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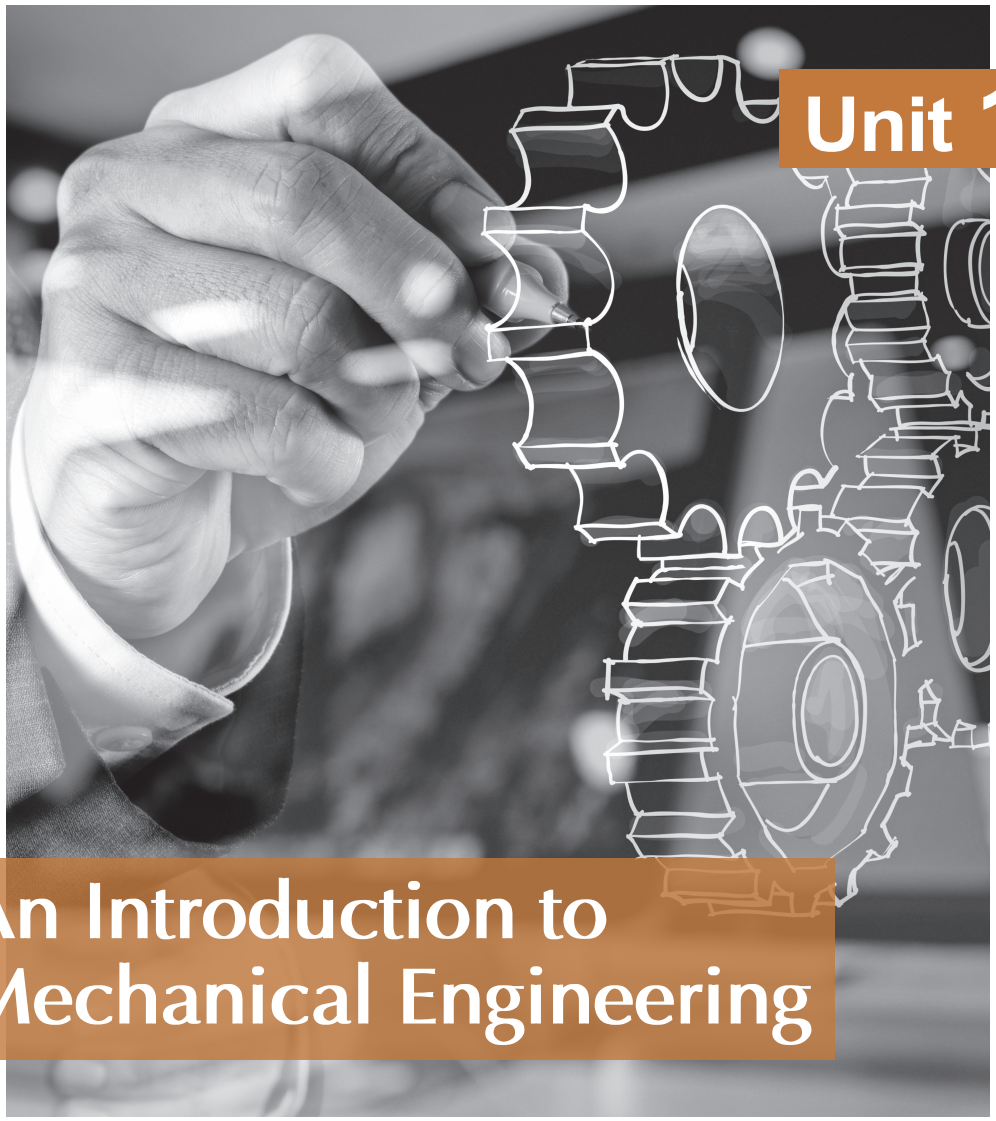


Unit 1

An Introduction to Mechanical Engineering

In this unit, you will learn:

- **Subject-related knowledge:** Mechanical engineering
  Mechanical engineering in the Information Age
- **Academic skill:** Searching for information
- **Reading strategy:** Dealing with unknown words (Part I)

Section A

Pre-reading

1 Read the following sentences taken from Text A, and guess the meaning of the words in bold. Share your answers in groups.

1. The invention of the steam engine in the latter part of the 18th century, providing a key source of power for the Industrial Revolution, gave an enormous **impetus** to the development of machinery of all types.
2. One aim is a completely automated machine shop for **batch production**, operating on a three-shift basis but attended by a staff for only one shift per day.
3. The demands of war have **channeled** huge resources into technical fields, however, and led to developments that have profound benefits in peace.
4. Bioengineering is a relatively new and distinct field of mechanical engineering that includes the provision of machines to replace or **augment** the functions of the human body and of equipment for use in medical treatment.

2 Discuss the following questions with your partner.

1. What were the main disadvantages of the early production of power before the steam engine was invented? Do you know any new ways of power production aside from the steam engine?
2. What is mechanical engineering? List some products of mechanical engineering.

[1] Mechanical engineering is the branch of engineering that deals with machines and the production of power. It is particularly concerned with forces and motion.

History of Mechanical Engineering

[2] The invention of the steam engine in the latter part of the 18th century, providing a key source of power for the Industrial Revolution, gave an enormous impetus to the development of machinery of all types. As a result, a new major classification of engineering, separate from civil engineering and dealing with tools and machines, developed, and received formal recognition in 1847 in the founding of the Institution of Mechanical Engineers in Birmingham, England.

[3] Mechanical engineering has evolved from the practice by the mechanic of an art based largely on trial and error to the application by the professional engineer of the scientific method in research, design, and production.

Mechanical Engineering

Text A

Fields of Mechanical Engineering

4 The high material standard of living in the modern world owes much to the machinery made possible by mechanical engineering. Mechanical engineers continually invent machines to produce goods and develop machine tools of increasing accuracy and complexity to build the machines.

5 The principal lines of development of machinery have been an increase in the speed of operation to obtain high rates of production, improvement in accuracy to obtain quality and economy in the product, and minimization of operating costs. These three requirements have led to the evolution of complex control systems.

6 The most successful production machinery is that the mechanical design of the machine is closely integrated with the control system, whether the latter is mechanical or electrical in nature. Developments are in hand to automate production machinery further, using computers to store and process the vast amount of data required for manufacturing a variety of components with a small number of versatile machine tools. One aim is a completely automated machine shop for batch production, operating on a three-shift basis but attended by a staff for only one shift per day.

7 Production machinery presupposes an ample supply of power. The steam engine provided the first practical means of generating power from heat to augment the old sources of power from muscle, wind, and water. One of the first challenges to the new profession of mechanical engineering was to increase thermal efficiencies and power; this was done principally by the development of the steam turbine and associated large steam boilers. The

20th century has witnessed continued rapid growth in the power output of turbines for driving electric generators, together with a steady increase in thermal efficiency and reduction in capital cost per kilowatt of large power stations. Finally, mechanical engineers acquired the resource of nuclear energy, whose application has demanded an exceptional standard of reliability and safety involving the solution of entirely new problems. The control systems of large power plants and complete nuclear power stations have become highly sophisticated networks of electronic, fluidic, electric, hydraulic, and mechanical components, all of these involving the province of the mechanical engineer.

8 The mechanical engineer is also responsible for the much smaller internal combustion engines, both reciprocating and rotary engines, with their widespread transportation applications. In the transportation field generally, in air and space as well as on land and sea, the mechanical engineer has created the equipment and the power plant, collaborating increasingly with the electrical engineer, especially in the development of suitable control systems.

9 The skills applied to war by the mechanical engineer are similar to those required in civilian applications, though the purpose is to enhance destructive power rather than to raise creative efficiency. The demands of war have channeled huge resources into technical fields, however, and led to developments that have profound benefits in peace. Jet aircraft and nuclear reactors are notable examples.

10 Bioengineering is a relatively new and distinct field of mechanical engineering that includes the provision of machines to replace or augment the functions of the human body and of equipment for use in medical treatment. Artificial limbs have been developed, incorporating such lifelike functions as powered motion and touch feedback.

11 Many of the products of mechanical engineering, together with technological developments in other fields, have side effects on the environment and give rise

to noise, the pollution of water and air, and the dereliction of land and scenery. A rapidly growing field for mechanical engineers and others is environmental control, comprising the development of machines and processes that will produce fewer pollutants and of new equipment and techniques that can reduce or remove the pollution already generated.

Functions of Mechanical Engineering

12 Four functions of the mechanical engineering, common to all the fields mentioned, are cited. The first is the understanding of and dealing with the bases of mechanical science. These include dynamics, concerning the relation between forces and motion, automatic control, and thermodynamics, dealing with the relations among the various forms of heat, energy, power, fluid flow, heat transfer, lubrication, and properties of materials.

13 The second is the sequence of research, design, and development. This function attempts to bring about the changes necessary to meet present and future needs. Such work requires not only a clear understanding of mechanical science and an ability to analyze a complex system, but also the originality to synthesize and invent.

14 The third is the production of products and power, which embraces planning, operation, and maintenance. The goal is to produce the maximum value with the minimum investment and cost while maintaining or enhancing longer-term viability and reputation of the enterprise or the institution.

15 The fourth is the coordinating function of the mechanical engineering, including management, consulting, and, in some cases, marketing.

16 In all of these functions there is a long continuing trend toward the use of scientific instead of traditional or intuitive methods, an aspect of the ever-growing professionalism of mechanical engineering. Operations research, value engineering, and PABLA (problem analysis by logical approach) are

typical titles of such new rationalized approaches. Creativity, however, cannot be rationalized. The ability to take the important and unexpected steps to open up new solutions remains in mechanical engineering.

The Future of Mechanical Engineering

17 The number of mechanical engineers continues to grow as rapidly as ever, while the duration and quality of their training increase. There is a growing awareness, however, among engineers and in the community at large that the exponential increase in population and living standards is raising formidable problems in pollution of the environment and the exhaustion of natural resources; this clearly heightens the need for all of the technical professions to consider the long-term social effects of discoveries and developments.

New words and expressions

impetus *n.* sth. that encourages a particular activity or makes that activity more energetic or effective 推动；促进；刺激

machinery *n.* machines, esp. large ones（尤指大型的）机器，机械

trial and error *n.* 反复试验；试错法

batch production *n.* 成批（间歇）生产

augment *vt.* to increase the size or value of sth. by adding sth. to it 提高；增大；加强

thermal efficiency *n.* 热效率

steam turbine *n.* 汽轮机

hydraulic *adj.* operated by or involving the pressure of water or some other liquid 水压的；液压的

internal combustion engine *n.* 内燃机

power plant *n.* 发电站

side effect *n.* 副作用

dereliction *n.* (esp. of a building) a state of not being cared for（尤指建筑物）荒废，弃置

thermodynamics *n.* 热力学

exponential *adj.* growing or increasing very rapidly 越来越快的

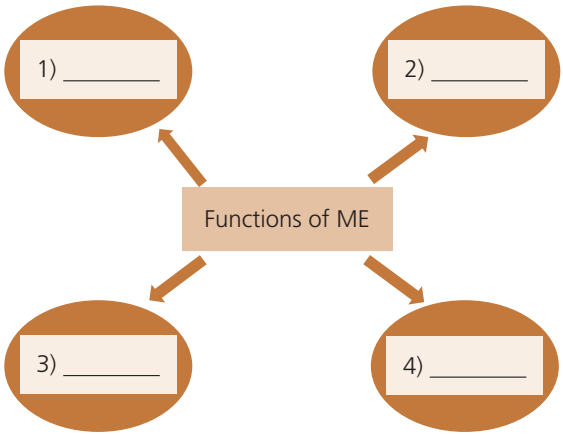
formidable *adj.* causing you to have fear or respect for sth. or sb. because that thing or person is large, powerful, or difficult 可怕的；令人敬畏的；难对付的

Reading comprehension

1 Read Text A to have a general command of the fields of mechanical engineering, list some examples of each field and complete the table.

Field of mechanical engineering	Example
Machines for the production of goods	
Machines for the production of power	
Military weapons	
Bioengineering	
Environmental control	

2 Read Text A, review the functions of mechanical engineering (ME) and complete the diagram.



Language focus

1 Use a term in mechanical engineering to complete each sentence.

1. Heat engines convert heat into work. _____ represents the fraction of heat.
2. _____ refers to **the energy contained within a system that is responsible for its temperature**.
3. _____ equipment or machinery involves or is operated by a fluid that is under pressure, such as water or oil.
4. _____ is the branch of physics that is concerned with the relationship between the action of heat and other types of energy.
5. _____ is a manufacturing process in which items or products are produced in batches.

2 Complete the sentences with the words given below and change the form of the words if necessary.

impetus	**minimization**	**machinery**	**augment**
dereliction	**bioengineering**	**exponential**	**formidable**

1. The workers destroyed _____ in factories in the early 19th century, because they believed it would take away their jobs.
2. A rapidly growing and ever-evolving field of study, _____ combines engineering and the life sciences in ways that advance scientific discovery, healthcare and medicine, manufacturing, agriculture, education and policy.
3. _____ operating costs is one of the major goals of mechanical engineering.
4. Mechanical engineering has many negative effects on the environment. For example, it may bring much noise, and lead to the _____ of land and forest.
5. Technological development in mechanical engineering can greatly replace human labor or _____ the functions of the human body.
6. As long as mechanical engineering technology did not undergo any further radical transformation, the _____ for further changes in the system was not compelling.
7. We are looking for _____ growth in mechanical products.
8. In almost all cases, the cap rock collapsed, which presented a(n) _____ risk factor in antiquity, and deterred us from further testing.

3 **Translate the following paragraph into English.**

在机械工程领域，新产品的研制、设计和开发一向以增加产量、改善经济、提高产品质量为目标。当然，最终目的是最大限度地满足人类的需求。但是，机械工程的快速发展对环境和生态造成了一些破坏。因此，未来机械工程新产品的研制将以降低资源消耗，发展清洁的可再生能源，治理、减轻或消除环境污染为重要任务。

Critical thinking

1 **Some people say that it is machinery that makes people lazy; machines, instead of liberating human's hands, enslave humans by offering all kinds of efficient tools. Do you agree with this viewpoint? And why?**

2 **The development of mechanical engineering benefits us a lot while causing great damage to the ecology in some areas. In terms of environmental protection, what can we do to balance the advantages and disadvantages of mechanical engineering?**

Research task

Academic skill: Searching for information

Information can come from virtually anywhere – media, blogs, personal experiences, books, journals and magazines, expert opinions, encyclopedias, web pages, etc.

1. Information sources

Type	Use
Magazine	• To find information or opinions about popular culture • To find up-to-date information about current events • To find non-scholarly articles about topics of interest within the subject of the magazine
Academic journal	• To get help for your scholarly research • To find out what has been studied on your topic • To find bibliographies that point to other relevant research
Database	• To find articles on specific topics • To find online journals or news articles
Newspaper	• To find editorials, expert or popular opinions, and commentaries • To find local, national or world news
Library catalog	• To find any topic • To find hard copies of current or back issue of journals, books, newspapers or magazines
Website	• To find information from all levels of government – central to local • To find expert or popular opinions • To find information of various types of media, e.g. audio and videos

2. Searching for information

Author/Title search

Searching by author and/or title obviously assumes that you are searching for a particular author, book or article, probably in either a database or a library catalog. Here are some tips:

- When searching by author, put the author's last name first, e.g. "Kotler, Philip", not "Philip Kotler", if he is from an English-speaking country. Sometimes, the author could be an organization, so you enter the full name of the organization as it commonly appears, e.g. "the World Bank".

- When searching by title, it is helpful if you enter the title as correctly as possible.

Keyword search

It is basically a way of searching through a subject or topic. Most library catalogs and databases include an option to search by keyword as an alternative to author and title. The first step of keyword search is to decide the keyword(s). Normally, the keyword(s) which can cover the topic you search can be selected as the keyword(s). A good research topic usually contains two or three concepts. For example, you need to write a paper on "The Impact of Cognitive Styles on Students' Spatial Knowledge". We can break the topic into concepts, like "cognitive styles" and "spatial knowledge", which can be used as keywords. Then type them in a search bar in a database, EBSCOhost, for instance. In a database, there are usually two ways of search, i.e. basic search and advanced search.

Basic search (Fig. 1) generates a large number of sources for you to differentiate, which is an exhausting task. But advanced search (Fig. 2), which provides more choices, can make the work lighter. There are many variables that can be chosen to refine the search. And you can define the relationship between the keywords by choosing "and", "or" or "not" based on the results you intend to obtain.

As "cognitive styles" are a broader topic and "spatial knowledge" is more specific,

Fig. 1: Basic search

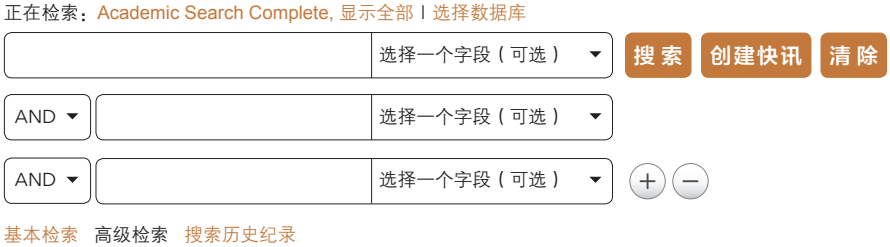


Fig. 2: Advanced search

they can be typed in the upper and middle search bars respectively. More relevant results will appear. You can then refine the search by selecting a specific variable. In this case, "subject" (主题语) can be chosen to filter the results (Fig. 3).

Fig. 3

It is a good way if your topic has a keyword or author. You can trace the citations of that author, using a specialized citation database to obtain other keywords or authors. You will follow the stream of research up to the near present and see the way in which the work or the author has influenced the subsequent studies.

3. Evaluating information

Once you find information that satisfies the requirements of your research, you should evaluate it. Evaluating information encourages you to think critically about the reliability, validity, accuracy, authority, timeliness, point of view or bias of information.

When evaluating information, you can use the five criteria, AAOCC, namely, authority, accuracy, objectivity, currency and coverage. They can be applied to check all information.

1) Authority of information
   - Who published the research paper?

- What institution published it?
- Did the publisher list his or her qualifications?

2) Accuracy of information
   - Who provided it, and can you contact him or her?
   - Does it provide enough details?
   - Has it been cited correctly?
3) Objectivity of information
   - What is the purpose of it?
   - Is it biased?
   - What opinions (if any) are expressed by the author?
4) Currency of information
   - When was it published?
   - When was it updated?
   - How up-to-date is it?
5) Coverage of information
   - Do citations in it complement the research?
   - Is it all text or a balance of text and image?
   - Is it free or is there a fee to obtain it?

Task

As is mentioned in the text, bioengineering is a relatively new and distinct field of mechanical engineering that includes the provision of machines to replace or augment the functions of the human body and of equipment for use in medical treatment. Make use of EBSCO and search more information on the application of mechanical engineering in this specific field with the help of keywords. Then report your findings to the class.

Section B

Reading strategy

Dealing with unknown words (Part I)

The ability to deal with unknown words is a key reading skill in the reading process. It is a vital skill because you are almost certain to find unknown or unfamiliar words in any text. The skill is not necessarily to "know" the words, but to guess the meaning of them so that you can read and understand the whole text. Here are several different ways that can help you guess the meaning of an unknown word.

Guessing by explanation

Sometimes, you find that the meaning of an unfamiliar word is implied in the text. In this case, what you need to do is not stop at the moment when you find an unfamiliar word and keep on reading. Typically, you can get the meaning from the context. For example:

> Kinematics is the study of motion, quite apart from the forces which produce that motion. More particularly, kinematics is the study of position, displacement, rotation, speed, velocity, and acceleration.

Here you should understand the meaning of "kinematics" by reading "the study of motion, quite apart from the forces which produce that motion." And further information is provided in the next sentence, as well.

Guessing by synonym and antonym

This is a very useful skill to learn. What you should do here is look at other words which relate to that word and work out what it may mean. These words may be either synonyms (words with a similar meaning) or antonyms (words with an opposite meaning). For example:

"In the last 30 years, advances in materials science have transformed formerly brittle ceramics into materials tough enough to withstand engine environments."

Here you can work out the meaning of "brittle" by its antonym "tough". All you need to do is to read the rest part of the sentence and infer the meaning of it.

Guessing by common sense and experience

Sometimes, when you come across an unknown word, besides guessing the meaning, you can also ignore the word, especially when the word starts with a capital letter or is in italics, which means that it is in all probability a proper name or a loanword. In this case, you should waste no time in trying to understand the exact meaning of the word. For example:

> History is full of people capable of applying and advancing technology from Archimedes, to Copernicus and Galileo, to Newton, Pascal and numerous other individuals that were the precursors of the Industrial Revolution that completely changed the perspective of technology in everyday life.

Here the word "Pascal" is a word that you should learn to ignore because it starts with a capital letter and is therefore a name of a certain person that may not influence the overall meaning of the sentence.

Task

Read Text B and apply the skills above to deal with the underlined words and phrases.

Text B

Mechanical Engineering in the Information Age

1 To understand mechanical engineering in the Information Age, engineers need to look at changes in the product development process, in engineering design, and in the workforce. They then must examine the implications of these changes for education, research, and the practice of engineering.

2 The most noticeable change in product development is the drastically shorter time allotted to create a successful product. Development cycles for major products have been compressed from six years, which used to be typical for both automobiles and mainframe computers, to less than two years. For other products, the development cycles may be as short as six months. In many cases, most of the product's profit is earned within six months of its release. Being late to market, therefore, means writing off a substantial portion of the anticipated profits, which will place subsequent product development efforts at a financial disadvantage.

3 In the early 1980s, engineers thought that massive research would be needed to speed up product development. But as it turns out, less research is actually needed because shortened product development cycles encourage engineers to use available technology. Developing a revolutionary technology for use in a new product is risky and prone to failure. Taking short steps is a safer and usually more successful approach to product development.

mainframe computer 主机；大型机

4 Shorter product development cycles are also beneficial in an engineering world in which both capital and labor are global. People who can design and manufacture various products can be found anywhere in the world, but containing a new idea is hard. If you have got a short development cycle, the situation is not catastrophic as long as you maintain your lead. But if you are in the midst of a six-year development process and a competitor gets wind of your work, the project could be in more serious trouble.

5 The idea that engineers need to create a new design to solve every problem is quickly becoming obsolete. The first step in the modern design process is to browse the Internet or other information systems to see if someone else has already designed a transmission, or a heat exchanger that is close to what you need. Through these information systems, you may discover that someone already has manufacturing drawings, numerical control (NC) programs, and everything else required to manufacture your product. Engineers can then focus their professional competence on unsolved problems.

6 In tackling such problems, the availability of computers and access to computer networks dramatically enhance the capability of the engineering team and its productivity. These Information Age tools can give the team access to massive databases of material properties, standards, technologies, and successful designs. Such pre-tested designs can be downloaded for direct use or quickly modified to meet specific needs. Remote manufacturing, in which product instructions are sent out over a network, is also possible. You could end up with a virtual company where you don't have to see any hardware. When the product is completed, you can direct the manufacturer to drop-ship it to your customer. Periodic visit to the customer can be made to ensure that the product you designed is working according to the specifications. Although all of these developments won't apply equally to every company, the potential is there.

remote manufacturing 远程制造

7 Custom design used to be left to small companies. Big companies sneered at it because they hated the idea of dealing with niche markets or small-volume custom solutions. "Here is my product," one of the big companies would say. "This is the best we can make; you ought to like it. If you don't, there is a smaller company down the street that will work on your problem."

8 Today, nearly every market is a niche market, because customers are selective. If you ignore the potential for tailoring our product to specific customers' needs, you will lose the major part of your market share, perhaps all of it. Since these niche markets are transient, your company needs to be in a position to respond to them quickly.

9 The emergence of niche markets and design on demand have altered the way engineers conduct research. Today, research is commonly directed toward solving particular problems. Although this situation is probably temporary, much uncommitted technology, developed at government expense or written off by major corporations, is available today at a very low cost. Following modest modifications, such technology can often be used directly in product development, which allows many organizations to avoid the expense of an extensive research effort. Once the technology is free of major obstacles, the research effort can focus on overcoming the barriers to commercialization rather than on pursuing new and interesting, but undefined, alternatives.

10 When viewed in this perspective, engineering research must focus primarily on removing the barriers to rapid commercialization of known technologies. Much of this effort must address quality and reliability concerns, which are foremost in the minds of today's consumers. Clearly, a reputation for poor quality is synonymous with bad business. Everything possible including thorough inspection at the end of the manufacturing line and automatic replacement of

sneer at 嘲笑
niche market 利基市场；小众市场
commercialization 商业化

defective products must be done to assure that the customer receives a properly functioning product.

11 Research has to focus on the cost benefit of factors such as reliability. As reliability increases, manufacturing cost and the final cost of the system will decrease. Having 30 percent junk at the end of the production line not only costs a fortune but also creates an opportunity for a competitor to take your idea and sell it to your customers.

12 Central to the process of improving reliability and lowering costs is the intensive and widespread use of design software, which allows engineers to speed up every stage of the design process. Shortening each stage, however, may not sufficiently reduce the time required for the entire process. Therefore, attention must also be devoted to concurrent engineering software with shared databases that can be accessed by all members of the design team.

13 As we move more fully into the Information Age, success will require that the engineer should possess some unique knowledge of and experience in both the development and the management of technology. Success will require broad knowledge and skills as well as expertise in some key technologies and disciplines; it will require a keen awareness of social and economic factors at work in the marketplace. Increasingly, in the future, routine problems will not justify heavy engineering expenditures, and engineers will be expected to work cooperatively in solving more challenging, more demanding problems in substantially less time. We have begun a new phase in the practice of engineering. It offers great promise and excitement as more and more problem-solving capability is placed in the hands of the computerized and wired engineers. Mechanical engineering is a great profession, and it will become even greater as we make the most of the opportunities offered by the Information Age.

defective 有缺陷的
cost benefit 成本效益