ПРОФЕССИЯ ИНЖЕНЕРА

Task 1

Прочтите тексты, сравните особенности работы инженера и ученого. Составьте список ключевых отличий.

What does an engineers do?

Engineers are grounded in applied sciences, and their work in research and development is distinct from the basic research focus of scientists. The work of engineers forms the link between scientific discoveries and their subsequent.

Relations with other disciplines

There exists an overlap between the sciences and engineering practice; in engineering, one applies science. Both areas of endeavor rely on accurate observation of materials and phenomena. Both use mathematics and classification criteria to analyze and communicate observations.

Scientists may also have to complete engineering tasks, such as designing experimental apparatus or building prototypes. Conversely, in the process of developing technology engineers sometimes find themselves exploring new phenomena, thus becoming, for the moment, scientists.

In the book *What Engineers Know and How They Know It*, Walter Vincenti asserts that engineering research has a character different from that of scientific research. First, it often deals with areas in which the basic physics and/or chemistry are well understood, but the problems themselves are too complex to solve in an exact manner.

VOCABULARY

To be grounded	опираться
Distinct	отчетливый
Discovery	открытие
Subsequent	последующий
Endeavor	усилие
To rely	полагаться
Accurate	точный
Observation	наблюдение
Criteria	критерии
To assert	утверждать
To deal	справиться, иметь дело
To solve	решить

The engineer’s work

As stated by Fung et al. in the revision to the classic engineering text, Foundations of Solid Mechanics:

"Engineering is quite different from science. Scientists try to understand nature. Engineers try to make things that do not exist in nature. Engineers stress invention. To embody an invention the engineer must put his idea in concrete terms, and design something that people can use. That something can be a device, a gadget, a material, a method, a computing program, an innovative experiment, a new solution to a problem, or an improvement on what is existing. Since a design has to be concrete, it must have its geometry, dimensions, and characteristic numbers. Almost all engineers working on new designs find that they do not have all the needed information. Most often, they are limited by insufficient scientific knowledge. Thus they study mathematics, physics, chemistry, biology and mechanics. Often they have to add to the sciences relevant to their profession. Thus engineering sciences are born."

Although engineering solutions make use of scientific principles, engineers must also take into account safety, efficiency, economy, reliability and constructability or ease of fabrication, as well as legal considerations such as patent infringement or liability in the case of failure of the solution.

VOCABULARY

To stress	подчеркнуть
To embody	воплотить
Gadget	гаджет
Improvement	улучшение
Relevant	соответствующая
Reliability	надежность
Patent	патент
Infringement	нарушение
Liability	ответственность
Failure	провал

Task 2

Расставьте в правильном порядке этапы работы над изобретением нового устройства. Последний и первый этапы обозначены.

1. Prototype identified
2. Prototype built in material
3. Version in material built
4. Design modified
5. Patent applied for
6. Models built to test design
7. Prototype modified
8. Prototype tested
9. Design drawn

10.Manufacturer licensed to produce

Task 3

Прочтите текст, выпишите основные этапы работы над изобретением и соотнесите их с теми, что упоминаются в предыдущем упражнении.

Problem solving

Engineers use their knowledge of science, mathematics, logic, economics, and appropriate experience or tacit knowledge to find suitable solutions to a problem. Creating an appropriate mathematical model of a problem allows them to analyze it (sometimes definitively), and to test potential solutions.

Usually multiple reasonable solutions exist, so engineers must evaluate the different design choices on their merits and choose the solution that best meets their requirements. Genrich Altshuller, after gathering statistics on a large number of patents, suggested that compromisesare at the heart of "low-level" engineering designs, while at a higher level the best design is one which eliminates the core contradiction causing the problem.

Engineers typically attempt to predict how well their designs will perform to their specifications prior to full-scale production. They use, among other things: prototypes, scale models, simulations, destructive tests, nondestructive tests, and stress tests. Testing ensures that products will perform as expected.

Engineers take on the responsibility of producing designs that will perform as well as expected and will not cause unintended harm to the public at large. Engineers typically include a factor of safety in their designs to reduce the risk of unexpected failure. However, the greater the safety factor, the less efficient the design may be.

The study of failed products is known as *forensic engineering*, and can help the product designer in evaluating his or her design in the light of real conditions. The discipline is of greatest value after disasters, such as bridge collapses, when careful analysis is needed to establish the cause or causes of the failure.

Design

Engineers develop new technological solutions. During the engineering design process, the responsibilities of the engineer may include defining problems, conducting and narrowing research, analyzing criteria, finding and analyzing solutions, and making decisions. Much of an engineer's time is spent on researching, locating, applying, and transferring information. Indeed, research suggests engineers spend 56% of their time engaged in various different information behaviours, including 14% actively searching for information.

Engineers must weigh different design choices on their merits and choose the solution that best matches the requirements. Their crucial and unique task is to

identify, understand, and interpret the constraints on a design in order to produce a successful result.

Design methods

Engineers apply the sciences of physics and mathematics to find suitable solutions to problems or to make improvements to the status quo. More than ever, engineers are now required to have knowledge of relevant sciences for their design projects. As a result, they may keep on learning new material throughout their career.

If multiple options exist, engineers weigh different design choices on their merits and choose the solution that best matches the requirements. The crucial and unique task of the engineer is to identify, understand, and interpret the constraints on a design in order to produce a successful result. It is usually not enough to build a technically successful product; it must also meet further requirements.

Constraints may include available resources, physical, imaginative or technical limitations, flexibility for future modifications and additions, and other factors, such as requirements for cost, safety, marketability, productibility, and serviceability. By understanding the constraints, engineers derive specifications for the limits within which a viable object or system may be produced and operated.

Analysis

Engineers apply techniques of engineering analysis in testing, production, or maintenance. Analytical engineers may supervise production in factories and elsewhere, determine the causes of a process failure, and test output to maintain quality. They also estimate the time and cost required to complete projects. Supervisory engineers are responsible for major components or entire projects. Engineering analysis involves the application of scientific analytic principles and processes to reveal the properties and state of the system, device or mechanism under study. Engineering analysis proceeds by separating the engineering design into the mechanisms of operation or failure, analyzing or estimating each component of the operation or failure mechanism in isolation, and re-combining the components. They may analyse risk.

Many engineers use computers to produce and analyze designs, to simulate and test how a machine, structure, or system operates, to generate specifications for parts, to monitor the quality of products, and to control the efficiency of processes.

Task 4

Прочтите текст. Используя материал текста, изложите свою точку зрения о необходимости использования различных компьютерных программ в работе инженера.

Computer use

As with all modern scientific and technological endeavors, computers and software play an increasingly important role. As well as the typical business application software there are a number of computer aided applications (Computer-aided technologies) specifically for engineering. Computers can be used to generate models of fundamental physical processes, which can be solved using numerical methods.

One of the most widely used tools in the profession is computer-aided design (CAD) software which enables engineers to create 3D models, 2D drawings, and schematics of their designs. CAD together with Digital mockup (DMU) and CAE software such as finite element method analysis or analytic element method allows engineers to create models of designs that can be analyzed without having to make expensive and time-consuming physical prototypes.

These allow products and components to be checked for flaws; assess fit and assembly; study ergonomics; and to analyze static and dynamic characteristics of systems such as stresses, temperatures, electromagnetic emissions, electrical currents and voltages, digital logic levels, fluid flows, and kinematics. Access and distribution of all this information is generally organized with the use of Product Data Management software.

In recent years the use of computer software to aid the development of goods has collectively come to be known as Product Lifecycle Management (PLM).[22]

Task 5

Прочтите текст и обсудите его содержание. Базируясь на материале текста, сформулируйте свое мнение об ответственности инженера в глазах обществе.

Ethics

Many engineering societies have established codes of practice and codes of ethics to guide members and inform the public at large. Each engineering discipline and professional society maintains a code of ethics, which the members pledge to uphold. Depending on their specializations, engineers may also be governed by specific statute, whistle blowing, product liability laws, and often the principles of business ethics.

Some graduates of engineering programs in North America may be recognized by the Iron Ring or Engineer's Ring, a ring made of iron or stainless steel that is worn on the little finger of the dominant hand. This tradition began in 1925 in Canada with The Ritual of the Calling of an Engineer, where the ring

serves as a symbol and reminder of the engineer's obligations for the engineering profession. In 1972, the practice was adopted by several colleges in the United States including members of the Order of the Engineer.