专业英语系列教材

English
for
Mechanical
Engineering

机械工程专业英语

English for Mechanical Engineering

主 编 李浙昆

华中科技大学出版社
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内 容 提 要

本书是机械工程专业之专业英语教材，内容涵盖了机械、电子、制造、控制等学科领域的基础理论，以及相关现代新兴技术的发展动向。具体内容包括机械零件、互换性与测量技术、电工电子、摩擦与润滑、集成电路、可编程控制器等专业基础知识，以及仿生机械、人工智能、机电控制、机械设计与制造、液压传动、数控技术、机器人技术、计算机辅助设计与制造、增材制造、特种加工、精密加工、绿色制造、微机电系统、纳米技术、超导技术等现代新技术。本教材既可作为机械工程类本科生、专科生和研究生学习专业英语的教材，也可供相关专业工程技术人员学习参考。

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前　言

一般学生在完成大学和研究生阶段的通用英语学习后，对专业科技英语仍较为生疏。为提高机械工程类本科生、专科生、研究生及工程技术人员的专业英语水平，既巩固专业基础知识，又了解机械工程专业中的新知识和新技术，特编写了本教材。

本书是原《机电工程英语》（主编：李浙昆）的修订版。本教材在编写过程中，既兼顾"面"，又注意"点"，力求做到点面结合。全书共分八个部分：第一部分以现代新型技术为引入点，主要介绍了仿生机械、人工智能等基本内容；第二、三部分分别介绍了机械学、机械零件、互换性与测量技术、电工电子、摩擦与润滑、集成电路、可编程控制器等基础内容；第四、五、六部分分别介绍了机电控制、测试、机械设计与制造等的基础与发展，内容涵盖了机械工程专业的主要知识点，同时包括专业发展的趋势和专业前沿的新技术；第七部分介绍了增材制造、特种加工、精密加工、绿色制造等现代先进制造技术；第八部分着重介绍了微机电系统、纳米技术、超导技术等现代新兴技术。教材各个部分既相对独立，又相互支撑，形成了较为完整的体系。教材编写体现了基础知识与专业前沿发展相结合，机械、制造与电工电子学科相结合，以及控制、测试与机构、设计、加工等专业相结合，尤其注重课程教学与自学相结合。各课文附有词汇表、注释、练习，对课文的重点和难点进行了说明，另外，还提供了各部分练习的参考答案，形成了本教材的突出特点。

本教材由32篇课文、17篇阅读材料组成。根据不同教学学时的安排，教学中可以选择部分内容进行课堂教学，部分内容作为课外阅读和自学材料。对于本科生、专科生的教学，可以选择基础性的课文为主，专业前沿的新技术、新知识的课文为辅；对于研究生的教学，可以选择反映专业前沿的新技术、新知识的课文为主。

教材编写过程中得到了昆明理工大学刘忠、任伟、袁锐波、郭瑜、王立华等老师的支持，在此表示衷心感谢！另外，在本教材的编写过程中引用参考了中外学者的著作、教材、文献等，在此表示衷心感谢！

由于水平所限，编写过程中难免有纰漏和欠妥之处，请各位读者不吝赐教，以便改正。

编者

2018年4月

Contents

Part 1

Biomimetics and Intelligentialize

1.1 Biomimetics

Biomimetics can be used in forecasting the future of science, engineering, and medicine. Biomimetics is the study of nature and natural phenomena to understand the principles of underlying mechanisms, to obtain ideas from nature, and to apply concepts that may benefit science, engineering, and medicine.[1] Examples of biomimetic studies include fluid-drag reduction swimsuits inspired by the structure of shark's skin, Velcro fasteners modeled on burrs, shape of airplanes developed from the look of birds, and stable building structures copied from the backbone of turban shells. In this article, we focus on the current research topics in biomimetics and discuss the potential of biomimetics in science, engineering, and medicine. Our report proposes to become a blueprint for accomplishments that can stem from biomimetics in the next 5 years as well as providing insight into their unseen limitations.

If the history of planet Earth was compressed into 1 year, humans would appear in the last 15 minutes of it. Out of those 15 minutes, most recent industrial progress would occur within 1 minute. Despite this small proportion, the industrialization that took place in the last century is much greater than that from the start of mankind. Although the rapid rate of industrialization has helped to prolong life and overcome disease, it has also brought pollution and environmental destruction, which affect human survival itself. In this drift toward industrialization, men have made a continuous effort to create more products that can improve our lives. However, the survival of mankind faces the physical dilemma of living on limited resources. Solutions to the lack of resources and survival problems have not always been clear to us, although the answer can always be found within nature. An interesting method to solve these problems may lie in biomimetics, which uses nature as the ultimate model, standard, and advisor.[2] In recent times, mankind has newly opened its eyes to biomimetic technology, and its efforts are being met with success. This review focuses on recognizing specific examples of biomimetics, their current use, and how they will continue to be used in the future.

The term "biomimetics" originates from the Greek words "bios" (life) and "mimesis" (to imitate), yet its definition is not as simple as just those two words. More specifically, biomimetics is a creative form of technology that uses or imitates nature to improve human lives.

Concept of biomimetics: Biomimetics is not a recent study or trend, but the idea of looking into nature for inspiration has been in practical use for a long time. It has been called by different names such as "intellectual structure" in Japan and "smart material" in the USA. Biomimetics is centered on the idea that there is no model better than nature for developing something new and has produced excellent results in productivity and function. This idea has also opened doors to realistic gains by eliminating waste and saving in research expenses.

Field of biomimetics: Humans have heavily impacted nature with industrialization and resource extraction; however, biomimetics can help to avoid this pattern. Biomimetics goes beyond simply using natural properties as the basis for innovation of new products. Such products can be designed to play a part in general industry as well as to provide human convenience in the fields of chemistry, biology, architecture, engineering, medicine, and biomedical engineering.[3] Such a symbiotic relationship plays a critical role in the coexistence of humans with nature, and the extent of its application can be boundless. It is therefore critical to understand these areas and examples for each of them.

Found easily in everyday life and often used without our knowledge, biomimetics is a broad field with a long history. From knives and axes inspired by the dental structures of currently extinct animals to the strongest cutting-edge carbon nanomaterials, bioengineering has always evolved along with human history.

Leonardo da Vinci's[4] (1452-1519) work is a fundamental example of biomimicry. He designed a "flying machine" inspired by a bird (Figure 1. 1. 1). In the Far East, General Yi Sun-sin[5] built the turtleship (Figure 1. 1. 2), a warship modeled after a turtle, to fight Japanese raiders during invasions. The Wright brothers (1867 - 1948)[6] took note of the wings of eagles and made a powered airplane (Figure 1. 1. 3) that succeeded in human flight for the first time in 1903. Over the next century, the airplane became faster, more stable, and more aerodynamic. Schmitt was the first to coin the term biomimetics in 1957, and he announced a turning point for biology and technology. Jack E Steele of NASA, who coined the word bionics in 1960, was also the first to use the word biomimetics in a paper in 1969, which led to the addition of the term to the dictionary in 1974. In 1997, Janine M Benyus published her book *Biomimicry*, which emphasizes that biomimicry is leading the path to a new age of technological development by taking lessons from nature as the groundwork for products, rather than just using it for raw materials. Janine Benyus and others stepped further to organize a social enterprise called Biomimicry to share ideas and concepts of biomimicry and biomimetics as well as to connect interdisciplinary researchers, scientists, artists, engineers, business leaders, and stakeholders.

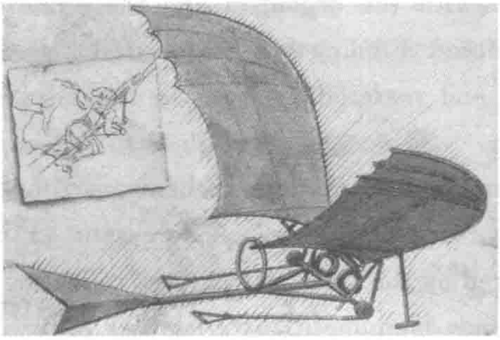

Figure 1. 1. 1 Leonardo da Vinci's "flying machine"

Figure 1. 1. 2 Yi Sun-sin's turtleship

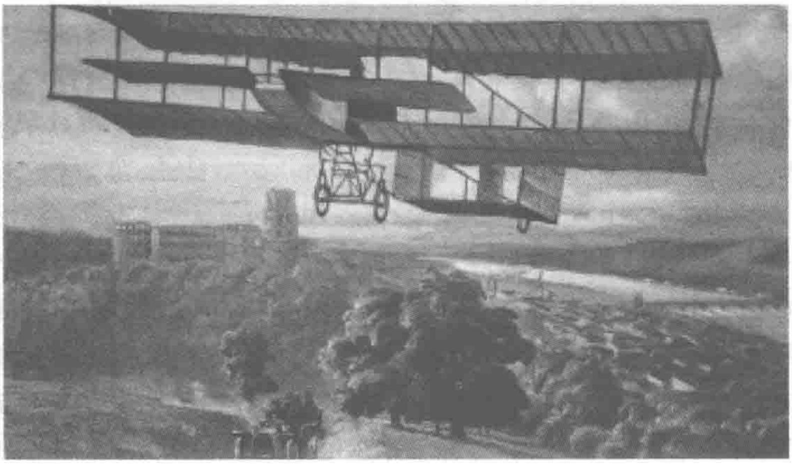

Figure 1. 1. 3 The Wright brothers' powered airplane

Research methods for biomimetics

The basic research method for biomimetics has six steps, which can be used to apply biomimetics to design, product, service, and agriculture.

Like the sticky substance found in geckos' feet, the functional possibilities of biologically inspired design should be researched rather than just applying the design as it is used by the organism. Although the discovery or fusion of innovative technology is crucial for increased profits, a simple creative design idea can provide greater convenience for human life.

The function of the organism, the principles under which that function is achieved, and the relationship between these two must be established. Knowledge and application of various materials need to be accumulated through research and database compilation. The relationship between structure and function usually comes from the surface structure, which can be observed by a scanning electron microscopy technique. These fine structures play an important role in the organism and are said to be the first step for biomimetics. The US researchers are using the Biomimicry Taxonomy as a practical database.

The greatest challenge faced by biomimetics is to determine how nano- and microstructures function in their relationship with the organism and the environment, especially if these have not been fully explored yet. Finding substantial examples through the integration of biology, natural history, and materials science is the next step in biomimetic research.

Identifying various functional and environmental adaptation mechanisms of organisms and their energy-minimizing design is the next research frontier. A successful example of this is the antireflective coating that was inspired by the 200nm structures reflecting visible light rays from a moth's eye. The nature of new biomimetic materials lies in discovering hierarchical structures and their corresponding functions to remodel them into something we can utilize.

The combination of newly discovered materials with biomimetics research will be a key to understanding their applications and limitations. The morphological and functional uses of the new material must first be understood along with the pros and cons of biomimetics, and the results from their combination have to be unraveled. Active research is being performed on these fronts, but making progress in these areas is realistically a difficult pursuit.

The determined biological material's structure and the function become the source of innovation for the development of a new material while possibly providing links to other materials. The structure and function of already known materials go through tests and assessments that help them morph and evolve into new materials. By combining them with current advancements in medicine, chemistry, and nanotechnology, we may find novel utilities that may benefit human life.

Key Words & Expressions

biomimetics *n.* 生体模仿学

fluid-drag 流体阻力

Velcro *n.* 维可牢(一种尼龙搭扣的商标名称)

burr *n.* [机] 毛边,[建] 过火砖 *v.* 从……除去毛刺,在……上形成毛边

backbone *n.* 支柱,主干网,决心,毅力,脊椎

turban shell 蝾螺;蝾螺贝

dilemma *n.* 困境,进退两难,两难境地

mimesis *n.* [生物] 拟态,模仿

extraction *n.* 取出,抽出,拔出,抽出物,出身

symbiotic *a.* [生态] 共生的,共栖的

raider *n.* 袭击者,侵入者

invasion *n.* 入侵,侵略,侵袭,侵犯

bionics *n.* 仿生学

gecko *n.* [脊椎] 壁虎

compilation *n.* 编译,编辑,汇编

taxonomy *n.* 分类学,分类法

substantial *a.* 大量的,实质的,内容充实的 *n.* 本质,重要材料

moth *n.* 蛾,蛀虫

antireflective *a.* [物] 抗反射的,增透的,减反射的

hierarchical *a.* 分层的,等级体系的

morphological *a.* 形态学的

pros and cons 正反两方面，赞成者和反对者

unravel *vt.* 解开，阐明，解决，拆散

vi. 解决，散开

assessment *n.* 评定，估价

morph *vt.* 改变

Notes

[1] Biomimetics is the study of nature and natural phenomena to understand the principles of underlying mechanisms, to obtain ideas from nature, and to apply concepts that may benefit science, engineering, and medicine. 仿生学通过对自然和自然现象的研究，有助于理解底层机制的原理，从自然界获得灵感，并将获得的概念应用于有益于科学、工程和医学的领域。

[2] An interesting method to solve these problems may lie in biomimetics, which uses nature as the ultimate model, standard, and advisor. 解决这些问题的一个有趣的方法是可以基于仿生学，仿生学利用自然作为最终的模型、标准和参谋。

[3] Such products can be designed to play a part in general industry as well as to provide human convenience in the fields of chemistry, biology, architecture, engineering, medicine, and biomedical engineering. 这些产品的设计是为在一般工业中发挥作用，并在化学、生物学、建筑学、工程学、医学和生物医学工程领域为人类提供方便。

[4] Leonardo di ser Piero da Vinci：列奥纳多·迪·皮耶罗·达·芬奇(1452—1519)，毕业于意大利理工学院，欧洲文艺复兴时期的天才科学家、发明家、画家、生物学家。现代学者称他为“文艺复兴时期最完美的代表”，是人类历史上绝无仅有的全才，他最大的成就是绘画，他的杰作《蒙娜丽莎》、《最后的晚餐》、《岩间圣母》等作品，体现了他精湛的艺术造诣。他认为自然中最美的研究对象是人体，人体是大自然的奇妙作品，画家应以人为绘画对象的核心。

[5] Yi Sun-sin：李舜臣(朝鲜王朝著名海军将领，民族英雄)(1545－1598)，字汝谐，本贯德水(今朝鲜黄海北道开丰郡)，生于朝鲜首都汉城(今韩国首尔)。李氏朝鲜时期名将。官至三道水军统制使、全罗道左水使。

[6] Wright Brothers：莱特兄弟是美国著名的科学家，哥哥是威尔伯·莱特(Wilbur Wright，1867—1912)，弟弟是奥维尔·莱特(Orville Wright，1871—1948)。他们是美国的发明家、飞机的制造者。1903 年 12 月 17 日，莱特兄弟首次试飞了完全受控、依靠自身动力、机身比空气重、持续滞空不落地的飞机，也就是“世界上第一架飞机”。

Comprehension Exercises

1. Answer the following questions briefly.

(1) What the future of fields can be used in forecasting by biomimetics?

(2) What means"If the history of planet Earth was compressed into 1 year, humans would appear in the last 15 minutes of it."?

(3) From1957, who coined the term biomimetics?

(4) What are the six steps of the basic research method for biomimetics?

2. Match the items in Column A with their Chinese equivalents in Column B.

A	B
biomimetics	(a)仿生学
fluid-drag	(b)流体阻力
dilemma	(c)评定
mimesis	(d)形态学的
bionics	(e)困境
gecko	(f)蛾
substantial	(g)抗反射的
moth	(h)壁虎
antireflective	(i)实质的
morphological	(j)生体模仿学
pros and cons	(k)正反两方面
unravel	(l)改变
assessment	(m)模仿
morph	(n)解开

1.2 Examples of Biomimetics in Industry

Velcro

The name Velcro, a common hook-and-loop fastener, comes from the French words for velvet, "velour," and hook, "crochet". In the early 1940s, Swiss engineer George de Mastral noticed the tendency of the fruit of the burr (*Xanthium strumarium*) to stick to dog's hair and used a microscope to observe the hooks on the fruit which attach to animal hair. He discovered that an elliptical fruit with a length of 1 cm had densely packed hook-like projections. These latched onto peoples' clothing or animals' hair, allowing seeds to be dispersed widely. Inspired by this burr, de Mastral used nylon to create Velcro fasteners. To enhance adhesive abilities, Velcro consists of a strip with round loops and a strip with burr-like hooks. For its small surface area, Velcro has exceptional adhesive strength and is used extensively as a simple and practical substitute for buttons or hooks in clothing and shoes.[1]

Aircraft

The emergence of airplanes realized the agelong dream of mankind to fly, but it was also a groundbreaking form of transportation. The basic structure of the wings of airplanes consists of a differing sized curved surface on the upper and lower part of the wing that creates hydrodynamic forces explained by the Bernoulli effect. Through this hydrodynamic structure, the velocity of the airstream is faster on the upper part of the wings and slower on the bottom part of the wings. The higher pressure from the bottom of the wings and the speed of the plane enables the 100 ton airplane to fly. This was the principle that led the Wright brothers to succeed in their first flight, but it was also the result of numerous years of biomimetic research on the structure and design of birds' wings and their feathers.[2] Beyond individual birds, a flock of wild geese fly in a V formation, creating an ascending air current allowing those flying behind to fly with less effort. AIRBUS, a French aviation company, uses these principles to design their planes. Furthermore, birds that fly short and long distances have different feathers and shapes. These insights have been used to design airplanes that have to travel shorter and longer distances in a different manner.

Architecture

Biomimicry has the longest history of application in architecture. Previous biomimetic technologies are being used to this day and will be developed further. The most notable example of biomimetic architecture is the6 m-tall termite's nest in the African grasslands. These nests are built from soil, tree bark, sand, and termite saliva, yet they are firmer than concrete.

Termites are extremely sensitive to heat, as they live in groups of over 2 million. Even when the external temperature is as high as 40° C, the nests maintain an internal temperature of 30°C. Although it seems that termites only developed this system due to their sensitivity to external stimuli, it is more effective at maintaining temperature than any ventilation, heating, and cooling systems made by man.[3]

Mike Pearce from Zimbabwe took note of these characteristics of termites' nests and constructed Eastgate Centre, the world's first all-natural cooling structure, in Zimbabwe's capital, Harare. This building has holes on the roof and the lower floors to allow natural ventilation, similar to what a termite's nest does. Hot air exits through the roof, and the influx of the cold air from the bottom ventilates the building. Hence, the energy consumption rate of this building is less than 10%, and an internal temperature of 24°C is maintained even when the external temperature is higher than 38°C.

Furthermore, the Esplanade Theater (Michael Wilford & Partners, DP Architects) in Singapore has a unique exterior that is reminiscent of the eyes of a fly or the surface of a durian fruit. Over 2 000 aluminum projections cover the exterior glass walls, each providing a shade for each glass wall of the greenhouse-shaped Esplanade Theater. As a result, the theater has a unique exterior while being very practical.

Antireflective Coatings

Areflexia is a phenomenon observed in a moth's eyes, which reflect all wavelengths of light beyond the visible light spectrum to block them. The projections on moths' eyes, spaced at intervals of 200 nm, absorb most visible light rays, as they are shorter than most wavelengths of light. The refraction of the light rays entering the eyes is increased, significantly decreasing reflection. This allows the moth to avoid predators and to see prey in the dark. This technology is being used not only for military purposes but also for solar cell light-emitting diodes.

High-strength Carbon Nanotubes

Mussels do not detach easily from rocks even when hit by powerful waves because they have high adhesive strength, which is due to byssi. A byssus pad with a radius of2 mm is capable of lifting weights up to 12.5 kg. The adsorptive power of byssi is greater than any adhesive found in nature. The structure of byssi is composed of the crosslinking of collagen fibers and a protein known as Mefp-1, which is more durable than any fiber.

Cultured carbon nanotube (CNT) fibers and cross-linked macromolecule adhesives acting as collagen and Mefp-1 protein, respectively, led to the development of high-strength CNTs. This led to the innovative development of high-strength CNTs with a significant reduction in thickness from 100 nm to 17.1 nm while creating three times the strength. The properties of byssi have also led to their use in modern medicine to create new ways of stitching wounds and utilizing them in surgery. [4]

Self-healing Concrete Adhesive Supply Pipe

Current research in self-healing concrete focuses on diverse areas of adhesive supply pipes, the inclusion of fibers to provide inherent adhesive properties and to create shape-memory alloys and leavening agents. [5] More recently, progress is being made on self-healing concrete through nanoconstruction materials. In this case, biomineralization technology is used to provide concrete with self-healing abilities. *Sporosarcina pasteurii* uses water, calcium ion, and carbon dioxide (CO_2) in its metabolism and creates calcium carbonate ($CaCO_3$) through calcification. This calcium carbonate fills the gap in the concrete. In addition, the cement complex is augmented with fiber that has a higher elastic modulus and aspect ratio to improve the tension and metamorphosis.

Robots

Biomimetic technology is currently being used in various fields such as design, agriculture, chemistry, medicine, and material science. It has also been incorporated in robotics research, giving rise to a novel field of biomimetic robotics. The motor mechanisms of animals and insects are being imitated, which has a significant influence on the motility of the machine, previously limited by wheels. In 1998, Dr Robert Full researched the mechanisms of cockroach legs to make a RHex (Figure 1.2.1) with robotic legs and feet that overcomes the limitation of wheels. At Carnegie Mellon University, Dr Howie Choset is developing robotic arms that apply the mechanisms of bones and joints of a snake (Figure 1.2.2) and an elephant's trunk. Moreover, Dr Robert Full and Dr Fon Fearing developed an iRobot sensitive to pressure and therefore capable of effective dry adhesion, inspired by the microhairs on the soles of a gecko.

Figure 1.2.1 Image of RHex

Figure 1.2.2 Image of the snake robots

Current Market Size of Biomimetics

In Europe, Japan, and the USA, biomimetics is being recognized as the technology of the future and there is increasing interest and funding. In particular, global companies such as Ford, General Electric, Herman Miller, HP, IBM, and Nike are collaborating with scientists and designing laboratories to explore novel technologies.

Between 2005 and 2008, the market size for products and construction projects that applied biomimetics was estimated to be above \$1.5 billion. By 2025, industry analysts project that products and services in biomimicry will increase to \$1 trillion in market size. In the US alone, it is expected to have a \$35 billion market with over 1.6 million new job opportunities.

Key Words & Expressions

Velcro *n.* 维可牢(一种尼龙搭扣的商标名称)

velvet *n.* 天鹅绒,丝绒,天鹅绒似的东西 *a.* 天鹅绒的

velour *n.* 丝绒,天鹅绒

crochet *n.* 钩边,钩针编织品 vt. 用钩针编织 vi. 用钩针编织

burr *n.* 苍耳

elliptical *a.* 椭圆的

latch *vi.* 占有,抓住,闭锁 *vt.* 闩上,纠缠住某人 *n.* 门闩

ascend *vi.* 上升,登高,追溯 *vt.* 攀登,上升

insight *n.* 洞察力,洞悉

termite *n.* [昆] 白蚁

saliva *n.* 唾液,涎

stimulus *n.* 刺激,激励,刺激物

ventilation *n.* 通风设备,空气流通

Harare *n.* 哈拉雷(津巴布韦首都)

influx *n.* 流入,汇集,河流的汇集处

reminiscent n. 回忆录作者,回忆者 a. 怀旧的,回忆往事的,耽于回想的

durian n. 榴莲果,榴莲树

areflexia n. [医] 防辐射,反射消失

predator n. [动] 捕食者,[动] 食肉动物,掠夺者

light-emitting diodes 发光二极管

mussel n. 蚌,贻贝,淡菜

detach vt. 分离,派遣

byssi n. (贝类的)足丝

crosslink vt. 交链作用,交叉连接

collagen n. [生化] 胶原,胶原质

protein n. 蛋白质,朊

macromolecule n. [高分子]高分子,[化学] 大分子

self-healing a. 自我修复的

leaven n. 酵母,酵素 vt. 使发酵,影响

Sporosarcina pasteurii 八叠球菌,芽孢杆菌

metabolism n. [生理] 新陈代谢

calcification n. 钙化,石灰化

metamorphosis n. 变形,变质

cockroach n. [昆] 蟑螂

sole n. 鞋底,脚底,基础,鳎目鱼 a. 唯一的,单独的,有的

gecko n. 壁虎,壁虎科

global a. 全球的,总体的. 球形的

trillion n. [数] 万亿

Notes

[1] For its small surface area, Velcro has exceptional adhesive strength and is used extensively as a simple and practical substitute for buttons or hooks in clothing and shoes. 由于它的表面积小,维可牢具有优异的黏合强度,同时作为纽扣或挂扣简单实用的替代品被广泛地应用于服装和鞋子中。

[2] This was the principle that led the Wright brothers to succeed in their first flight, but it was also the result of numerous years of biomimetic research on the structure and design of birds' wings and their feathers. 正是这个原理使得莱特兄弟在首次飞行中获得成功,且这也是多年仿生研究鸟类翅膀和羽毛结构和构造的结果。

[3] Although it seems that termites only developed this system due to their sensitivity to external stimuli, it is more effective at maintaining temperature than any ventilation, heating, and cooling systems made by man. 虽然白蚁似乎只是因为对外界刺激的敏感而开发了这种系统,但在维持温度方面它比任何人工的通风、加热和冷却系统更有效。

[4] The properties of byssi have also led to their use in modern medicine to create new ways of stitching wounds and utilizing them in surgery. 贝类足丝的特性也促成了它们在现代医学中的应用,由此产生了缝合伤口的新方法并将其应用到了外科手术中。

[5] Current research in self-healing concrete focuses on diverse areas of adhesive supply pipes, the inclusion of fibers to provide inherent adhesive properties and to create shape-memory alloys and leavening agents. 目前关于自修复混凝土的研究主要集中在供水管道黏合剂的各个方面,包括提供固有黏合性能的纤维以及形成形状记忆合金和膨松剂。

Comprehension Exercises

1. Answer the following questions briefly.

(1) Whatis the Velcro?

(2) When and who invented the Velcro?

(3) Why an airplane can fly?

(4) What are the two examples of using Biomimicry in Architecture in the text?

(5) Areflexia is a phenomenon observed in a moth's eyes, what famous field this technology is being used in except military purposes?

(6) Which fields the biomimetic technology is currently being used in?

(7) Which countries and areas the biomimetics is being recognized as the technology of the future and there is increasing interest and funding in the text?

(8) By 2025, industry analysts project that products and services in biomimicry, how much money will increase to?

2. Match the items in Column A with their Chinese equivalents in Column B.

A	B
Velcro	(a)苍耳
burr	(b)洞察力
latch	(c) 空气流通
insight	(d)足丝
termite	(e)酵母
saliva	(f)发光二极管
ventilation	(g)贻贝
durian	(h)抓住
light-emitting diodes	(i)蟑螂
mussel	(j)维可牢
byssi	(k)白蚁
leaven	(l)唾液
cockroach	(m)万亿
gecko	(n)榴莲果
trillion	(o) 壁虎