普通高校“十二五”规划教材

机械工程英语教程

张 力 主编
龚堰珏 罗红旗 刘学军 编著

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内容简介

本书内容共分 6 个模块，每个模块包含 5～7 个单元，涵盖了机械设计、先进制造技术、工程材料与热处理、机电一体化、新能源和制造企业管理等领域的相关知识。既体现了机械工程领域各分支学科的差异，又保持了本书的前后连贯。

本书对每个单元中一些常用词汇进行普通词义与专业词义的比较，便于学生了解其差异，有利于提高读者的专业英语理解能力。

读者对象为机械类专业本科生或其他工科本科生及有志拓展科技英语知识的人群。

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前　　言

近年来，随着我国机械工业的迅猛发展和对外经济贸易往来增多，机械工程专业的大学毕业生在工作中越来越多地接触到各种英文资料，掌握专业英语知识已成为工作中必不可少的基本技能。然而，在实际应用中，机械工程专业的很多英语单词与大学基础英语教材中的意义和用法不尽相同，因此，在本科生完成大学英语基础教育后，有必要继续学习机械工程方面的专业英语知识。本书正是在这样的大背景下编写的。该教材具有以下几个特点：

1. 权威性和趣味性：所有文本均选自英美原文，语言地道，文字优美，文笔流畅，使人乐知、好知；

2. 新颖性和时效性：文本的遴选注重机械工程的最新发展和最新内容，尽力做到内容上的“引领潮流，高屋建瓴”；

3. 知识性和实用性：力争覆盖机械工程知识的关键领域，可以比作为一部机械工程英语的小百科；对于相关的短语和词汇，可谓是“教程在手，应有尽有”；

4. 富含机械工程文化：相关文化是任何教材都不可或缺的内容之一，因此机械工程文化部分在本书中有所加强，旨在为使用者成为机械工程方面的“文化人”助上一臂之力。

全书共分6个模块，涵盖了机械设计、先进制造技术、工程材料与热处理、机电一体化、新能源和制造企业的管理等领域的相关知识，既相互对立，又前后连贯，每个模块共有5～7个单元，每单元由课文、词汇和短语、注释和练习组成。书后附有词汇表，便于学生查阅。

本教材适用于机械类专业的本科生，也可供其他工科类的本科生和英语爱好者使用。鉴于本科生在完成基础阶段的学习后，已经达到了大学英语的基本要求，并且具有机械工程方面的基础知识，因此具备了进一步学习专业英语的能力。通过专业英语的学习，学生可掌握更多的英文语法知识，扩大词汇量，提高阅读理解能力，同时，还可拓展机械方面的专业知识，使之事半功倍、鱼与熊掌兼得。

本书获得“北京市属高等学校人才强校计划资助项目”的资助，编号为PHR201107110。由于时间仓促，加之编者水平有限，书中难免不当之处，请读者不吝赐教。

编　者

2011年1月

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Unit 1 Introduction

Definition of Design and Designer

Design is an interesting engineering activity that:

- affects almost all areas of human life.
- uses the laws[1] and insights of science.
- builds upon special experience.
- provides the prerequisites for the physical realization of solution ideas.
- requires professional integrity and responsibility.

In *psychological* respects, designing is a creative activity that calls for a sound grounding in mathematics, physics, chemistry, mechanics, thermodynamics, hydrodynamics, electrical engineering, production engineering, materials technology, machine elements and design theory, as well as knowledge and experience of the domain of interest. Initiative, resolution, economic insight, tenacity, optimism and teamwork are qualities that stand all designers in good stead and are indispensable to those in responsible positions.

In *systematic* respects, designing is the optimization of given objects within partly conflicting constraints. Requirements change with time, so that a particular solution can only be optimized for a particular set of circumstances.

In *organizational* respects, design is an essential part of the product life cycle. This cycle is triggered by a market need or a new idea. It starts with product planning and ends -when the product's useful life is over-with recycling or environmentally safe disposal [2]. This cycle represents a process of converting raw materials into economic products of high added value. Designers must undertake their tasks in close cooperation with specialists in a wide range of disciplines[3] and with different skills.

In this book, the designer is used synonymously to mean design and development engineers. Designers contribute to finding solutions and developing products in a very specific way. They carry a heavy burden of responsibility, since their ideas, knowledge and skills determine the technical, economic and ecological properties of the product in a decisive way.

Tasks of Designers

The main task of engineers is to apply their scientific and engineering knowledge to the solution of technical problems, and then to optimize those solutions within the requirements and constraints set by material, technological, economic, legal, environmental and human-related considerations [6]. Problems become concrete tasks after the problems that engineers have to solve to create new technical products are clarified and defined. This happens in individual work as well as in teams in order to realize interdisciplinary product development. The mental creation of a new product is the task of design and development engineers so called designers, whereas its physical realization is the responsibility of production engineers.

The tasks of designers are influenced by several characteristics.

Origin of the task: Projects related to mass production and batch production are usually started by a product planning group after carrying out a thorough analysis of the market. The requirements established by the product planning group usually leave a large solution space for designers.

In the case of a customer order for a specific one-off or small batch product, however, there are usually tighter requirements to fulfill. In these cases it is wise for designers to base their solutions on the existing company know-how that has been built up from previous developments and orders. Such developments usually take place in small incremental steps in order to limit the risks involved.

If the development involves only part of a product (assembly or module), the requirements and the design space are even tighter and the need to interact with other design groups is very high. When it comes to the production of a product, there are design tasks related to production machines, jigs[6] and fixtures, and inspection equipment. For these tasks, fulfilling the functional requirements and technological constraints is especially important.

Organization: The organization of the design and development process depends in the first instance on the overall organization of the company. In product-oriented companies, responsibility for product development and subsequent production is split between separate divisions of the company based on specific product types (e. g. rotary compressor division, piston compressor division, accessory equipment division).

Problem-oriented companies split the responsibility according to the way the overall task is broken down into partial tasks (e. g. mechanical engineering, control systems, materials selection, and stress analysis). In this arrangement the project manager must pay particular attention to the coordination of the work as it passes from group to group. In some cases the project manager leads independent temporary project teams recruited from the various groups. These teams report directly to the head of development or senior management.

Novelty: New tasks and problems that are realized by original designs incorporate new solution principles. These can be realized either by selecting and combining known principles and technology, or by inventing completely new technology. The term original design is also used when existing or slightly changed tasks are solved using new solution principles. Original designs usually proceed through all design phases, depend on physical and process fundamentals and require a careful technical and economic analysis of the task. Original designs can involve the whole product or just assemblies or components.

Branch: Mechanical engineering covers a wide range of tasks. As a consequence the requirements and the type of solutions are exceptionally diverse and always require the application of methods and tools used to be adapted to the specific task in hand[7]. Domain-specific embodiments are also common. For example, food processing machines have to fulfill specific requirements regarding hygiene; machine tools have to fulfill specific requirements regarding precision and operating speed; agricultural machines have to fulfill specific requirements regarding functionality and robustness; and office machines have to fulfill specific requirements regarding ergonomics and noise levels.

Goals: Design tasks must be directed towards meeting the goals to be optimized, taken into account the given restrictions. New functions, longer life, lower costs, production problems, and changed ergonomic requirements are all examples of possible reasons for establishing new design goals.

Moreover, an increased awareness of environmental issues frequently requires completely new products and processes for which tasks and the solution principle have to be revisited. This requires a holistic view on the part of designers and collaboration with specialists from other disciplines.

To cope with this wide variety of tasks, designers have to adopt different approaches, use a wide range of skills and tools, have broad design knowledge and consult specialists on specific problems. This becomes easier if designers master general working procedures, understand generation and evaluation methods, and are familiar with well-known solutions to existing problems.

New Words

prerequisite	*n.*	先决条件，前提
realization	*n.*	实现，完成
psychological	*adj.*	心理上的
synonymously	*adv.*	同义地
ecological	*adj.*	生态的
thermodynamics	*n.*	热力学
hydrodynamics	*n.*	水动力学
initiative	*n.*	首创精神，积极性
resolution	*n.*	决心，坚定
tenacity	*n.*	坚韧，顽强
indispensable	*adj.*	不可缺少的，绝对必要的
constraint	*n.*	约束，限制

optimize	*vt.*	使最优化
trigger	*vt.*	引起,触发
clarify	*vt.*	澄清,阐明
interdisciplinary	*adj.*	各学科间的
batch	*n.*	一批产品,一次生产量
novelty	*n.*	新奇,新产品
original	*adj.*	最初的,原始的,创新的
robustness	*n.*	坚固,结实耐用
ergonomics	*n.*	人机工程学
holistic	*adj.*	整体的, 全盘的
embodiment	*n.*	具体化,具体设备(装置)
hygiene	*n.*	卫生, 卫生学
exceptionally	*adv.*	异常地

Phrases and Expressions

one-off	一次性的
know-how	专门技能,生产经验
in the first instance	首先
stand sb. in good stead	对某人很有用
in close cooperation with	与…密切合作
carry out	完成,实现,执行
rotary compressor	转子式压缩机
piston compressor	活塞式压缩机
as well as	也,又
be broken down into	被分成
take into account	考虑
as a consequence	因而,结果
cope with	应付,处理
call for	要求

Notes

1) **law** *n.*

普通词义:法律

All citizens are equal before the *law*. 法律面前人人平等。

专业词义:定律

The problem can be solved by Newton's second *law*. 这个问题可用牛顿第二定律求解。

2) It starts with product planning and ends-when the product's useful life is over-with recycling or environmentally safe disposal.

语法点:when 引导的状语从句作为插入语将谓语 ends 和 with 分开,其目的是避免整段句子显得头重脚轻。

翻译:设计以产品计划为开始,在产品使用寿命到期时,以再循环或环境安全处理为结束。

3) **discipline** *n.*

普通词义:纪律

It is a teacher's responsibility to maintain classroom *discipline*. 维护课堂纪律是一个教师的责任。

专业词义:学科

The project involves knowledge of many scientific *disciplines*. 这个项目涉及很多学科的知识。

4) The main task of engineers is to apply their scientific and engineering knowledge to the solution of technical problems, and then to optimize those solutions within the requirements and constraints set by material, technological, economic, legal, environmental and human-related considerations.

语法点:"task, purpose, aim 等名词作主语+be 动词+不定式短语作表语"是科技文章中常见的句式结构。

翻译:工程师的主要任务是将他们的科学及工程知识应用到技术问题的解决方案中,然后在材料、工艺、经济性、法律、环境以及与人相关的考虑所设定的要求和约束条件下将这些解决方案最优化。

5) **assembly** *n.*

普通词义:集和,议会

Several leaders have delivered their speeches in General *Assembly*. 几个领袖在联合国大会上发了言。

专业词义:装配,组合件

Many cable *assemblies* will be used for construction of the bridge. 许多钢索组件将用于这个桥梁的建造。

6) **jig** *n.*

普通词义:快步舞

Jig is a kind of lively dances in triple time. 快步舞是一种三拍的欢快舞蹈。

专业词义:模具,夹具

The quality of *jigs* and fixtures is one of the main factors to determine the accuracy of machined parts. 模具和夹具的质量是决定机加工零件精度的主要因素之一。

7) As a consequence the requirements and the type of solutions are exceptionally diverse and always require the application of methods and tools used to be adapted to the specific task in hand.

语法点:used 引导的是一个过去分词短语做定语,用来修饰 methods 和 tools,该过去分词短语里又包含了一个表示被动语气的不定式短语。为避免语句繁复,可将该分词短语分开

翻译。

翻译:因此解决方案的要求和类型特别多样化,在应用方法和工具时总是需要使它们与正在进行的特定任务相适应。

Exercises

1. Based on the information of the text, please answer the following questions:

1) What qualities are necessary to those designers in responsible positions?

2) What is the wise method for designers to deal with the case of a customer order for small batch product?

3) How is the organization of the designing process related to the overall organization of the company?

4) Give some examples of disciplines on which the designing activity is based.

5) What factors should design engineers consider when they optimize solutions of technical problems?

6) What specific requirements have to be met for machine tools?

7) What issue has been aware increasingly for new products?

8) What could designers think about when they are trying to establish new design goals?

2. Translate the following sentences from English into Chinese:

1) In product-oriented companies, responsibility for product development and subsequent production is split between separate divisions of the company based on specific product types (e. g. rotary compressor division, piston compressor division, accessory equipment division).

2) Products to be made in large quantities (large batch or mass production) must have their technical and economic characteristics fully checked prior to full-scale production. This is achieved using models and prototypes and often requires several development steps.

3) In the design process, the required design activities have to be structured in a purposeful way that forms a clear sequence of main phase and individual working steps, so that the flow of work can be planned and controlled.

4) Moreover, an increased awareness of environmental issues frequently requires completely new products and processes for which tasks and the solution principle have to be revisited.

5) This becomes easier if designers master general working procedures, understand generation and evaluation methods, and are familiar with well-known solutions to existing problems.

Unit 2 The Design Process

It is important that a rational method of design be understood by engineers. There are two reasons for this. The first is that a rational method of design helps engineers to manage their task when confronted with a vast amount of input information. The second reason is that the use of a common procedure for design greatly facilitates interaction among engineers. Although the content of each engineering design problem is unique, the methodology for solving these problems is universal and can be described in a specific way. Although a number of authorities on the methodology of design have presented descriptions of the process, most of these descriptions tend to be similar. The design process, as we will describe it, involves the six-step procedure diagrammed in Fig. 1. We will now look at the activity that takes place during each of these steps.

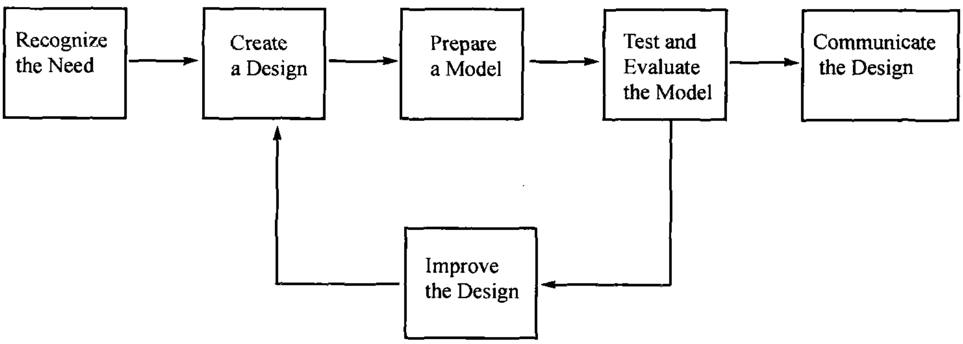

Fig. 1 Six-Step Process of Design

Step 1: Recognize the need

Some people mistakenly believe that engineers create need. This is, of course, no more true than the notion that physicians create illness or farmers create hunger [5]. The products and process created by engineering design are a direct response to specific needs of society. The first step in the design process is probably the single most important part of the overall process. Yet it is frequently given inadequate treatment in the design process. A carefully formulated statement of need can often save considerable time and energy later in the design cycle. Implied in any statement of need is an understanding of the real constraints on the problem. Once a statement of need has been established, the designer would be well advised to review this statement periodically during the design process so that it can be revised if necessary.

Step 2: Create a design

Once the need has been clearly recognized and stated in a succinct way, the next step is to begin creating design ideas that will satisfy this need. Of all of the steps in the design process, this one requires the most ingenuity and imagination.

Step 3: Prepare a model

Once an idea has been clearly created, it becomes necessary to find a means to evaluate the quality of that idea in satisfying the need requirements. One way to do this, of course, would be build the suggested design idea. This procedure is usually impractical for reasons of cost, time and effort. In order to conserve cost, time and effort, engineers frequently make use of a simplified model to evaluate a design idea. A model may be real or abstract and may be anything from a simple mental image of the idea to a complex mathematical or physical reproduction of the proposed concept. A frequently used model is a mathematical equation that describes the physical performance of the part. A designer must understand that all models are only approximations of a physical phenomenon. It is thus important to know when a model is robust enough to give meaningful results. An understanding of significant figures in calculations is also highly important to performing design analysis.

Step 4: Test and evaluate the model

Once the model has been prepared, it is time to evaluate the proposed design idea by exercising the model. The testing usually involves judgment. In the case of a mathematical model of a physical phenomenon, the engineer will put values into the equations and look at the results. What becomes obvious as a result of this type of model is that it is important for the designer to become proficient in the manipulation[1)] of mathematical models and that a good system of documenting the solution process is highly desirable [6)].

Step 5: Improve the design

As a result of the tests performed on the model, the engineer should have a quantitative measure of the success or failure of the idea. The engineer will likely know whether the idea should be abandoned or whether it should be retained for future improvement. One of the fortunate results of testing and evaluation is that this process often provides considerable insight into where improvements can and should be made. Thus, this step leads back to the creation step. Since a number of different design ideas may be tried, modified and improved before a final design is made, the process show in Fig. 1 is quite iterative[2)]. What is important to realize is that the design process may yield many workable solution or no solution at all. This characteristic is one that makes design problem solving quite different from most engineering science problems, where there is often only one right answer.

Step 6: Communicate the design

No matter how well a design may satisfy a particular human need, it cannot be converted into a useful product or process if the details of the design are not communicated to those who will implement its use. Thus, the communication step is a very important part of the design process. Communication of engineering design ideas may be by written words, spoken words, or by pictures, graphs, or drawing.

As we think about applying the engineering design method diagram, several facts are worth keeping in mind. First, the human mind is capable of handling straightforward design decisions with remarkable speed. The complete process of making a good design choice need not take excessive time for routine problems. Second, the human mind often has difficulty defining boundaries between the steps in the process. The designer may combine one or more of the blocks in the diagram into what seems like a single activity. While this procedure is not wrong, it should be avoided if it results in inadequate treatment of each important step.

Types of Engineering Analysis

several types of engineering analysis are generally involved in the design process mentioned above. Examples are as follows:

Structural analysis consists of linear and non-linear models. Linear models use simple parameters and assume that the material is not plastically deformed. Non-linear models consist of stressing the material past its elastic capabilities. Normally, the stresses[3] in the material vary with the amount of deformation in a complex way.

Vibrational analysis is used to test a material against random vibrations, shock, and impact. Each of these incidences may act on the natural vibrational frequency of the material which, in turn, may cause resonance and subsequent failure [7].

Fatigue[4] ***analysis*** helps designers to predict the life of a material or structure by showing the effects of cyclic loading on the specimen. Such analysis can show the areas where crack propagation is most likely to occur. Failure due to fatigue may also show the damage tolerance of the material.

Heat Transfer analysis models the conductivity or thermal fluid dynamics of the material or structure. This may consist of a steady-state or transient transfer. Heat transfer analysis can be performed through numerical computations by means of finite difference method, finite element method or finite volume method.

New Words

rational	*adj.*	理性的,合理的
facilitate	*vt.*	使容易,帮助,促进
methodology	*n.*	方法学,方法论
universal	*adj.*	普遍的,通用的
recognize	*vt.*	认识,认清,认识到
notion	*n.*	观念,想法