机电一体化概论

英语文选

INTRODUCTION TO MECHATRONICS ENGLISH READINGS

朱超甫

北京理工大学出版社

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内 容 简 介

本书包括16篇文章，其主要内容是：机电一体化的基本概念和优点，机电一体化系统的组成部分，数控技术及其应用，机器人，计算机辅助制造，柔性制造系统，计算机集成制造，计算机辅助设计与制造等。

每篇文章之后，除生词表外，还对专业术语、有关专业技术问题以及复杂句和难译句，均作了较详尽的注释。本书既可作为高校机电一体化专业高年级本科生和研究生的专业英语阅读教材，也可供工程技术人员和其它有关专业的学生作为机电一体化技术的入门读物。

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前　言

“机电一体化”是一门新兴的学科，近年来在我国技术界受到普遍的重视，并且在其推广和应用方面取得了可喜的进展。目前，国内许多大专院校已设立了机电一体化专业，在研究生、本科生和专科生等不同层次上进行人材培养。编者为满足机电一体化专业英语教学的需要，编写了这本教材。经过北京科技大学机电一体化专业本科生和硕士研究生试用两年，反映良好。现经修订，由北京理工大学出版社出版。

全书共选了 16 篇文章，主要介绍了机电一体化的基本概念和优点、机电一体化系统的组成部分、数控技术及其应用、机器人、计算机辅助制造、柔性制造系统、计算机集成制造、计算机辅助设计与制造等有关内容。

本书除了适合作为高等学校有关专业的教材外，主要还有以下特点：

1. 可作为机电一体化技术的入门读物

所选文章从宏观上对机电一体化技术进行概括性的介绍，使读者对机电一体化技术的全貌有一基本了解。

书中对专业词汇和术语、有关专业技术问题作了较详尽的注释，读者通过阅读本书可以学到机电一体化技术的初步专业知识。在当前机电一体化技术的专业书籍不太丰富的条件下，本书不失为一本机电一体化技术的入门读物。

2. 适于自学，有助于提高阅读英语科技文献的能力

每篇文章之后有较详尽的词汇表，并对文章中的一些语法现象、复杂的句子结构和难译的句子作了注释。在对难译句的翻译注释中，既遵照英文的原意和风格，也考虑到汉语表达的习惯，以便为读者准确理解原文和学习翻译方法提供参考。因此，本书适于具有一定英语基础的读者自学之用；同时，对高校学生来说，有助于提高他们阅读科技文献的能力。

3. 编有总词汇表，便于复习记忆

在本书最后部分，编写了总词汇表，便于读者查阅某些在书中多次出现的不常用词汇。并且，同根的派生词、多义词、术语、词组等汇总在一起，便于联想记录。另外，在总词汇表中，每个单词、术语或缩略词都注明其出现于某篇文章的序号，可为读者提供以下便利条件：

(1) 可比较多义词在不同文章内的用法；

(2) 查找术语或专业词汇注释的出处。

本书既可作为高等学校机电一体化专业高年级本科生和研究生的专业英语阅读教材，也可供工程技术人员和其它专业的学生作为自学教材或作为机电一体化技术的入门读物。

由于编者水平所限，书中存在缺点和错误，欢迎批评指正。

编　者

一九九六年元月

Contents

1. What Is "Mechatronics"?

"Mechatronics" is a term coined by the Japanese to describe the integration of mechanical and electronic engineering. ① The concept may seem to be anything but new, since we can all look around us and see a myriad of products that utilize both mechanical and electronic disciplines. ② Mechatronics, however, specifically refers to a multidisciplined, integrated approach to product and manufacturing system design. ③ It represents the next generation of machines, robots, and smart mechanisms necessary for carrying out work in a variety of environments —primarily, factory automation, office automation, and home automation as shown in Figure 1. ④

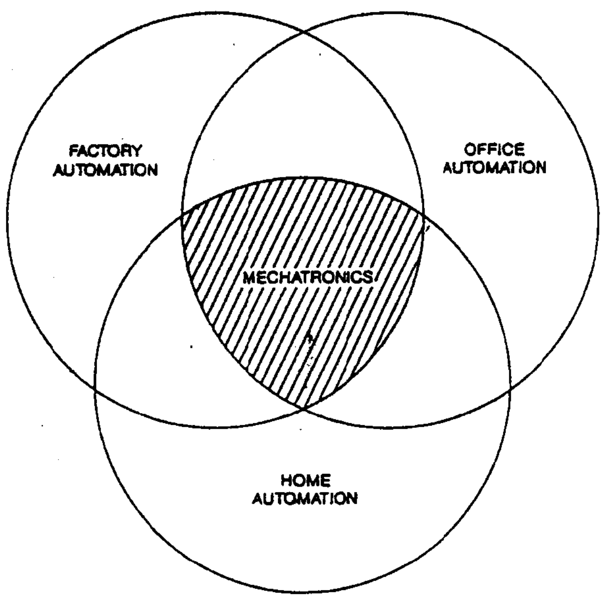

Figure 1. Mechatronic Environments.

By both implication and application, mechatronics represents a new level of integration for advanced manufacturing technology and processes. The intent is to force a multidisciplinary approach to these systems as well as to reemphasize the role of process understanding and control. This mechatronic approach is currently speeding up the already-rapid Japanese process for transforming ideas into products. ⑤

Currently, **mechatronics describes the Japanese practice of using fully integrated teams of product designers, manufacturing, purchasing, and marketing personnel acting in concert with each other to design both the product and the manufacturing system.** ⑥

The Japanese recognized that the future in production innovation would belong to those who learned how to optimize the marriage between electronic and mechanical systems. ⑦ They realized, in particular, that the need for this optimization would be most intense in application of advanced manufacturing and production systems where artificial intelligence, expert systems, smart robots, and advanced manufacturing technology systems would create the next generation of tools to be used in the factory of the future. ⑧

From the very beginnings of recorded time, mechanical systems have found their way into every aspect of our society. ⑨ Our simplest mechanisms, such as gears, pulleys, springs, and wheels, have provided the basis for our tools. Our electronics technology, on the other hand, is completely twentieth-century, all of it created within the past 75 years. ⑩.

Until now, electronics were included to enhance mechanical systems' performance, but the emphasis remained on the mechanical product. There had never been any master plan on how the integration would be done. ⑪ In the past, it had been done on a case-by-case basis. ⑫ More recently, however, because of the overwhelming advances in the world of electronics and its capability to physically simplify mechanical configurations, the technical community began to reassess the marriage between these two disciplines.

The most obvious trend in the direction of mechatronic innovation can be observed in the automobile industry. There was a time when a car was primarily a mechanical marvel with a few electronic appendages.

First came the starter motor, and then the generator, each making the original product a bit better than it was before. ⑬ Then came solid-state electronics, and suddenly the mechanical marvel became an electro-mechanical marvel. ⑭ Today's machine is controlled by microprocessors, built by robots, and fault-analyzed by a computer connected to its "external interface connector". ⑮ Automotive mechanical engineers are no longer the masters of their creations.

The process that describes the evolution of the automobile is somewhat typical of other products in our society.[16] Electronics has repeatedly improved the performance of mechanical systems, but that innovation has been more by serendipity than by design.[17] And that is the essence of **mechatronics — the preplanned application of, and the efficient integration of, mechanical and electronics technology to create an optimum product.**[18]

A recent U. S. Department of Commerce report entitled "*JTECH Panel Report on Mechatronics in Japan*" compared U. S. and Japanese research and development trends in specific areas of mechatronics technology.[19] Except for a few areas, the technology necessary to accomplish the development of the next generation of systems embodying the principles of mechatronics is fully within the technological reach of the Japanese.[20]

Comparisons were made in three categories: basic research, advanced development, and product implementation.[21] Except for machine vision and software, Japanese basic research was comparable to the United States, with the Japanese closing in fast on macchine vision system technology.[22] Japanese artificial intelligence research is falling behind, primarily because the Japanese do not consider it an essential ingredient of their future systems, they appear capable of closing even that gap, if required. In the advanced development and product implementation areas, Japan is equal to or better than the United States, and is continuing to pull ahead at this time.

The Department of Commerce report concluded that Japan is maintaining its position and is in some cases gaining ground over the United States in the application of mechatronics.[23] Their progress in mechatronics is important because it addresses the very means for the next generation of data-driven advanced design and manufacturing technology.[24] In fact, the Department of Commerce report concludes that this has created a regenerative effect on Japan's manufacturing industries.

To close the gap, we will need to go much further than creating new tools. If we accept the fact that mechanical systems optimally coupled with electronics components will be the wave of the future, then we must also understand that the ripple effect will be felt all the way back to the university, where we now keep the two disciplines of mechanics and electronics separated and allow them to meet only in occasional overview sessions.[25] New curricula must be created for a new hybrid engineer — a mechatronics engineer. Only then can we be assured that future generations of product designers and manufacturing engineers will fully seek excellence in these new techniques.

We need to rethink our present-day approach of separating our engineering staffs both from each other and from the production engineers. [26] Living together and communicating individual knowledge will create a new synergistic effect on products. Maximum interaction will be the key to optimum designs and new product development. [27]

The definition of mechatronics is much more significant than its combined words imply. It can physically turn engineering and manufacturing upside down. [28] It will change the way we design and produce the next generation of high technology products. [29] The nation that fully implements the rudiments of mechatronics and vigorously pursues it will lead the world to a new generation of technology innovation with all its profound implications. [30]

New Words and Expressions

mechatronics [mi'kætrɔniks] *n.* 机械电子学,机电一体化

term [təːm] *n.* 术语

coin [kɔin] *v.* 创造(新词)

integration [intig'reiʃən] *n.* 结合,一体化

discipline ['disiplin] *n.* 学科

multidisciplined [ˌmʌlti'disiplind] *adj.* 多学科的

integrate ['intigreit] *v.* 使一体化,使结合

generation [dʒenə'reiʃən] *n.* (一)代

robot ['rɔbət] *n.* 机器人

smart [smɑːt] *adj.* 灵敏的,灵巧的

implication [impli'keiʃən] *n.* 含义;本质

process ['prəusis] *n.* 工艺(技术),工艺过程;过程;*v.* 加工,处理

multidisciplinary [ˌmʌlti'disiplinəri] *adj.* 包括多种学科的

reemphasize [ri'emfəsaiz] *v.* 反复强调

team [tiːm] *n.* 队,组

purchase ['pəːtʃəs] *v.* 购买,采购

market *v.* 销售

personnel [pəːsə'nel] *n.* (全体)人员,班底

innovation [inəu'veiʃən] *n.* 改革,革新

optimize ['ɔptimaiz] *v.* 使最佳化

marriage ['mæridʒ] *n.* 结合;结婚

optimization [ɔptimi'zeiʃən] *n.* 优化

intense [in'tens] *adj.* 紧张的,强烈的

enhance [in'hɑːns] *v.* 增强,提高

performance [pə'fɔːməns] *n.* 性能,特性

emphasis ['emfəsis] *n.* 显著(性)

overwhelming [əuvə'hwelmiŋ] *adj.* 压倒的,不可抵抗的

physically ['fizikəli] *adv.* 实际上

simplify ['simplifai] *v.* 简化

configuration [kənfigju'reiʃən] *n.* 结构;外形

community [kə'mjuːniti] *n.* 团体;界

reassess ['riːə'ses] *v.* 对…再评价

automobile ['ɔːtəməbil] *n.* 汽车

marvel [ˈmaːvəl] *n.* 奇迹
appendage [əˈpendidʒ] *n.* 附件
starter [ˈstaːtə] *n.* 起动器
generator [ˈdʒenəreitə] *n.* 发电机
microprocessor [ˈmaikrəprəusisə] *n.* 微处理器
interface [ˈintəfeis] *n.* 接口
connector [kəˈnektə] *n.* 连接器
automotive [ɔːtəˈməutiv] *adj.* 汽车的
creation [kriːˈeiʃən] *n.* 创造物
evolution [iːvəˈluːʃən] *n.* 发展,进展
repeatedly [riˈpiːtidli] *adv.* 反复地,再三地
serendipity [serənˈdipiti] *n.* 善于发掘新奇事物的才能
essence [ˈesns] *n.* 精华;本质
preplan [priːˈplæn] *v.* 预先计划,规划
commerce [ˈkɔməːs] *n.* 贸易,商业
panel [pænl] *n.* 小组,委员会
embody [imˈbɔdi] *v.* 具体化
comparison [kəmˈpærisn] *n.* 比较,对照
implementation [implimenˈteiʃən] *n.* 实现
software [ˈsɔftwɛə] *n.* 软件
ingredient [ingˈriːdiənt] *n.* 组成部分,要素
gap [gæp] *n.* 差距;间隙
regenerative [riˈdʒenəritiv] *adj.* 正反馈的
optimally [ˈɔptiməli] *adv.* 最佳地,最恰当地
ripple [ripl] *n.* 微波,涟漪
overview [ˈəuvəvjuː] *n.* 综述,概述
session [ˈseʃən] *n.* 上课时间;学期
curriculum [kəˈrikjuləm] (*pl.* **curricula** [kəˈrikjulə] *n.* 课程,课程表
hybrid [ˈhaibrid] *adj.* 混合的
seek [siːk] *v.* 寻找,探寻
staff [staːf] *n.* (全体)工作人员
communicate [kəˈmjuːnikeit] *v.* 连通;互通
synergistic [sinəˈdʒistik] *adj.* 叠加的,复合的
interaction [intərˈækʃən] *n.* 相互作用,相互影响
implement [ˈimplimənt] *v.* 实现;提供方法
rudiment [ˈruːdimənt] *n.* (*pl.*) 基础,入门
vigorously [ˈvigərəsli] *adv.* 强有力地
pursue [pəˈsjuː] *v.* 推行,贯彻
profound [prəˈfaund] *adj.* 意义深远的

Notes

① "Mechatronics" is a term:…engineering.("机电一体化"是日本人新造的术语,用来描述机械工程与电子工程的结合。)

"Mechatronics"这一术语于七十年代被日本人首先使用,他们用英语 Mechanics(机械学)的前半部和 Electronics(电子学)的后半部组合成这个英语新名词。

从这个组合词的构成来说,表达了"机械电子学"的意义。同时,由于日本人用日语汉字"機電一体化"来表示这个组合词,因此在中文中常把这个词译为"机电一体化"。

需要强调的是,Mechatronics 表达的是"机械与(微)电子技术一体化"的新概念,而不

是机械与电气的一体化。

目前，国内外对“机电一体化”尚无统一的定义，较为被人们所接受的是“日本机械振兴协会”的解释：“机电一体化是在机械的主动能、动力功能、信息功能和控制功能上引进微电子技术，并将机械装置与电子装置用相关软件有机结合而构成系统的总称。”

机电一体化技术是一门新兴的综合性技术，它在技术上并没有什么新发明或新发现，而主要地是把机械、电子、信息等有关技术综合应用。因此，机电一体化是一门跨学科的边缘学科，是在信息论、控制论和系统论基础上建立起来的应用学科。关于上述论点可从以下几个方面去理解：

1. 机电一体化技术实际上是由机械学、电子学、计算机技术组合而成。

2. 采用计算机后，可以很容易地实现大量信息的采集、传输和处理。

3. 通过电子技术和计算机技术，易于实现对设备或系统的控制。

4. 为获得最佳的机电一体化技术的效果，应从系统观点出发，把机械部分和电子、计算机部分融合在一起，通盘考虑。

机电一体化技术主要包括机电一体化产品和机电一体化系统。

典型的机电一体化产品有数控机床、机器人、电子化的照相机、传真机、复印机、录相机、磁盘驱动器、按键式电话机等。

典型的机电一体化系统主要用于机械制造行业，例如计算机辅助设计与制造(CAD/CAM)系统、柔性制造系统(FMS)和计算机集成制造系统(CIMS)等。

② but：*prep.* 除…外；a myriad of：无数的，数不清的。

③ Mechatronics，…system design.（然而，机电一体化特别指的是多学科相结合的产品设计和制造系统设计的方法。）

approach to ＋*n.*：(做某事的)方法。

④ the next generation of：下一代的；necessary for：…所需的；factory automation：工厂自动化；office automation：办公自动化；home automation：家庭自动化。

⑤ speed up：使加速。

⑥ Currently，…the manufacturing system.（目前，机电一体化阐述了日本人使用充分结合的队伍的实践，这一队伍包括产品设计者、制造人员、采购人员和销售人员，他们相互一致行动，既设计产品又设计制造系统。）

acting in concert with (同…一致行动)是现在分词短语修饰 personnels；manufacturing personnel：制造人员；purchasing personnel：采购人员；marketing personnel：销售人员。to design…是不定式短语，作状语，修饰 acting。

⑦ The Japanese…Systems.（日本人承认，在生产革命中未来将属于知道怎样使电子系统和机械系统之间结合得最好的人们。）

learn：*v.* 知道，认识到。

⑧ need for…：…的需要；artificial intelligence：人工智能；expert system：专家系统；smart robot：灵巧机器人。

⑨ very *adj.* 用来加强名词的语气，可译作“正…”；find one's way into：达到，设法赶到。

⑩ century＝centennial：*adj.* 百年的，世纪的。

⑪ master plan：总体规划；on：关于。

⑫ case-by-case：就事论事。

⑬ First came the starter motor（首先出现的是起动器马达）这是表示强调的倒装结构；and then the generator（然后出现的是发电机）是倒装＋省略谓语动词 came 的结构；come：*v.* 这里当"出现"讲；each making…it was before 是分词独立结构。

⑭ solid-state：（1）泛指半导体材料；（2）指"固态电路"——由集成块、晶体管和二极管组成的整体电路，其特点是可靠性好。

⑮ Today's machine…creations. 全句由三个并列句组成，主语都是 Today's machine，谓语分别是 is controlled，（is）built，（is）fault-analyzed。fault-analyze：故障分析；external interface connector：外接口连接器。

⑯ be typical of…：是…的典型

⑰ Electronics…than by design.（电子技术已再三地改善了机械系统的性能，但这个革新与其说是依靠设计，不如说是依靠善于创新的才能。）

by：依靠；more M than N：与其说是 N，不如说是 M；serendipity 是英国的一位作家所造的词，原意是"偶然发现珍贵物品的才能"。

⑱ And that…optimum product：这是机电一体化的精华——机械技术和电子技术预先计划应用和有效结合以创造一种最佳的产品。

⑲ U. S. Department of Commerce：美国贸易部；JTECH Panel 是 Japanese Technology Evaluation Program Panel（日本技术评价规划委员会）的缩略语。

⑳ Except for … the Japanese. 这句话直译为："除少数领域外，完成使机电一体化的原理具体化的下一代系统的研制所必需的技术完全在日本人技术上所能及的范围之内。"意思是说："日本人在技术上完全能够研制出下一代系统，使机电一体化原理具体化。"

necessary to＋*inf.*：（做）…所需的；development：*n.* 研制；reach：*n.* 能所及的范围

㉑ basic research：基础研究；advanced development：试制样品；product implementation：产品实现。

㉒ with the Japanese closing in fast on machine vision system technology.（日本人在机器视觉系统技术方面迅速接近。）是分词独立结构作状语，附加说明情况。

close in：靠近，接近。

machine vision：机器视觉——系统通过传感、物体识别、图象分析和解释来确定物体之方位和形状的能力，称为机器视觉。

㉓ gain ground：占优势；over：*prep.* 胜过，优于。

㉔ address：*v.* 指引，引导；very：*adj.* 真正的；data-driven：以数据为主导的。

㉕ If we … overview session.（如果我们接受与电子元件最佳结合的机械系统将是未来的浪潮这一事实，那么我们也一定能理解这波纹效应一直到大学都能感觉到。在大学里，我们把机械学和电子学这两门学科分离，而且仅在偶然的综述性课程中允许二者相遇。）

must：*v.* 一定；all the way：一直。

㉖ present-day：*adj.* 现在的，现代的；separate M from N：使 M 与 N 分离。

㉗ key to …：…的关键。

㉘ turn … upside down：把…完全颠倒，扰乱。

engineering：*n.* 工程，工程技术——是把理论转变为实际应用的环节称为"工程"。

㉙ It will change the way 后面的 we design and …是定语从句，其关联词是 in which，常可省略。

㉚ The nation … profound implication：充分为机电一体化提供基础，并强有力地推行机电一体化的国家将把世界导向一场具有深远意义的新一代技术革命。

2. Benefits of Mechatronics

Mechatronics may sound like utopia to many product and manufacturing managers because it is often presented as the solution to nearly all of the problems in manufacturing. In particular, it promises to increase productivity in the factory dramatically. Design changes are easy with extensive use of mechatronic elements such as CAD; CAP and MIS systems help in scheduling; and flexible manufacturing systems, computer-aided design, and computer-integrated manufacturing equipment cut turnaround time for manufacturing. ① These subsystems minimize production costs and greatly increase equipment utilization. Connections from CAE, CAD, and CAM help create designs that are economical to manufacture; control and communications are improved, with minimal paper flow; and CAM equipment minimizes time loss due to setup and materials handling. ②

Many companies that make extensive use of computers view their factories as examples of mechatronic concepts, but on close examination their integration is horizontal—in the manufacturing area only—or at best includes primarily manufacturing and management. ③ General Electric, as part of its effort to become a major vendor of factory automation systems, has embarked on ambitious plans for integration at several of its factories, including its Erie Locomotive Plant, its Schenectady Steam Turbine Plant, and its Charlottesville Controls Manufacturing Division. ④ The primary benefits of mechatronics, with an emphasis on advanced manufacturing technology and factory automation, are summarized below. ⑤

High Capital Equipment Utilization

Typically, the throughput for a set of machines in a mechatronics system will be up to three times that for the same machines in a stand-alone job shop environment. ⑥ The mechatronic system achieves high efficiency by having the computer schedule every part to a machine as soon as it is free, simultaneously moving the part on the automated material handling system and downloading the appropriate computer program to the machine. ⑦ In addition, the part arrives at a machine already fixtured on a pallet (this is done at a separate work station) so that the machine does not have to wait while the part is set up. [8]

Reduced Capital Equipment Costs

The high utilization of equipment results in the need for fewer machines in the mechatronic system to do the same work load as in a conventional system. [9] Reductions of 3:1 are common when replacing machining centers in a job-shop situation with a mechatronic system. [10]

Reduced Direct Labor Costs

Since each machine is completely under computer control, full-time oversight is not required. Direct labor can be reduced to the less skilled personnel who fixture and defixture the parts at the work station, and a machinist to oversee or repair the work stations, plus the system supervisor. [11] While the fixturing personnel in mechatronic environments require less advanced skills than corresponding workers in conventional factories, labor cost reduction is somewhat offset by the need for computing and other skills which may not be required in traditional workplaces.

Reduced Work-in-Process Inventory and Lead Time[12]

The reduction of work-in-process in a mechatronic system is quite dramatic when compared to a job-shop environment. Reductions of 80 percent have been reported at some installations and may be attributed to a variety of factors which reduce the time a part waits for metal-cutting operations. These factors include concentration of all the equipment required to produce part into a small area; reduction in the number of fixtures required; reduction in the number of machines a part must travel through because processes are combined in work cells; and efficient computer scheduling of parts batched into and within the mechatronic system. [13]

Responsiveness to Changing Production Requirements

A mechatronic system has the inherent flexibility to manufacture different products as the demands of the marketplace change or as engineering design changes are introduced. Furthermore, required spare part production can be mixed into regular runs without significantly disrupting the normal mechatronic system production activities. [14]

Ability to Maintain Production

Many mechatronic systems are designed to degrade gracefully when one or more machines fail. This is accomplished by incorporating redundant machining capability and a material handling system that allows failed machines to be bypassed. Thus, throughput is maintained at a reduced rate.

High Product Quality

A sometimes-overlooked advantage of a mechatronic system, especially when compared to machines that have not been federated into a cooperative system, is improved product quality. The basic integration of product design characteristics with production capability, the high level of automation, the reduction in the number of fixtures and the number of machines visited, better designed permanent fixtures, and greater attention to part/machine alignment all result in good individual part quality and excellent consistency from one workpiece to another, further resulting in greatly reduced costs of rework. [15]

Operational Flexibility

Operational flexibility offers a significant increment of enhanced productivity. In some facilities, mechatronic systems can run virtually unattended during the second and third shifts. [16] This nearly "unmanned" mode of operation is currently the exception rather than the rule. [17] It should, however, become increasingly common as better sensors and computer controls are developed to detect and handle unanticipated problems such as tool breakages and part-flow jams. [18] In this operational mode, inspection, fixturing, and maintenance can be performed during the first shift.

Capacity Flexibility

With correct planning for available floor space, a mechatronics system can be designed for low production volumes initially; as demand increases, new machines can be added easily to provide the extra capacity required. [19]

New Words and Expressions

sound [saund] *v.* 听起来

utopia [juːˈtəupiə] *n.* 乌托邦,理想的完

美境界

promise [ˈprɔmis] *v.* 有…可能

dramatically [drəˈmætikəli] *adv.* 显著地

element *n.* 组成部分

scheduling [ˈʃedjuːliŋ] *n.* 编制进度

cut *v.* 削减

turnaround [ˈtəːnəraund] *n.* 工作周期

subsystem [ˈsʌbsistim] *n.* 子系统

minimize [ˈminimaiz] *v.* 使…减至最小

utilization [juːtilaiˈzeiʃən] *n.* 利用(率)

create [kriˈeit] *v.* 产生,形成,创造

communication [kənjuːniˈkeiʃən] *n.* 通讯,联络

setup *v.* 装卡;安装

horizontal [hɔriˈzɔntəl] *adj.* 横向的,水平的

vendor [ˈvendə] *n.* 卖主

embark [imˈbɑːk] *v.* 从事,着手

Erie [ˈiəri] *n.* 伊利(美国东部城市)

locomotive [ˈləukəməutiv] *n.* 火车头

Schenectady [skiˈnektədi] *n.* 斯克奈塔第(美国纽约州东部一城市)

Charlottesville [ˈtʃɑːlətsvil] *n.* 夏洛茨维尔(美国北卡罗来纳州南部一城市)

turbine [ˈtəːbin] *n.* 透平(机),汽轮机,涡轮(机)

division *n.* 部门

summarize [ˈsʌməraiz] *v.* 概括,摘要

capital [ˈkæpitl] *adj.* 主要的;基本的;资本的

throughput [ˈθruːput] *n.* 生产量

schedule [ˈʃedjuːl] *v.* 安排,调度,排定

simultaneously [siməlˈteinjəsli] *adv.* 同时地

download [ˈdaunləud] *v.* 下行传输

fixture [ˈfikstʃə] *v.* 夹紧,固定 *n.* 夹具

pallet [ˈpælit] *n.* 托板

oversight [ˈəuvəsait] *n.* 监督,观察

full-time *adj.* 全部时间的,全部工作日的

skilled [skild] *adj.* 熟练的,需要技能的

defixture [diˈfikstʃə] *v.* 松开,放松

machinist [məˈʃiːnist] *n.* 机械工人,机械师

oversee [əuvəˈsiː] *v.* 监视;照料

supervisor [ˈsjuːpəvaizə] *n.* 管理人员,检查员

skill [skil] *n.* 技能,技术

offset [ˈɔfset] *v.* 抵消

workplace [ˈwəːkpleis] *n.* 车间,工厂;工作面

inventory [inˈventəri] *n.* 库存

installation [instɔːˈleiʃən] *n.* 装置

attribute [ətriˈbjuːt] *v.* 由…引起

batch [bætʃ] *v.* 分批

responsiveness [riˈspɔnsivnis] *n.* 响应度,反应性

inherent [inˈhiərənt] *adj.* 固有的,先天的

flexibility [fleksiˈbiliti] *n.* 灵活性,适应性,柔性

introduce *v.* 提出

significantly [sigˈnifikəntli] *adv.* 大大地;有意义地

disrupt [disˈrʌpt] *v.* 中断,干扰

degrade [digˈreid] *v.* 降低(等级);减少

gracefully [ˈgreisfuli] *adv.* 适度地

fail *v.* 失效,损坏

incorporate [inˈkɔːpəreit] *v.* 使结合

redundant [riˈdʌndənt] *adj.* 多余的

bypass [ˈbaipɑːs] *v.* 绕过,走旁路