的人员进行更好的交流。

11. Better information for production planning, including cutter life, forecasting, materials requirements planning, scheduling, and inventory control.

11. 可以更好地获得编制生产计划所需的信息，其中包括刀具寿命、预测、物料需求、计划、进度和库存控制。

Most important for CIM, computer-aided process planning produces machine readable data instead of handwritten plans. Such data can readily be transferred to other systems within the CIM hierarchy for use in planning.

对计算机集成制造最为重要的是，计算机辅助工艺设计可以生成机器可以阅读的数据，而不是手写的规程。这种数据可以传递到计算机集成制造体系中的另一个系统中，用以编制工艺规程。

There are basically two approaches to computer-aided process planning: variant and generative.

计算机辅助工艺设计通常有两种类型：派生法和创成法。

In the variant approach, a set of standard process plans is established for all the parts families that have been identified through group technology. The standard plans are stored in computer memory and retrieved for new parts according to their family identification. Again, GT helps to place the new part in an appropriate family. The standard plan is then edited to suit the specific requirements of a particular job.

在派生法中，对采用成组技术确定的一个零件族中的所有零件编制一套标准的加工工艺规程。这个标准工艺规程存贮在计算机的存储器中，根据新零件的零件族编码进行检索。成组技术可以帮助把新零件归类于适当的零件族中。通过对标准工艺规程的编辑，可以满足特定工作的专门要求。

In the generative approach, an attempt is made to synthesize each individual plan using appropriate algorithms that define the various technological decisions that must be made in the course of manufacturing.

在创成法中，通过采用确定加工制造过程中各种工艺决策的适当算法，将各个单独的工艺规程综合起来。

In a truly generative process planning system, the sequence of operations, as well as all the manufacturing process parameters, would be automatically established without reference to prior plans.

在一个真正的创成法计算机辅助工艺设计系统中，工序的排列和所有的制造过程参数都可以在不必参考以前的工艺规程的情况下自动生成。



In its ultimate realization, such an approach would be universally applicable: present any plan to the system, and the computer produces the optimum process plan.

在它最终实现之后，这种方式将会是普遍适用的：将任何一个计划提交给这个系统，计算机都会产生最优的工艺规程。

No such system exists, however. So called generative process-planning systems—and probably for the foreseeable future—are still specialized systems developed for a specific operation or a particular type of manufacturing process. The logic is based on a combination of past practice and basic technology.

然而，这种系统目前还不存在。所谓的创成法计算机辅助工艺设计系统——大概在可以预料的将来——仍然是应用于一个特定的工序或者特定的加工过程的专用系统。其逻辑原理是以过去的经验与基本理论的组合为基础的。

# Lesson 66 Numerical Control

Terminology

Text tour

# ***Terminology***

## **Prerecord**

To record (a program, for example) at an earlier time for later use

将...预先录入，预先录制：为后期的使用而预先录制（如程序）

## **Punch**

1. A tool for circular or other piercing

打孔器：用来进行球形或其他形式穿透的工具：

2. To use a punch or use a punch on

使用打孔器或用打孔器在...上打孔

# Rerun

## 重新 [再] 运行

A repeat of a machine run from its beginning, usually made desirable or necessary by a false start, by an interruption, or by a change.

从起点重复一次机器运行，通常是因为不正确启动、中断或变更的需要而进行的。

## ***Text tour***

One of the most fundamental concepts in the area of advanced manufacturing technologies is numerical control (NC). Prior to the advent of NC, all machine tools were manually operated and controlled. Among the many limitations associated with manual control machine tools, perhaps none is more prominent than the limitation of operator skills.

先进制造技术中的一个最基本的概念是数字控制(NC)。在数控技术出现之前，所有的机床都是由人工操纵和控制的。在与人工控制的机床有关的很多局限性中，操作者的技能大概是最突出的问题。

With manual control, the quality of the product is directly related to and limited to the skills of the operator. Numerical control represents the first major step away from human control of machine tools.

采用人工控制时，产品的质量直接与操作者的技能有关。数字控制代表了从人工控制机床走出来的第一步。

Numerical control means the control of machine tools and other manufacturing systems through the use of prerecorded, written symbolic instructions <sup>[1]</sup> .

数字控制意味着采用预先录制的、存储的符号指令，控制机床和其他制造系统。

Rather than operating a machine tool, an NC technician writes a program that issues operational instructions to the machine tool. For a machine tool to be numerically controlled, it must be interfaced with a device for accepting and decoding the programmed instructions <sup>[2]</sup>, known as a reader.

一个数控技师的工作不是去操纵机床，而是编写能够发出机床操纵指令的程序。对于一台数控机床，其上必须装有一个被称为阅读机的界面装置，用来接受和解译编程指令。



Numerical control was developed to overcome the limitation of human operators, and it has done so. Numerical control machines are more accurate than manually operated machines, they can produce parts more uniformly, they are faster, and the long-run tooling costs are lower.

发展数控技术是为了克服人类操作者的局限性，而且它确实完成了这项工作。数字控制的机器比人工操纵的机器的精度更高、生产出零件的一致性更好、生产速度更快、而且长期的工艺装备成本更低。

The development of NC led to the development of several other innovations in manufacturing technology:

数控技术的发展导致制造工艺中其他几项新发明的产生：

1. Electrical discharge machining.

1. 电火花加工技术。

2. Laser cutting.

2. 激光切割。

3. Electron beam welding.

3. 电子束焊接。

Numerical control has also made machine tools more versatile than their manually operated predecessors.

数字控制还使得机床比它们采用人工操纵的前辈们的用途更为广泛。

An NC machine tool can automatically produce a wide variety of parts, each involving an assortment of widely varied and complex machining processes.

一台数控机床可以自动生产很多种类的零件，每个零件都可以有不同的和复杂的加工过程。

Numerical control has allowed manufacturers to undertake the production of products that would not have been feasible from an economic perspective using manually controlled machine tools and processes.

数控可使生产厂家承担那些对于采用人工控制的机床和工艺来说，在经济上是不划算的产品的生产任务。

Like so many advanced technologies, NC was born in the laboratories of the Massachusetts Institute of Technology. The concept of NC was developed in the early 1950s with funding provided by the U.S. Air Force.

与许多先进技术一样，数控诞生于麻省理工学院的实验室中。数控这个概念是20世纪50年代初在美国空军的资助下提出来的。

The APT (Automatically Programmed Tools) language was designed at the servomechanism laboratory of MIT in 1956. This is a special programming language for NC that uses statements similar to English language to define the part geometry, describe the cutting tool configuration, and specify the necessary motions.

APT(自动编程工具)语言是1956年在麻省理工学院的伺服机构实验室中被设计出来的。这是一个专门适用于数控的编程语言，使用类似于英语的语句来定义零件的几何形状，描述切削刀具的形状和规定必要的运动。

The development of the APT language was a major step forward in the further development of NC technology. The original NC systems were vastly different from those used today.

APT语言的研究和发展是在数控技术进一步发展过程中的一大进步。最初的数控系统与今天应用的数控系统是有很大的差别的。

The machines had hardwired logic circuits. The instructional programs were written on punched paper, which was later to be replaced by magnetic plastic tape. A tape reader was used to interpret the instructions written on the tape for the machine. Together, all of this represented a giant step forward in the control of machine tools. However, there were a number of problems with NC at this point in its development.

在那时的机床中，只有硬线逻辑电路。指令程序写在穿孔纸带上(它后来被塑料磁带所取代)，采用带阅读机将写在纸带或磁带上的指令给机器翻译出来。所有这些共同构成了机床数字控制方面的巨大进步。然而，在数控发展的这个阶段中还有着许多问题。



A major problem was the fragility of the punched paper tape medium. It was common for the paper tape containing the programmed instructions to break or tear during a machining process. This problem was exacerbated [ek'sæsəbeɪtɪd] by the fact that each successive time a part was produced on a machine tool, the paper tape carrying the programmed instructions had to be rerun through the reader.

一个主要问题是穿孔纸带的易损坏性。在机械加工过程中，载有编程指令信息的纸带断裂和被撕坏是常见的事情。在机床上每加工一个零件，都需要将载有编程指令的纸带放入阅读机中重新运行一次。因此，这个问题变得很严重。

If it was necessary to produce 100 copies of a given part, it was also necessary to run the paper tape through the reader 100 separate times. Fragile paper tapes simply could not withstand the rigors of a shop floor environment and this kind of repeated use.

如果需要制造100个某种零件，则应该将纸带分别通过阅读机100次。易损坏的纸带显然不能承受严酷的车间环境和这种重复使用。

This led to the development of a special magnetic plastic tape. Whereas the paper tape carried the programmed instructions as a series of holes punched in the tape, the plastic tape carried the instructions as a series of magnetic dots.

这就导致了一种专门的塑料磁带的研制。在纸带上通过采用一系列的小孔来载有编程指令，而在塑料带上通过采用一系列的磁点来载有编程指令。

The plastic tape was much stronger than the paper tape, which solved the problem of frequent tearing and breakage. However, it still left two other problems.

塑料带的强度比纸带的强度要高很多，这就可以解决常见的撕坏和断裂问题。然而，它仍然存在着两个问题。

The most important of these was that it was difficult or impossible to change the instructions entered on the tape. To make even the most minor adjustments in a program of instructions, it was necessary to interrupt machining operations and make a new tape.

其中最重要的一个问题是，对输入带中的指令进行修改是非常困难的，或者是根本不可能的。即使对指令程序进行最微小的调整，也必须中断加工，制作一条新带。

It was also still necessary to run the tape through the reader as many times as there were parts to be produced. Fortunately, computer technology became a reality and soon solved the problems of NC associated with punched paper and plastic tape.

而且带通过阅读机的次数还必须与需要加工的零件的个数相同。幸运的是，计算机技术的实际应用很快解决了数控技术中与穿孔纸带和塑料带有关的问题。

The development of a concept known as direct numerical control (DNC) solved the paper and plastic tape problems associated with numerical control by simply eliminating tape as the medium for carrying the programmed instructions. In direct numerical control, machine tools are tied, via a data transmission link, to a host computer.

在形成了直接数字控制(DNC)这个概念之后，可以不再采用纸带或塑料带作为编程指令的载体，这样就解决了与之有关的问题。在直接数字控制中，几台机床通过数据传输线路联接一台主计算机上。

Programs for operating the machine tools are stored in the host computer and fed to the machine tool as needed via the data transmission linkage.

操纵这些机床所需要的程序都存储在这台主计算机中。当需要时，通过数据传输线路提供给每台机床。

Direct numerical control represented a major step forward over punched tape and plastic tape. However, it is subject to the same limitations as all technologies that depend on a host computer.

直接数字控制是在穿孔纸带和塑料带基础上的一大进步。然而，它也有着与其他依赖于主计算机的技术一样的局限性。

When the host computer goes down, the machine tools also experience downtime. This problem led to the development of computer numerical control.

当主计算机出现故障时，由其控制的所有机床都将停止工作。这个问题促使了计算机数字控制技术的产生。

The development of the microprocessor allowed for the development of programmable logic controllers (PLCs) and microcomputers. These two technologies allowed for the development of computer numerical control (CNC). With CNC, each machine tool has a PLC or a microcomputer that serves the same purpose.

微处理器的发展为可编程逻辑控制器和微型计算机的发展做好了准备。这两种技术为计算机数控(CNC)的发展打下了基础。采用CNC技术后，每台机床上都有一个可编程逻辑控制器或者微机对其进行数字控制。



This allows programs to be input and stored at each individual machine tool. It also allows programs to be developed off-line and downloaded at the individual machine tool.

这可以使得程序被输入和存储在每台机器内部。它还可以在机床以外编制程序，并且将其下载到每台机床中。

CNC solved the problems associated with downtime of the host computer, but it introduced another problem known as data management. The same program might be loaded on ten different microcomputers with no communication among them. This problem is in the process of being solved by local area networks that connect microcomputers for better data management.

计算机数控解决了主计算机发生故障所带来的问题，但是它产生了另一个被称为数据管理的问题。同一个程序可能要分别装入十个相互之间没有通信联系的微机中。这个问题正在解决之中，它是通过采用局部区域网络将各个微机连接起来，以利于更好地进行数据管理。

# Lesson 71 Industrial Robots

Terminology

Text tour

# ***Terminology***

Industrial robot 工业机器人

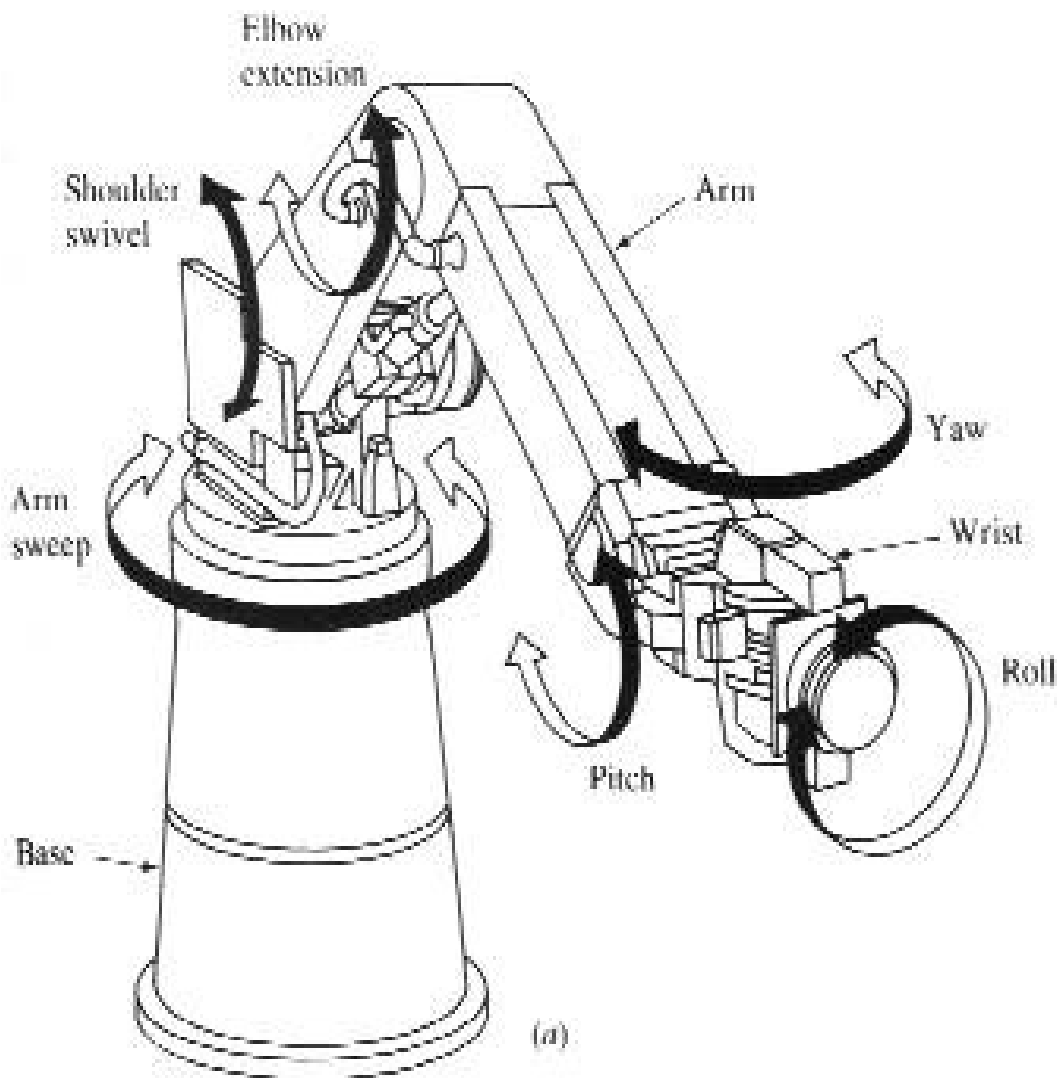


# Articulate

Consisting of sections united by joints,  
jointed

由关节连接的：由关节连接组成部分的，连接的

## T-3 robot T-3机器人



## Parting

1. The act or process of separating or dividing.

分离，分开：分离或分开的行为或过程

2. The state of being separated or divided.

分离，分开：分离或分开的状态

## Shutdown

A cessation of operations or activity, as at a factory

停工，关闭：停止操作或活动，如在工厂中

## ***Text tour***

There are a variety of definitions of the term robot. Depending on the definition used, the number of robot installations worldwide varies widely. Numerous single-purpose machines are used in manufacturing plants that might appear to be robots. These machines are hardwired to perform a single function and can not be reprogrammed to perform a different function.

有许多关于机器人这个术语的定义。采用不同的定义，全世界各地机器人的数量就会发生很大的变化。在制造工厂中使用的许多单用途机器可能会看起来像机器人。这些机器是硬连线的，不能通过重新编程的方式去完成不同的工作。

Such single-purpose machines do not fit the definition for industrial robots that is becoming widely accepted. This definition was developed by the Robot Institute of America:

这种单用途的机器不能满足被人们日益广泛接受的关于工业机器人的定义。这个定义是由美国机器人协会提出的：

A robot is a reprogrammable multifunctional manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks.

机器人是一个可以改编程序的多功能操作器，被设计用来按照预先编制的、能够完成多种作业的运动程序运送材料、零件、工具或者专用设备。



Note that this definition contains the words reprogrammable and multifunctional. It is these two characteristics that separate the true industrial robot from the various single-purpose machines used in modern manufacturing firms.

注意在这个定义中包含“可以改编程序”和“多功能”这两个词。正是这两个词将真正的机器人与现代制造工厂中使用的单一用途的机器区分开来。

The term “reprogrammable” implies two things: The robot operates according to a written program, and this program can be rewritten to accommodate a variety of manufacturing tasks.

“可以改编程序”这个术语意味着两件事：机器人根据编写的程序工作，以及可以通过重新编写程序来适应不同种类的制造工作的需要。

The term “multifunctional” means that the robot can, through reprogramming and the use of different end-effectors, perform a number of different manufacturing tasks. Definitions written around these two critical characteristics are becoming the accepted definitions among manufacturing professionals.

“多功能”这个词意味着机器人能通过编程和使用不同的末端执行机构，来完成不同的制造工作。围绕着这两个关键特征所撰写的定义正在变成为制造业的专业人员所接受的定义。

The first articulated arm came about in 1951 and was used by the U. S. Atomic Energy Commission. In 1954, the first programmable robot was designed by George Devol. It was based on two important technologies:

第一个带有活动关节的手臂于1951年被研制出来，由美国原子能委员会使用。在1954年，第一个可以编程的机器人由乔治·狄弗设计出来。它基于下面两项重要技术。

**Numerical control (NC) technology.**

(1) 数字控制(NC)技术。

(2) Remote manipulation technology.

(2) 远程操作技术。

Numerical control technology provided a form of machine control ideally suited to robots. It allowed for the control of motion by stored programs.

数字控制技术提供一种非常适合于机器人的机器控制技术。它可通过存储的程序对运动进行控制。

These programs contain data points to which the robot sequentially moves, timing signals to initiate action and to stop movement, and logic statements to allow for decision making.

这些程序包含机器人进行顺序运动的数据，开始运动和停止运动的时间控制信号，以及做出决定所需要的逻辑语句。

Remote manipulation technology allowed a machine to be more than just another NC machine. It allowed such machines to become robots that can perform a variety of manufacturing tasks in both inaccessible and unsafe environments. By merging these two technologies, Devol developed the first industrial robot, an unsophisticated programmable materials handling machine.

远程操作技术使得一台机器的性能超出一台数控机器。它可以使这种机器能够在不容易进入和不安全的环境中完成各种制造任务。通过融合上述两项技术，狄弗研制出第一个机器人，它是一个不复杂的，可以编程的物料运送机器人。

The first commercially produced robot was developed in 1959. In 1962, the first industrial robot to be used on a production line was installed by General Motors Corporation. This robot was produced by Unimation.

第一台商业化生产的机器人在1959年研制成功。通用汽车公司在1962年安装了第一台用于生产线上的工业机器人，它是尤尼梅森公司生产的。

A major step forward in robot control occurred in 1973 with the development of the T-3 industrial robot by Cincinnati Milacron. The T-3 robot was the first commercially produced industrial robot controlled by a minicomputer.

在1973年，辛辛那提·米兰克朗公司研制出T-3工业机器人，在机器人的控制方面取得了较大的进展。T-3机器人是第一台商业化生产的采用计算机控制的机器人。

Numerical control and remote manipulation technology prompted the wide-scale development and use of industrial robots. But major technological developments do not take place simply because of such new capabilities. Something must provide the impetus for taking advantage of these capabilities. In the case of industrial robots, the impetus was economics.

数字控制技术和远程操作技术推动了大范围的机器人研制和应用。但是主要的技术进步并不仅仅是由于这些新的应用能力而产生的，而是必须由利用这些能力所得到的效益来提供动力。就工业机器人而言，这个动力是经济性。

The rapid inflation of wages experienced in the 1970s tremendously increased the personnel costs of manufacturing firms. At the same time, foreign competition became a serious problem for U. S. manufacturers. Foreign manufacturers who had undertaken automation on a wide-scale basis, such as those in Japan, began to gain an increasingly large share of the U.S. and world market for manufactured goods, particularly automobiles.

在20世纪70年代，工资的快速增长大大增加了制造业的企业中的人工费用。与此同时，来自国外的竞争成为美国制造业所面临的一个严峻的考验。诸如日本等外国的制造厂家在广泛地应用自动化技术之后，其工业产品，特别是汽车，在美国和世界市场中占据了日益增大的份额。



Through a variety of automation techniques, including robots, Japanese manufacturers, beginning in the 1970s, were able to produce better automobiles more cheaply than nonautomated U. S. manufacturers. Consequently, in order to survive, U.S. manufacturers were forced to consider any technological developments that could help improve productivity.

通过采用包括机器人在内的各种自动化技术，从20世纪70年代开始，日本的制造厂家能够比没有采用自动化技术的美国制造厂家生产更好的和更便宜的汽车。随后，为了生存，美国制造厂家被迫考虑采用任何能够提高生产率的技术。

It became imperative to produce better products at lower costs in order to be competitive with foreign manufacturers. Other factors such as the need to find better ways of performing dangerous manufacturing tasks contributed to the development of industrial robots. However, the principal rationale has always been, and is still, improved productivity.

为了与国外制造厂家进行竞争，必须以比较低的成本，生产出更好的产品。其他的因素，诸如寻找能够更好地完成带有危险性的制造工作的方式也促进了工业机器人的发展。但是，主要的理由一直是，而且现在仍然是提高生产率。

One of the principal advantages of robots is that they can be used in settings that are dangerous to humans. Welding and parting are examples of applications where robots can be used more safely than humans. Even though robots are closely associated with safety in the workplace, they can, in themselves, be dangerous.

机器人的一个主要优点是它们可以在对于人类来说是危险的位置上工作。采用机器人进行焊接和切断工作是由人工来完成这些工作更安全的例子。尽管机器人与工作地点的安全密切相关，它们本身也可能是危险的。

Robots and robot cells must be carefully designed and configured so that they do not endanger human workers and other machines. Robot work envelopes should be accurately calculated and a danger zone surrounding the envelope clearly marked off. Red flooring strips and barriers can be used to keep human workers out of a robot's work envelope.

应该仔细地设计和配置机器人和机器人单元，使它们不会伤害人类和其他机器。应该精确地算出机器人的工作范围，且在这个范围的四周清楚地标出危险区域。可以采用在地面上画出红颜色的线和设置障碍物以阻止工人进入机器人的工作范围。

Even with such precautions it is still a good idea to have an automatic shutdown system in situations where robots are used. Such a system should have the capacity to sense the need for an automatic shutdown of operations. Fault-tolerant computers and redundant systems can be installed to ensure proper shutdown of robotics systems to ensure a safe environment.

即使有了这些预防措施，在使用机器人的场地中设置一个自动停止工作的系统仍然不失为一个好主意。机器人的这个系统应该具有能够检测出是否有需要自动停止工作的要求的能力。为了保证能有一个安全的环境，应当安装容错计算机和冗余系统来保证在适当的时候停止机器人的工作。

# Lesson 77 Technical Report Elements

Terminology

Text tour

# *Terminology*

## Abstract

A statement summarizing the important points of a text

摘要：概括正文重要论点的陈述

## Epitome [i'pitəmi]

A brief summary, as of a book or an article

梗概：一本书或一篇文章的简要总结

## Xerox['ziərɒks]

A trademark used for a photocopying process or machine employing xerography. This trademark often occurs in print in uppercase or lowercase as a verb, an adjective, and a noun, such as “Letters you send should be xeroxed after you sign them”

施乐：商标名，用于采用静电复印术的影印过程或机器。该商标常印刷为大写体或小写体，可作为动词、形容词和名词来使用，例如：“您发出的信件应当在您签字后复印”。



# Text tour

Abstract The Abstract is a condensed statement of the important information contained in the complete report. It is the epitome of a summary. It stresses the objective and conclusions.<sup>[1]</sup>

stress这里指“强调”全句可译为：

摘要是在报告全文中重要信息的凝练语句，它是个综述的缩影。它强调目的和结论。

An Abstract allows the reader to survey the purpose, content, and conclusions of a report quickly. The two most important requirements of an abstract are that it be concise and informative. To accomplish this, the abstract is usually written last.

读者通过摘要可以快速了解报告的目的、内容和结论。摘要最重要的两个要求是简明和  
有内容。要达到这些要求，摘要通常最后撰写。

摘要写作

Introduction The primary function of an Introduction is to let the reader know the importance of the work and to clearly define the objective. Once this is stated, a brief plan of development should follow. A well-constructed Introduction should stimulate reader interest and summarize the contents of the report. Background information of a theoretical or historical nature may be warranted to support this preliminary information. As you would expect, the Introduction is the section that introduces the work to the reader.

引言的主要功能是使读者明确文章工作的重要性 and 目的。一旦这个阐述了，接下来就要有个简要的计划。一个结构良好的引言会激发读者兴趣并概括报告内容。理论和历史状态的背景信息可以用来支持这些初步信息。正如你希望的那样，引言是把工作介绍给读者的章节。

The beginning of the Introduction usually explains the problem and the objective of the report. Journalists are taught to answer the five W's: who, what, where, when and why. It is probably a good idea to keep these in mind when writing your Introduction and to answer those W's that are pertinent to your objective. For example, the WHO might be the names of previous investigators that you found in a literature search. The WHAT would be the problem statement. The WHY might be pertinent applications of your results. The WHERE and WHEN are obvious.

引言的开始通常阐明问题和目的。记者被教导要回答五个“W”问题：人物，事件、地点、时间和原因。当你写引言和回答与你的目的有关的“W”时考虑这些也许是个好主意。例如，WHO也许是你在文献检索中发现的先前研究者的名字。WHAT就是问题陈述。WHY可能是和你的结论有关的应用。WHERE和WHEN就显而易见了。

The Introduction is used to acquaint the reader with the material of the report. As part of this presentation it is advisable to state some of the important principles of the work and enumerate assumptions.

引言用来使读者熟知报告的素材。作为表述的部分陈述一些工作的重要原则和列举假设是明智的。

**Analysis** The Analysis section is used to develop a pertinent theory based on the basic principles that explain the phenomenon you are investigating. Most experimental studies involve the interaction of a variety of complex influences and subtleties. The purpose of the analysis is to remove the mask of complexity and expose the underlying facts. It is a process of systematic thinking, combining logical assumptions with basic principles to develop a relationship that explains your results. This relationship is usually the hypothesis that is the subject of the report. The experiment is the study of this hypothesis to test if your assumptions and logic are correct.

**分析** 分析章节用来展开一个基于用来解释你所研究现象的基本原理的相关理论。大多数实验研究包含种种复杂影响和微妙之处的相互作用。分析的目的在于掀开复杂的面具并揭露隐藏的事实。它是系统思维的过程，结合逻辑假设和基本原理去发现能解释结论的关系。这个关系常常是关于报告主题的假说。实验是测试你的假设和逻辑是否正确研究。

The Analysis is usually interspersed with equations. It is not simply a series of equations devoid of explanatory material. The explanation of technical material is naturally associated with mathematics. Assumptions, which are expressed in words, are transformed into their mathematical equivalents.

分析通常用公式来点缀。不单是一连串缺乏说明材料的公式。对技术素材的解释自然地 and 数学联系在一起。用言语表达的假说要转换为等价的数学形式。

Basic principles are also expressed in mathematical terms and are combined with the assumptions to develop the hypothesis. However, your presentation should be complete enough that a peer could duplicate your work.<sup>[2]</sup>

2. **peer** 这里指“同行”全句可译为：  
基本原理也用数学形式表达并与假设结合以推出假说。然而，你表达的内容应该足够完整，使得你的同行能够重复你的工作。

It is frustrating to see the expression, “it can readily be seen that” between two equations which bear no apparent relationship one to the other.

在两个没有明显关系的公式间看到“容易得出”这样的表述是令人沮丧的。

If some real detail is necessary to fully explain a particular point but is extraneous to your basic presentation, then this work belongs in an appendix.<sup>[3]</sup>

3. **extraneous to**意为“无关的，与正题无关的”。全句可译为：

如果确定需要用某个细节来把一个特殊问题解释清楚，但它与你的基本内容无关，这时就可以将其放在附录中。



Equations must be presented clearly with explanatory material relating the equation to the remainder of the report. Symbols should be defined when they are first introduced. All the symbols in an equation must be defined. However, it is not necessary to redefine terms once they have been presented. If the report contains a number of unfamiliar symbols, give a **nomenclature** [nəu'menklətʃə] section.

公式必须和与之相关的说明材料一起在报告的余下部分清楚地给出。第一次出现的符号应该给出定义。公式中的所有符号都要定义。然而如果它们已经被表述过就不必重新定义。如果报告中有许多不为人熟悉的符号，则专门给出一个术语章节。

**Procedure** This section describes the apparatus and details the experimental procedure for taking measurements. In this section, you must explain what was measured and how you measure it. You should provide sufficient detail so that the experiment can be replicated using the same or equivalent equipment. Drawings showing the setup are often useful. They can be an aid in describing certain measurements and they should show the interconnections of the various instruments.

**步骤** 这个部分描述仪器和测量实验步骤的细节。在这一部分你必须解释测的什么和怎么测的。你要提供足够的细节以使实验能用相同的或等价的设备重现。经常使用图来显示实验设置。它们能帮助描述确切的测量结果而且显示各种仪器的相互关联。

The Procedure does not contain results. You can explain that 20 separate tests were performed. You can say that the means and standard deviation were calculated, but you do not give the numerical values.<sup>[4]</sup> These values are presented in the Results Section.

4. **means and standard deviation**意为“平均值和标准差”。全句可译为：

步骤不包括结果。你可以说做了20次单独测试。你可以说对平均值和标准差进行了计算，但你不要给出它们的数值。这些数值要在结论部分给出。

Discussion of Results Results are the facts. They are the data you collected and the data you calculated. Means, standard deviations, confidence intervals and errors are all results.<sup>[5]</sup>

5. **confidence interval**意为“置信区间”。全句可译为：

结果的讨论 结果是事实。它们是你收集和计算的数据。平均值，标准差，置信区间和误差都是结果。

Present the results in a logical and concise fashion. You can place sample calculations in this section. But if you want detail and an explanation of a series of extraneous calculations, then use an appendix. In general, the detailed calculations of the experimental errors are best placed in an appendix unless the analysis of the errors is the object of the report.

以合乎逻辑和简明的方式给出结果。你可以在这个部分放置一些简单的计算。但如果你要详细说明和一系列不重要的计算说明，那就用附录。总之，实验误差的详尽计算最好放在附录中，除非对误差的分析是报告的目的。

Do not transcribe your raw data. These are the numbers you recorded from your experimentation. A Xerox or carbon copy of the data should be in the appendix forming the last page of your report.<sup>[6]</sup> Thus, it is important to keep a neat, clear and informative laboratory notebook, and all your lab partners could have the same identical last page of their report.

6. **Xerox or carbon copy**意为“复印或复写件”。全句可译为：

不要抄录你的原始数据。这些数字是从你的实验中记录的。这些数据的复印或复写件应该作为你的报告的最后一页放到附录中。这样，重要的是保留一个整洁、清楚而有益的实验室笔记本，并且你实验室的所有同伴在他们报告的最后一页都有相同的内容。

In the Procedure, you explained how and what were measured. Now you give the results. The results are the facts; given the same raw data, the reader should get the same results. Repeating the experiment should give similar results. But even when the results are identical, readers may interpret the results differently weighing certain information more heavily. These interpretations of the results are called conclusions.

在步骤中，你解释了测量方法和测量对象。现在给出结果。结果就是事实；给出同样的原始数据，读者能得到同样的结果。重复这个实验会得出同样的结果。但即使结果相同，读者可能会因更重地权衡一些确定信息而对结果有不同的解释。这些对结果的解释就叫结论。

Conclusions It is interesting that, given the same results, two people can draw two different conclusions, and neither conclusion is necessarily incorrect.<sup>[7]</sup>

7. **draw conclusion**意为“得出结论”。全句可译为：

有趣的是，对于相同的结果，两个人可以得出两种不同的结论，而且这两个结论可能都是正确的。

That is not to say that any conclusion is correct but that a conclusion is personal; it is your interpretation of the results and is subjective. However, the conclusion should relate to the objective of the report.

不是说任何结论都是正确的，但结论是与个人有关的；它是你对结果的解释，是主观的。然而，结论应该与文章的主题有关。

Students hesitate to make conclusions for fear of being wrong. "This method of determining the coefficient of friction was a reasonably good way of obtaining fairly accurate results," says nothing. It straddles the issue and avoids being wrong. It is better to be decisive when the results warrant a decision.

学生们因为怕犯错而犹豫着不敢下结论。“这个摩擦系数的确定方法是获得相当精确结果的适当的好方法，”等于什么也没说。这是避免犯错的骑墙态度。当结果能证明一个判断时最好做出断言。



Some legitimate conclusions are:

以下是些合理的结论的例子:

- (a) This experiment showed that the coefficient of static friction between aluminum and brass is not a simple value but can vary by as much as 50 % .

实验显示铝和黄铜之间的静摩擦系数不是一个单一的值，变化最多可达50%。

- (b) This experiment showed that it is not necessary to use sophisticated or expensive equipment to obtain accurate results.

实验显示没有必要使用高级的或昂贵的设备来获得精确的结果。

- (c) For an experiment stressing precision, the equipment was unusually crude. No wonder the results had such variability. Better equipment would have given more precise answers.

对于实验压力的精确度来说，设备实在是太粗糙了。怪不得实验结果容易发生变化。较好的设备会给出较高精度的结果。

All these conclusions may be valid; it depends upon the results.

Remember that conclusions are not facts. They are your interpretation of the facts, and these interpretations should pertain to the objective of the report.<sup>[8]</sup> They should bring your report to a sensible finish.

8. **pertain to**意为“与.....有关”。全句可译为：

所有这些结论都可能是有效的；它们取决于实验结果。记住结论不是事实。它们是你对事实的解释，而这些解释应该与报告的目的有关。它们将带给你的报告一个能被理解的结局。

# Lesson 78 Writing the Technical Report

Terminology

Text tour

# ***Terminology***

Substantiate [sʌbs'tænfieit]

1. To support with proof or evidence;  
verify

证实，证明

2. To give material form to, embody  
使具体化

## **Reading**

The information indicated by a gauge  
or graduated instrument

读数，指示数：由测量仪器或标有刻度的  
仪器所表明的信息

Appendix  
A collection of  
supplementary material,  
usually at the end of a book  
附录：通常位于书末尾处  
的补充材料

# ***Text tour***

Communication of your ideas and results is a very important aspect of engineering. Many engineering students picture themselves in professional practice spending most of their time doing calculations of a nature similar to those they have done as students.<sup>[1]</sup> Fortunately, this is seldom the case. Actually, engineers spend the largest percentage of their time communicating with others, either orally or in writing.

1. **picture**这里指“构想，想象”全句可译为：

观念和结果的沟通是工程上一个重要的方面。许多工科学生想象他们将来从事专业技术工作时，也会像他们当学生时那样花费大量的时间进行计算工作。幸运的是，这种事情很少发生。实际上，工程技术人员把他们最多的时间都花在和他人交流上了，口头的或者是书面的。

When your design is done, it is usually necessary to present the results to your client, peers, or employer. The usual form of presentation is a formal technical report. Thus, it is very important for the engineering student to develop his or her communication skills. You may be the cleverest person in the world, but no one will know that if you cannot communicate your ideas clearly and concisely. In fact, if you cannot explain what you have done, you probably don't understand it yourself.

当你的设计完成以后，往往需要将结果呈递给你的客户、同行或是老板。结果呈递通常的形式是一份正式的技术报告。这样，对工科学生来讲提高他或者她的沟通技能就是非常重要的了。你可能是这个世界上最聪明的人，但如果你不能清楚而简明地交流你的思想就不会有人知道这点。事实上，如果你不能解释你做的工作，你可能自己也不懂。

The following suggestions are presented as a guide to technical writing and an aid in avoiding some of the most common mistakes.

以下的建议是技术写作的指导并帮助避免一些最常见的错误。

Title The title should be a meaningful description of what you have written.

标题 标题应该是你要写的内容的有意义的描述。



## Important Information

Emphasize important information; beware of the common error of burying it under a mass of details.<sup>[2]</sup>

2. a mass of 意为“大量的”全句可译为：

重要信息 要强调重要的信息，注意不要将其混入到大量的细节之中。

Fact vs. Opinion      Separate fact from opinion. It is important for the reader to know what your contributions are, what ideas you obtained from others (the references should indicate that), and which are opinions not substantiated by fact.

事实与观点      把事实与观点分开。对读者来说重要的是知道你的贡献是什么，哪些思想是你从别人那里得到的（参考文献应该指出这个），哪些是不被事实证实的观点。

Tense The choice of the tense of verbs is often confusing to student writers. The following simple rules are usually employed by experienced writers:

**时态** 动词时态的选择常常困扰着学生作者。以下的简单规则常被有经验的作者使用：

Past tense. Use to describe work done in the laboratory or in general, to past events, "Hardness readings were taken on all specimens. “

过去时 用于描述实验室中已做的工作或一般指过去的事件，“所有样本都有硬度读数。”

Present tense. Use in reference to items and ideas in the report itself. “It is clear from the data in Figure 4 that strain energy *is* the driving force for recovery.”<sup>[3]</sup>

3. **driving force**意为“驱动力”。全句可译为：

现在时 用于在自身报告中有关的事项和思想。“图4中的数据清楚地表明应变能是恢复的驱动力。”

Future tense. Use in making prediction from the data that will be applicable in the future. “The data given in Table 2 indicate that the tonnage will continue to increase in the next ten years.”<sup>[4]</sup>

4. **tonnage**意为“吨位, 排水量”。全句可译为：

将来时 用于从数据中得到的将来可能用到的预测。“表2中的数据表明在下一个十年中，吨位将会持续增长。”

The following paragraphs provide the basics necessary for preparing each section of a technical report.

以下段落提供了准备技术报告的每个部分所需的基本要素。

The Abstract- Summary of the Entire Report. An Abstract must be a complete, concise distillation of the full report, and, as such, should always be written last.<sup>[5]</sup> It should include a brief (one sentence) introduction to the subject, a statement of the problem, highlights of the results (quantitative, if possible), and major conclusions. It must stand alone without citing figures or tables. A concise, clear approach is essential, since most Abstracts are less than 250 words.

5. **as such**意为“因而”。全句可译为：

摘要-整个报告的总结。一篇摘要应该完整、简明地将整篇报告的精华介绍出来，因而它总是最后写成的。它应该包括对主题的一个简短介绍（一个句子），对问题的陈述，对结果的强调（如果可能要定量），和主要的结论。它必须脱离引用的图形或表格独立存在。一个简明、清楚的方法是必要的，因此大多数摘要不少于250个单词。

The Introduction- Why Did You Do What You Did? An Introduction generally identifies the subject of the report, provides the necessary background information including appropriate literature review, and, in general, provides the reader with a clear rationale [ˌræʃəˈnɑːli] for the work described. The Introduction does not contain results, and generally does not contain equations.

引言-为什么你要做这个工作？引言通常确定报告的主题，提供必要的背景信息包括适当的文献综述，而且通常提供给读者这个工作的清楚的基本原理。引言不包括结果，一般也没有公式。

Analysis-What Does Theory Have to Say? An Analysis section describes a proposed theory or a descriptive model. It does not contain results, nor should extreme mathematical details be provided. Sufficient detail (mathematical or otherwise) should be provided for the reader to clearly understand the assumptions associated with a theory or model.

分析-什么是理论所必须说明的?分析章节描述一个建议的理论或一个描述性模型。它不包含结果,也不应提供很多数学细节。足够的细节(数学的或其他的)应该使读者清楚地理解与理论或模型有关的假设。

Experimental Procedure- What Did You Measure and How? The Experimental Procedure section is intended to describe how the experimental results were obtained and to describe any nonstandard types of apparatus or techniques that were employed. As a rule of thumb, provide sufficient details to allow the experiment to be conducted by someone else. If a list of equipment is included in the report, it should be a table in the body of the report, or should be placed in an appendix.

实验步骤-你测量什么以及怎么测量？实验步骤部分将描述实验结果是怎么获得的以及描述所用到的任何非标准仪器和技巧。根据经验，提供足够的细节将允许其他人指导实验。如果报告中包含一个设备清单，应该在报告主体中有一个表格，或应该放到附录中。



Results and Discussion-So What Did You Find? Results of your work must be presented, as well as discussed, in this section of the report. Data must be interpreted to be useful to most readers.

When presenting your results remember that even though you are usually writing to an experienced technical audience, what may be clear to you may not be obvious to the reader. Assuming too much knowledge can be a big mistake, so explain your results even if it seems unnecessary. If you can't figure them out, say so, "The mechanism is unclear and we are continuing to examine this phenomenon."

结果和讨论-你发现了什么？你工作的结果必须要在在这个部分表达出来并进行讨论。数据要对大多数读者有用就必须进行解释。当呈现你的结果是要记住即使你经常写信给一个经验丰富的有技术的观众，你清楚的未必读者也显而易见。自以为是地堆太多知识会是个大错误，因此即便是好像不必要也要解释你的结果。如果你弄不清楚，就这样说：“尚不清楚其机制，我们还要继续观察这个现象。”

Often the most important vehicles for the clear presentation of results are figures and tables.<sup>[6]</sup> Column heads in tables should accurately describe the data that appear in that column.<sup>[7]</sup>

6. **vehicle**这里指“手段”全句可译为：

图和表通常是清楚地介绍结果的最重要的手段。

7. **column head**意为“各列内容的名称”。  
全句可译为：

表中各列内容的名称应该对在这列中的数据进行准确的描述。

Each of the figures and tables should be numbered and have a descriptive title. Each table and figure must be explicitly [ik'splisitli] and individually referenced and described in the text of the Results section.

每个图表都应该编号并有描述性的标题。  
每个图表必须明确而独立的引用，并在结果的正文部分描述。

Conclusions- What Do I Know Now?  
The Conclusions section is where you should concisely restate your answer to the question: "What do I know now?" It is not a place to offer new facts, nor should it contain another rendition of experimental results or rationale.<sup>[8]</sup> Conclusions should be clear and concise statements of the important findings of a particular study; most conclusions require some quantitative aspect to be useful.

8. 全句可译为：

结论-现在我知道什么？结论部分是你对这个问题进行简明重述的地方：“我现在知道什么？”它不是一个提供新的事实的地方，它也不应该再一次对实验结果和基本原理进行介绍。结论应该用清楚而简明的句子阐述一项个别研究的重要发现；大多数结论要求使用一些定量的形式。

Appendixes Appendixes are the final elements in formal reports that contain supplemental information or information that is too detailed and technical to fit well into the body of the report or that some readers need and others do not. The recent trend in formal reports has been to place highly technical or statistical information in appendixes for those readers who are interested in such material.

**附录** 附录是正式报告中的最后元素，包含增补信息或那些太具体太技术性而不便放到报告正文中的信息，或一些读者需要而另一些不需要的信息。新趋势是在正式报告中把高度技术性的或统计信息放入附录，以满足那些对这些材料感兴趣的读者。

## 英语写作常用转接词

1. 例如, for example, instance, more specifically, to illustrate, let me explain with this example
2. 对照 similarly, in the same way, likewise, the same applies to, like, unlike, in spite of, on the other hand, on the contrary, nevertheless, but, however, conversely, whereas,
3. 原因, 理由, because, this is because, this is the reason, for this reason, as, since, on account of
4. 结果, 结论, as a result, therefore, hence, consequently, accordingly, in conclusion, etc.
5. 目标, for this purpose, to this end, by way of,
6. In addition, not only, but, furthermore, besides

7. If unless, under these  
circumstances, although
8. First ,second, third ,next,  
finally, the first point I would like  
to makes is
9. With respect to , regarding,  
talking of , now for, by the way,
10. Meanwhile, in the meantime,
11. On the opposite side,  
adjacent to
12. As far as is concerned, as far  
as I know, to my knowledge,
13. Let me turn now to the next  
subject, moving on to
14. What about, how do you
15. To review briefly, in short ,  
on the whole, to sum up, in  
summary, in brief.

## 1. Figure

**figure**通常指几何图形或图案；此外书中的插图不管是什么图都可以用**figure**表示：

**Figure 5 is the schematic diagram of a d/a converter.** (图5是数/模转换器的原理图)

## 2. Diagram

**diagram**是科技英语中用得比较广泛的一个词，用于一般的图形、图表：

**This simplified block diagram is valuable.** (这个简化了的框图很有用。)

**3. Graph** 一般用于指曲线图、标绘图，也可指图解：

**The graph of this equation has been drawn above.** (此方程所对应的曲线图已在上面画出。)

**4. Plot** 往往可以与**graph**互换：

**The plot of  $I$  versus  $V$  is a straight line.** ( $I$ 随 $V$ 的变化曲线是一条直线。)

**5. View** 一般用于机械图或各种结构图中的各向视图，也用来指航海中使用的“对景图”(即实物图片)：

**The top and cross-sectional views of the memory structure are shown below.** (这种存储器结构的俯视图和剖析图如下面所示。)

**6. Profile** 一般指零(部)件的外形轮廓图，剖面形状图：**stratigraphic profile** 地层纵断面图

**profile**也可指各种分布图：  
**density profile**密度分布图，  
**pressure profile**压力分布图

**7. Pattern** 用于指图型、图案、花纹等 **A mask with 100 tiny individual patterns is**

**placed over the chip and exposed to light.** (将带有1000个微小分立图样的掩膜放在晶片上并曝光。)

**8. Drawing** 主要用于各种工程图纸及有关工程设计的附图、插图：  
**perspective drawing** 透视图  
**projection drawing** 投影图

**9. Chart** 多用于航线图和某种方向的图，如**nautical chart**航海图，**flight chart** 航空图。



10. **Map** 指地图、天体图、布局图以及一些专用图形。 **seismic map** 地震图  
**weather map** 气象图 **radar map** 雷达图
11. **Sketch** 一般指粗略勾画的示意图，草图。
12. **Layout** 着重于被描绘对象的总体概貌，外形轮廓，总体安排和设计。 **Among the disadvantages are great layout difficulties.** (缺点之一是(电路)排图困难。 )
13. **Line** 一般仅用于线条描绘的轮廓和外形图，如船体型线图： **The engineers are making the designing of the hull lines.** (工程师们正在设计船体型线图。 )
14. **Scheme; Schematic** 指草图、示意图：  
**wiring scheme** 电气配线图
15. **Draft, Delineation** **Draft** 含有底稿的意思， **delineation** 只用于草图、略图、示意图。这两个词用得较少