机械工程科技英语

SCIENCE AND TECHNOLOGY ENGLISH FOR MECHANICAL ENGINEERING

程安宁 周新建 主编

西安地图出版社

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主编　程安宁　周新建

编者　（以姓氏笔画排序）

马胜利　何万库　周新建

韩　敏　程安宁

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前　言

国家教委颁布的《大学英语教学大纲》把专业英语阅读列为必修课而纳入英语教学计划，强调通过四年不断线的教学使学生能够顺利阅读专业英语文献，能够以英语为工具进行本专业的学习、研究和学术交流。

本教材是为调整后的机械设计制造及其自动化专业与工业工程专业而编写，涉及的内容主要包括：机械设计、机械制造、机械电子、管理的作用和位置、信息系统等，难易程度及篇幅基本与学时安排相协调，选材广泛、语言规范，利于学生由浅入深、循序渐进。

全书由65篇课文和7篇阅读材料组成，全部课文均有参考译文，阅读材料的专业词汇及部分长难句子，均有中文注释。参加本书编写的有（以姓氏笔画排序）马胜利、何万库、周新建、韩敏和程安宁。由程安宁和周新建担任主编，确定了课文内容，审校了所有注解，润饰了所有译文。

为使教育能够“面向世界、面向未来”，教育部提出了高等教育双语教学的要求。在完全使用英语原版教材、用英语讲授、用英语测试的教学目标实施过程中，专业英语的教学，起着不容忽视的作用。比较各专业课的英语教材，专业英语或称科技英语更侧重于英语语言的学习。

希望学生通过本书的学习，对于机械专业或工业工程专业科技资料的阅读与翻译水平有所提高；用英语进行科技交流的水平有所加强；在后续专业课的双语教学的学习中，真正收到实效。

由于编者水平有限，书中难免有一些缺陷和不足，衷心欢迎批评指正。

编　者

2003年6月

译文说明

翻译是运用一种语言把另一种语言所表达的思维内容准确而完整地表达出来的语言活动。语言是思维的外壳，思维是存在的反映，而存在是可以认识的，所以翻译应该是可能的。由于背景知识掌握难，原文内容理解难，中文语言表达难，所以翻译工作并不容易。

现在学生中的英语翻译，有些是逐字硬译，主要缺点是不连贯，即段落之间没有层次，段落之内没有主题，句子前后互不对应。这一方面固然是由于英语水平的原因，不能准确地理解原文，但更主要的是他们不太重视语言表达的通顺。硬译似乎是忠实于原文，但如果语言晦涩、逻辑不清，别人看不懂，也就谈不到忠实。

专业英语教材附有参考译文，有利于同学们对照和参考，在课前预习和课后复习，这样可以使教师着重解决难点，增加内容，提高教学的针对性和规范性。

对于本教材的所有译文，编者都进行了认真仔细的推敲，力求准确、流畅。期望学生通过学习能够了解翻译常用的方法和技巧。这包括词义的选择、引申，词类的转译，增词法和省略法以及各种语态和语句的译法等。

尽管做了极大的努力，但译文难免有一些缺陷和不足，只能权作引玉之砖，敬请斧正并点睛。

译文涉及知识十分广泛，得到了许多同志的帮助，特别是张燕清同志，提出了许多宝贵意见，在此一并致谢。

编 者

2003 年 6 月

Contents

Lesson 1 Overview of Engineering Mechanics

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.

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?" 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.

The goal of this text is to provide the background, analyses, methods, and data required to consider many important quantitative aspects of the mechanics of structures. In practice, these quantitative methods are used in two quite different ways:

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

(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. Our best designs often evolve through a successive elimination of weak points.

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

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. While our mathematics may be precise, the overall analysis is generally only approximate, and different skilled people can obtain different solutions. In this book 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.

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.).

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 (we shall briefly mention how this is done). Whenever the dynamic forces are small relative to the static loadings, the system is usually considered to be static.

As we proceed, you will begin to appreciate the various types of approximations that are inherent in any real problem:

Primarily, we will be discussing things that 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.

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.

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.

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. In addition, we are beginning to experience an influx of "personal computers" on campus, in the home, and in business. Accordingly, we will begin to introduce computer methods in this text.

Words and Expressions

ceramics	[si'ræmiks]	n. 陶瓷，陶瓷材料
perceive	[pə'si:v]	vt. 感觉，觉察，发觉，领会，理解
inertia	[i'nə:ʃiə]	n. 惯性，惯量，惰性
meld	[meld]	v. = merge 融合，汇合，组合 配合，交汇
lifetime	[laiftaim]	n. 使用寿命，持续时间，生存期
quantitative	['kwɔntitətiv]	adj. 数量的，定量的
interactive	[,intər'æktiv]	adj. 相互作用的，相互影响的，交互的
iterative	['itərətiv]	adj. 反复的，迭代的，重复的
durability	[,djuərə'biliti]	n. 耐久性，持久性，耐用期限
pinpoint	[pinpɔint]	vt. 准确定位，正确指出，确认，强调
evolve	[i'vɔlv]	v. 研究出，（经试验研究等）得出
substance	['sʌbstəns]	n. 物质，材料，内容，要点，梗概
lucrative	['lju:krətiv]	adj. 可获利的，赚钱的，有利的
statics	['stætiks]	n. 静力学
deformation	[,difɔ:'meiʃən]	n. 变形，形变，畸变
dynamic	[dai'næmik]	adj. 动力的，动力学的，冲击的
appreciate	[ə'pri:ʃieit]	vt. 正确评价，理解，体会到懂得
false	[fɔ:ls]	adj. 假的，不真实的，似是而非的
render	['rendə]	v. 提出，给予，描绘，表现
tractable	['træktəbl]	adj. 易处理的，易加工的

prohibitive	[prəˈhibitiv]	adj.	禁止的，抑制的，起阻止作用的
influx	[ˈinflʌks]	n.	流入，注入，涌进，汇集，河口
strength of materials			材料力学
(be) inherent in			为……所固有，是……的固有性质

Lesson 2 Fundamentals of Mechanical Design

Mechanical design means the design of things and systems of a mechanical nature—machines, products, structures, devices, and instruments. For the most part mechanical design utilizes mathematics, the materials sciences, and the engineering-mechanics sciences.

The total design process is of interest to us. How does it begin? Does the engineer simply sit down at his desk with a blank sheet of paper? And, as he jots down some ideas, what happens next? What factors influence or control the decisions which have to be made? Finally, then, how does this design process end?

Sometimes, but not always, design begins when an engineer recognizes a need and decides to do something about it. Recognition of the need and phrasing it in so many words often constitute a highly creative act because the need may be only a vague discontent, a feeling of uneasiness, or a sensing that something is not right.

The need is usually not evident at all. For example, the need to do something about a food-packaging machine may be indicated by the noise level, by the variation in package weight, and by slight but perceptible variations in the quality of the packaging or wrap.

There is a distinct difference between the statement of the need and the identification of the problem which follows this statement. The problem is more specific. If the need is for cleaner air, the problem might be that of reducing the dust discharge from power-plant stacks, or reducing the quantity of irritants from automotive exhausts.

Definition of the problem must include all the specifications for the thing that is to be designed. The specifications are the input and output quantities, the characteristics and dimensions of the space the thing must occupy and all the limitations on these quantities. We can regard the thing to be designed as something in a black box. In this case we must specify the inputs and outputs of the box together with their characteristics and limitations. The specifications define the cost, the number to be manufactured, the expected life, the range, the operating temperature, and the reliability.

There are many implied specifications which result either from the designer's particular environment or from the nature of the problem itself. The manufacturing processes which are available, together with the facilities of a certain plant, constitute restrictions on a designer's freedom, and hence are a part of the implied specifications. A small plant, for instance, may not own cold-working machinery. Knowing this, the designer selects other metal-processing methods which can be performed in the plant. The labor skills available and the competitive situation also constitute implied specifications.

After the problem has been defined and a set of written and implied specifications has been obtained, the next step in design is the synthesis of an optimum solution. Now synthesis can not take place without both analysis and optimization because the system under design must be analyzed to determine whether the performance complies with the specifications.

The design is an iterative process in which we proceed through several steps, evaluate the results, and then return to an earlier phase of the procedure. Thus we may synthesize several components of a system, analyze and optimize them, and return to synthesis to see what effect this has on the remaining parts of the system. Both analysis and optimization require that we construct or devise abstract models of the system which will admit some form of mathematical analysis. We call these models mathematical models. In creating them it is our hope that we can find one that will simulate the real physical system very well.

Evaluation is a significant phase of the total design process. Evaluation is the final proof of a successful design, which usually involves the testing of a prototype in the laboratory. Here we wish to discover if the design really satisfies the need or needs. Is it reliable? Will it compete successfully with similar products? Is it economical to manufacture and to use? Is it easily maintained and adjusted? Can a profit be made from its sale or use?

Communicating the design to others is the final, vital step in the design process. Undoubtedly many great designs, inventions, and creative works have been lost to mankind simply because the originators were unable or unwilling to explain their accomplishments to others. Presentation is a selling job. The engineer, when presenting a new solution to administrative, management, or supervisory persons, is attempting to sell or to prove to them that this solution is a better one. Unless this can be done successfully, the time and effort spent on obtaining the solution have been largely wasted.

Basically, there are only three means of communication available to us. These are the written, the oral, and the graphical forms. Therefore the successful engineer will be technically competent and versatile in all three forms of communication. A technically competent person who lacks ability in any one of these forms is severely handicapped. If ability in all three forms is lacking, no one will ever know how competent thet person is!

The competent engineer should not be afraid of the possibility of not succeeding in a presentation. In fact, occasional failure should be expected because failure or criticism seems to accompany every really creative idea. There is a great deal to be learned from a failure, and the greatest gains are obtained by those willing to risk defeat. In the final analysis, the real failure would lie in deciding not to make the presentation at all.

Words and Expressions

blank	[blænk]	adj. 空白的
jot	[dʒɔt]	v. 把……摘记下来，匆匆地记下
recognition	[ˌrekəg'niʃən]	n. 认识，承认，重视，认可
phrase	[freiz]	v. 用话表示，措词
vague	[veig]	adj. 不明确的，含糊的
discontent	['diskən'tent]	adj. 不满的，不安的

perceptible	[pə'septibl]	adj.	能觉察得出的，明显的
package	['pækidʒ]	n.	包裹，包装，捆
wrap	[ræp]	n.	包装，打包
stack	[stæk]	n.	烟囱
irritant	['iritənt]	n.	刺激物
exhaust	[ig'zɔst]	n.	排气
implied	[im'plaid]	adj.	暗指的，含蓄的
synthesis	['sinθisi:z]	n.	合成，综合，结构综合
comply	[kəm'plai]	v.	同意，遵守，履行
synthesize	['sinθisaiz]	v.	合成，综合，接合
originator	[ə'ridʒəneitə]	n.	创作者，发明者
accomplishment	[ə'kʌmpliʃmənt]	n.	完成，实施，成就
presentation	[ˌprezən'teiʃən]	n.	提出，展示

Lesson 3 The Machine Designer's Responsibility

A new machine is born because there is a real or imagined need for it. It evolves from someone's conception of a device with which to accomplish a particular purpose. From the conception follows a study of the arrangement of the parts, the location and length of links (which may include a kinematic study of the linkage), the places for gears, bolts, springs, cams, and other elements of machines. With all ideas subject to change and improvement, several solutions may be and usually are found, the seemingly best one being chosen.

The actual practice of designing is applying a comhination of scientific principles and a knowing judgment based on experience. It is seldom that a design problem has only one right answer, a situation that is often annoying to the beginner in machine design.

Engineering practice usually requires compromises. Competition may require a reluctant decision contrary to one's best engineering judgment; production difficulties may force a change of design; etc.

A good designer needs many attributes, for example:

(1) A good background in strength of materials, so that the stress analyses are sound. The parts of the machine should have adequate strength and rigidity, or other characteristics as needed.

(2) A good aequaintance with the properties of materials used in machines.

(3) A familiarity with the major characteristics and economics of various manufacturing processes, because the parts that make up the machine must be manufactured at a competitive cost. It happens that a design that is economic for one manufacturing plant may not be so for another. For example, a plant with a well-developed welding department but no foundry might find that welding is the most economic fabricating method in a particular situation; whereas another plant faced with the same problem might decide upon casting because they have a foundry (and may or may not have a welding department).

(4) A specialized knowledge in various circumstances, such as the properties of materials in corrosive atmospheres, at very low (cryogenic) temperatures, or at relatively high temperatures.

(5) A preparation for deciding wisely: (a) when to use manufacturers' catalogs, buying stock or relatively available items, and when custom design is necessary; (b) when empirical design is justified; (c) when the design should be tested in service tests before manufacture starts; (d) when special measures should be taken to control vibration and sound (and others).

(6) Some aesthetic sense, because the product must have "customer appeal" if it is to sell.

(7) A knowledge of economics and comparative costs, because the best reason for the existence of engineers is that they save money for those who employ them. Anything that increases the cost should be justified by, for instance, an improvement in performance, the addition of an attractive feature, or greater durability.

(8) Inventiveness and the creative instinct, most important of all for maximum effectiveness. Creativeness may arise because an energetic mind is dissatisfied with something as it is and this mind is willing to act.

Naturally, there are many other important considerations and a host of details. Will the machine be safe to operate? Is the operator protected from his own mistakes and carelessness? Is vibration likely to cause trouble? Will the machine be too noisy? Is the assembly of the parts relatively simple? Will the machine be easy to service and repair?

Of course, no one engineer is likely to have enough expert knowledge concerning the above attributes to make optimum decisions on every question. The larger organizations will have specialists to perform certain functions, and smaller ones can employ consultants. Nevertheless, the more any one engineer knows about all phases of design, the better. Design is an exacting profession, but highly fascinating when practiced against a broad background of knowledge.

Words and Expressions

evolve	[i'vɔlv]	v. 发展，进化
arrangement	[ə'reindʒmənt]	n. 配置，布局，构造
linkage	['liŋkidʒ]	n. 连杆，连杆机构
seemingly	['si:miŋli]	adv. 表面上，外观上，看上去
kinematic	[kaini'mætik]	adj. 运动学的
annoy	[ə'nɔi]	vt. 使……烦恼
compromise	['kɔmprəmaiz]	n. 妥协
reluctant	[ri'lʌktənt]	adj. 不愿的，勉强的，难得到的
attribute	['ætribju:t]	n. 属性，特性，特征
acquaintance	[ə'kweintəns]	n. 熟悉，了解，
foundry	['faundri]	n. 铸造，翻砂
fabricate	['fæbrikeit]	vt. 制作，制造
atmosphere	['ætməsfiə]	n. 大气层，空气，
cryogenic	[,kraiə'dʒenik]	adj. 冷冻的，低温的
stock	[stɔk]	n. 原料，材料，

empirical	[em'pirik(ə)l]	adj. 经验的，实验的
aesthetic	[iːs'θetik]	adj. 审美的，美学的，美术的
appeal	[ə'piːl]	n. 吸引……的注意，有感染力
comparative	[kəm'pærətiv]	adj. 比较的，相当的
justify	['dʒʌstifai]	v. 证明，认为……有理由
inventiveness	[in'ventivnis]	n. 发明创造能力，创造性
instinct	['instiŋkt]	n. 本性，本能，直觉
energetic	[ˌenə'dʒetik]	adj. 能的，有力的，精力旺盛的
host	[həust]	n. 许多，多数
service	['səːvis]	v. 服务，运转，使用，操作，维修
consultant	[kən'sʌltənt]	n. 顾问，咨询，商议者
fascinating	['fæsineitiŋ]	adj. 引人入胜的，极有趣的
a host of		许多，一大群，一大批

Lesson 4 Philosophies of Design

We think of an inventor as starting from scratch and creating a new design. However, even though he creates a machine never before conceived, he uses ideas that have long been known and, in more or less degree, he benefits from the engineering experiences of one or several industries.

Most designs follow a pattern familiar to and typical of an industry: a new model sewing machine is generally quite similar to the previous one, and a new model automobile is similar in most respects to the old. Changes (based on experience with the old model) are introduced either for the purpose of improving the machine or to gain or maintain an economic or competitive advantage in the market.

The philosophical approach to a particular design depends somewhat on the kind of industry or the kind of machine. A chemical plant, which is a large and complicated machine, may be a one-shot proposition. One plant only is designed and built. If the design is not right, the mistakes are corrected on the job, an expensive but necessary procedure, until the plant operates as planned. The designer who works where only one product is made from the design develops attitudes or philosophies quite different, for instance, from an airplane or automotive designer.

In the airplane industry, light weight and reliability are of utmost importance. The philosophy of the airplane designer leads him to relatively high-precision (and high-cost) designs, because the results are worth the money. Often the designed product is manufactured and operated under actual or simulated actual conditions, perhaps repeatedly, before the design is considered acceptable. In the automotive industry, the designer wants to be sure that his design is suitable for mass production. A subassembly design, such as the transmission, which will be made in quantities of hundreds of thousands or in millions, will be tested under actual operating conditions, because the "bugs" need to be eliminated before mass production begins.

In heavy industries, such as the manufacture of large pressure vessels, the designer does not think in terms of the precision necessary in an airplane engine, nor is he particularly concerned about the weight. Moreover, there is no mass production in the automotive sense.

If theory and practice do not agree, either theory or practice is wrong. Methods of design undergo an evolutionary process, just as a machine invariably evolves into better and better forms. New discoveries are made each day, but, because many theories are or become inadequate, we never know when the accepted formula will be discarded.

In any derivation, we first make certain assumptions in order to simplify the work and to obtain a formula which appears to satisfy our requirements, but before long we often find that the formula fails. This failure results in renewed study, and we usually find that one or more of our original assumptions were not justified. We then search for a formula with new variables that will care for a new environment. With respect to the use of theory, it is not by any means always economic to design by the most comprehensive theoretical and experimental analysis available, and engineering judgment must answer the question of whether a certain design decision is worth $10~15 or $10 000~15 000, or what. This means that the designer needs to continue to add to his knowledge of theory in order to be in a better position to judge. When it is difficult to incorporate the results of experience into a theoretical equation, we often resort to the use of practical, modifying constants until the difficulty is resolved. Hence, if experience dictates certain portions of a design, it behoves us to use experience as a guide until a more satisfactory state of theoretical knowledge is attained. If the machine is almost entirely new and different, as a rocket engine was a few years ago, look for related experience. So much information is still uncoordinated, so much remains to be learned, that the student, particularly in design, should adopt an agnostic attitude, welcoming further investigation.

Design problems have more than one answer. Given a general statement of a design problem, such as design a machine to wash clothes in the home automatically, and there will be as many different answers as there are design teams——as attested by the number of washing machines on the market.

These brief remarks are intended, not to define the philosophies of design in each of the industries mentioned, but to show that are quite different attitudes and to suggest that, in each field of design, the designer evolves a philosophy befitting the nature of the work he is doing.

Words and Expressions

philosophy	[fi'lɔsəfi]	n.. 哲学，基本原理，原则
scratch	[skrætʃ]	n.. 划痕，乱写
conceive	[kən'si:v]	v. 构思，设想，持有
pattern	['pætn]	n. 模式，规范，制度
philosophical	[ˌfilə'sɔfikəl]	adj. 理性的，自然科学研究的
approach	[ə'prəutʃ]	n. 途径，方法，手段
proposition	[prɔpə'ziʃən]	n. 建议，主张，计划，事情
simulate	['simjuleit]	vt. 模拟，制作模型，模拟实验
transmission	[trænz'miʃən]	n. 传动装置，变速箱