# 心理学专业外语翻译第8页（5篇范例）

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*第一篇：心理学专业外语翻译第8页The humanistic approach to psychologyORIGINS AND HISTORY  Thehumanisticmovementdeveloped in America in...*

**第一篇：心理学专业外语翻译第8页**

The humanistic approach to psychology

ORIGINS AND HISTORY  The

humanistic

movement

developed in America in the early 1960s,and was termed the third force in psychology since it aimed to replace the two main approaches in the subject at that time;Behaviorism and psychoanalysis.Influenced by gestalt pshychology’s idea studying whole units, and existential philosophy with its belief in conscious free will , humanists argued that behaviourism’s artificial and dehumanising approach and psychoanalysis’s

gloomy

determinism were insufficient to provide a complete psychology. The humanistic approach aimed to

investigate all the uniquely human aspects of experience such as love ,hope, creativity , ect.and emphasised theimportance of the inpidual’ interaction with the environment.Humanists such as Maslow ,believed that

every inpidual

has

the

need

to

self-actualise or reach their

心理学的人本主义研究方法

起源与历史

 人本主义运动发展壮大于20世纪

60年代初的美国, 由于它旨在取代这一领域的两大心理学核心研究方法而被称为心理学的第三势力。受格式塔心理学研究整体的思想，和存在主义哲学对自由意志崇尚的影响,人本主义者论证道：行为主义的机械的和非人化 的方法以及精神分析学阴沉的决定论不足支撑完整的心理学。

 人本主义心理学目的在于探讨人

类独有的经验，例如，爱、希望、创造力等，并且强调个人与环境相互作用的重要性.人本主义者如马斯洛相信每个人都有自我实现的或达到自己潜能的需要,罗杰斯的患者疗法—患者中心疗法是来帮助个体在此过程中完成自我实现。

potentia,and Rogers developed client –centred therapy to helpindviduals in this process of self-actualisation.Carl Rogers

‘Humanistic psychology has as its ultimate goal the preparation of a complete description of what it means to be

alive

as

a

human

being.’

Bugental(1967)ASSUMPTION

Bugental(1967), the first president of the American Association for Humanistic Psycholohy,described

some

of

its

fundamental assumption ：

 A proper understanding of human

nature can only be gained from studying humans,not other animals. Psychology should research areas

that are meaningful and important to human existence,not neglect them because

they

are

too

difficult.Psychology should be applied to enrich human life. Psychology should study internal

experience as well as external behaviour

and

consider

that

inpiduals can show some degree of free will.卡尔•罗杰斯

“人本主义心理学把对人类来说存在意义的完整阐述作为其终极目标。” 巴根特尔（1967）

理论假设

第一届美国人本主义心理学协

会主席巴根特尔（1967）描述了一些基本的假设:

 只有通过研究人类，而绝非其他的动物，才能获取对人性的合理理解。

 心理学应当研究对人类的生存有

意义且重要的区域，而并非因为困难而忽视它们。心理学应当被用来丰富人类的生活。

 心理学应当像研究外显行为一样

研究内在经验并且认为个体能够在一定程度上展现自由意志。

 Psychology should study the

inpidual case(an idiographic method)rather than the average performance

of

groups(a

nomothetic approach).In general, humanistic Psychologists assume that the Whole person should be studied in their environmental context.METHORDS OF INVESTIGATION Humanist take a phenomenological approach, investigating the inpidual’s conscious experience of the world.For this reason they employ the idiographic case study method, and use a variety of inpidualistic techniques such as Flexible open ended interviews The Q-sprt technique,where the

participant is given one hundred different statement on cards ,such as ‘I don’t trust my emotions’ or ‘I have an attractive personality’ which they have to sort into piles for personal relevance.AREAS OF EXPLANATION The humanistic has been applied to relatively few areas of psychologycompared to other approaches.The main areas of explanation have been in

 心理学应当研究个案而不是团体的平均表现。

总之，人本主义心理学家认为对整个人的研究应当在他们的生存环境中进行。调查研究方法

心理学家运用现象学方法研究个体的有意识的经验。由于这个原因，他们使用特殊规律个案研究法并且使用不同的个体化技术，例如：

 灵活开放性的访谈

 Q分类技术 在运用时，给与每一

个参与者具有一百个不同语句的卡片，例如：我不信任我的情绪，或者我有一个吸引人的个性。他们要把这些语句分类成个性相关的一类按照相关的个性进行分类。

阐述领域

相对于其他方法而言，人本主义已经被应用于与心理学相关的一些领域，最主要的领域在：

 Personality/self identity,e.g.Rogers’s

self theory

 Motivation,e.g.Maslow’s hierarchy

of needs and self-actualization Abnormality,e.g.due to imposed

conditions of worth by others or the inability

to

accept

the

true

self.Humanists bare against the nomothetic classification

of

abnormality

PRAICAL APPLICATIONS

The humanistic approach’s primary application has been to therapeutic treatment

for

anybody

suffering

‘problems with living’.Some humanistic therapies include

 Client-centered therapy-where by

the client is encouraged to develop positive self-regard and overcome mismatch between their perceived self,true self,and ideal self

 Gestalt therapy-developed by Fritz

Perls ,the aim is to help the client become a ‘whole’(gestalt)person by getting them to accept every aspectof themselves STRENGTHS

The humanistic approach has contributed to psychology by

 个性/自我认同，例如：罗杰斯的‘自我理论’

 动机:例如 马斯洛的需要层次理

论和自我实现

 变态 例如 由于被他人强加的条

件或无法接受真实的自我。人本主义者毫无遮掩的反对变态的常规分类。具体应用

人本主义方法的主要应用来为遭受生活困扰的人做治疗。一些人本主义治疗包括

 以求诊者为中心的治疗方法——  患者如何被鼓励去建立积极的自

我关注以及克服他们的本我、自我和超我之间的不协调

 格式塔疗法——由波尔斯发展而

来，它的目标是帮助病人通过接受他们自己的每一方面从而成为一个完整的人。优势

人本主义方法对心理学的贡献为：

 Re-emphasizing the need to study

consciousness

and

human

experience for a complete study of the subject

 Serving as a valuable agent of

criticism against the extremes of the earlier major approaches

 Highlighting the value of more

inpidualistic

and

idiographic

methods of study ,particularly in the areas of personality and abnormality  Emphasizing the importance of self

–actualisation ,responsibility, freedom

of

choice,and

social

context in therapyWEAKNESSES Humanistic

psychology

has

not,however,had the significant impact on mainstream academic psychology that the other approaches have.This is probably because humanists deliberately take a less scientific approach to studying humans since

 Their belief in free will is in

opposition to the deterministic lawsof science

·They adopt a more idiographic approach, seeking the more unique aspects

of

inpiduals,rather

than

producing generalized

 再次强调，一个完整的研究必须包

括意识和人类经验

 作为一个有价值的批评依据来反

对早期的主要的极端主义方法

 突出更多个人的价值和研究的具

体方法，尤其是在个性和变态领域

 强调自我实现、责任、选择自由以

及社会背景在治疗中的重要性缺点

然而，人本主义心理学并没有像其他方法一样对主流心理学学术有重要的影响。这可能是因为人本主义者很少运用科学方法来研究人类 由于：

 他们自由意识的信仰违背了既定的科学规律义（普遍）规律

 他们采用更具体的方法，寻求个体

更多的不同寻常的方面，而不是发现应（适）用于每个人的行为的广

laws of behaviour that apply to everyone  The issues they investigate ,such an

consciousness and emotion, are amongst the most difficult to objectively study

 他们研究的课题，比如意识和情

感，属于客观性研究当中很困难的课题。

**第二篇：心理学专业外语翻译第19页**

Cultural bias in psychologicaltheory and research

EXAMPLES

OF

CULTURAL

BIAS

IN

PSYCHOLOGY Social

influence

Cross-cultural

replications of

obedience

and

conformity studies have revealed wide differences in resistance to influence.Interpersonal relationships – culture bias in Western research on this topic, is revealed by its focus on

 brief, new acquaintance, rather than

long term, kin relationships. the idea that marriage on the basis

of romantic love is more desirable than on the basis of companionate love.Helping behavior – Western economic theories on the costs and rewards of helping behavior may not be suitable for other culture.Abnormality – The increased diagnosis of mental disorder in immigrants may reflect prejudice or misunderstanding by a native diagnoser.心理学理论和 研究中的文化偏见

心理学中文化偏见举例

社会影响 –对顺从和服从的跨文化研究揭示了在抗拒影响方面存在广泛的差异。

人际关系such as whether they emphasise

inpidualism

or

collectivism，masculine or feminine values，etc.（Triandis,1990）.Since cultural values strongly shape the construction of theories，a major problem is ethnocentrism，which involves

 inappropriately

generalising

the

values and research finding of one culture to another without bothering to test other cultures.This limits the validity of theories and neglects important

cross

culture

differences。

 imposing those values upon other

cultures when conductingcross智商和性格测试在内容、措辞、应用以及评估方面表现出文化上的偏见。

理论偏差

不同文化中的许多重要方面也会有所不同，例如在他们的价值观，行为规范和社会结构方面在大量的美国和欧洲的著名心理学研究中只应用白人做被试。回顾研究显示，在这些国家中被试不是白人的数量往往不到5％。

 在欧洲为中心的科学手段的使用

（以‘对自然的控制’、与被试的客观的分离和对个体的‘ 差异性\'和‘独特性 \'的调查为基），如实验室实验，其对非洲观念\'与自然的和谐统一\'，\'集体性\'和\'相似性\'是陌生的（Nobles，1967年）。这些方法代表了一种强加的\'语音学的\'（即对外来文化的研究）有效数据，只能从一个\'音位学的\'方法获得（从文化的内在中得来）。.施加\'语音学的\'方法可以导致

outside)when ecologically valid data can only be gained from an ‘emic’

study(from

within

the

culture).Imposed ‘etics’ can lead to very culturally biased tests such as those

on

IQ

described

by

Gould(1982).CONSEQUENCES OF CULTURAL BIAS Nobles(1976)argues

that

western

psychology has been a tool of oppression and dominance.Cultural bias has also made it difficult for psychologists

to

separate

the

behaviour they have observed from the context in which they observed it.VALIDITY OF CULTURAL BIAS Culturally biased views have been exposed in many area of psychology.REDUCING CULTURAL BIAS Equal opportunity legislation aims to rid psychology of cultural bias and racism, but we must be aware of merely swapping old, overt racism for new,more

subtle

forms

of

racism(HowittandOwusu-Bempah,19 94).对文化上的测试产生偏见。例如Gould所描述的智商测试（1982年）。

文化偏见带来的后果

Nobles（1976）认为，西方心理学已经成为其压迫和统治的工具。文化偏见也使心理学家很难从他们所观察到的行为所处的环境背景中将他们所观察到的行为分离出来。

文化偏见的有效性

文化偏见的看法已经暴露在心理学的诸多领域。文化偏见的降低

机会平等法的目的是消除文化偏见和种族主义的心理，但是我们必须警惕决不能用新的、更加精细的种族主义代替旧的、公开的种族主义（Howitt

and Owusu-Bempah，1994年）。

**第三篇：专业外语翻译求职简历**

专业外语翻译求职简历 简历

求职意向

期望从事职业：-翻译（英语翻译）、广交会外语翻译、专职外语翻译

期望月薪：3500元

工作经历

2024年1-3月，在广州冰福生物科技有限公司当外籍经理助理，主要协助外籍经理处理工作，及负责产品销售推广工作；

2024年7-8月，在云浮青少年宫暑假培训班当辅导老师，主要负责一年级到高一年级学生英语、数学等科目的学习；

2024年7-8月，在云浮市旭升国际货运代理有限公司当文员，主要负责沟通客户、校对跟单以及相关文件的翻译工作等；

业余时间进行礼仪小姐、街舞商业演出以及贸易相关邮件的中英文互译等兼职。

教育经历

毕业院校：2024年9月-2024年6月，就读广州外语外贸大学，外语系，高级翻译专业。主修课程：高级日常英语，高级休闲英语，高级职业英语，高级时事英语，高级英语写作，跨文化交际，变化中的英语文学阅读与欣赏，英语综合实践，英美国家概况，英语报刊选读，翻译理论与实践（口语），高级综合英语 外语水平：CET-4计算机水平：硬件维修技师其它培训情况：

个人优点

适应能力强、勤奋好学、认真负责、吃苦耐劳、勇于接受新的挑战。重视诚信，讲原则，说到做到，绝不推卸责任；有自制力，做事始终坚持有始有终，决不半途而废；有问题不逃避，愿意虚心向别人学习；自信但不自负，不以自我为中心；愿意用谦虚态度接纳优越者、权威者；会用100%的热情已精力投入到工作中；平易近人，脚踏实地、有较强的团队精神，工作积极进取，态度认真。有较强的组织能力，乐于助人，诚实守时。

自我鉴定

本人性格外向，思想活跃，待人真诚，善于交际，有团队合作精神，适应能力强，敢于拼搏。经常利用业余时间参加兼职实践活动，具备相对丰富的工作经验，擅于进行社交活动，更有组织各种文艺活动的经验。对工作有较强的责任心和热情，能制定缜密计划，能在较短时间内适应高压力的工作。

精通粤语，普通话；熟悉英语，有较好的翻译能力和口语能力，通过国家CET四级,CET六级考试；打字熟练，并熟悉掌握电脑基本操作，如Word文档，Excel，Powerpoint等

**第四篇：化学工程与工艺专业外语翻译**

Unit 1

Chemical Industry 化学工业

Before reading the text below, try to answer following question: 1.When did the modern chemical industry start? 2.Can you give a definition for the chemical industry? 3.What are the contribution which the chemical industry has made to meet and satisfy our needs? 4.Is the chemical industry capital-or labor-intensive? Why? 1.Origins of the Chemical Industry Although the use of chemicals dates back to the ancient civilizations, the evolution of what we know as the modern chemical industry started much more recently.It may be considered to have begun during the Industrial Revolution, about 1800, and developed to provide chemicals roe use by other industries.Examples are alkali for soapmaking, bleaching powder for cotton, and silica and sodium carbonate for glassmaking.It will be noted that these are all inorganic chemicals.The organic chemicals industry started in the 1860s with the exploitation of William Henry Perkin‟s discovery if the first synthetic dyestuff—mauve.At the start of the twentieth century the emphasis on research on the applied aspects of chemistry in Germany had paid off handsomely, and by 1914 had resulted in the German chemical industry having 75% of the world market in chemicals.This was based on the discovery of new dyestuffs plus the development of both the contact process for sulphuric acid and the Haber process for ammonia.The later required a major technological breakthrough that of being able to carry out chemical reactions under conditions of very high pressure for the first time.The experience gained with this was to stand Germany in good stead, particularly with the rapidly increased demand for nitrogen-based compounds(ammonium salts for fertilizers and nitric acid for explosives manufacture)with the outbreak of world warⅠin 1914.This initiated profound changes which continued during the inter-war years(1918-1939).1． 化学工业的起源 尽管化学品的使用可以追溯到古代文明时代，我们所谓的现代化学工业的发展却是非常近代（才开始的）。可以认为它起源于工业革命其间，大约在 1800 年，并发展成为为其它工 业部门提供化学原料的产业。比如制肥皂所用的碱，棉布生产所用的漂白粉，玻璃制造业所 用的硅及 Na2CO3.我们会注意到所有这些都是无机物。有机化学工业的开始是在十九世纪 六十年代以 William Henry Perkin 发现第一种合成染料—苯胺紫并加以开发利用为标志的。20 世纪初，德国花费大量资金用于实用化学方面的重点研究，到 1914 年，德国的化学工业 在世界化学产品市场上占有 75%的份额。这要归因于新染料的发现以及硫酸的接触法生产 和氨的哈伯生产工艺的发展。而后者需要较大的技术突破使得化学反应第一次可以在非常高 的压力条件下进行。这方面所取得的成绩对德国很有帮助。特别是由于 1914 年第一次世界 大仗的爆发，对以氮为基础的化合物的需求飞速增长。这种深刻的改变一直持续到战后（1918-1939）。date bake to/from: 回溯到 dated: 过时的，陈旧的 stand sb.in good stead: 对。很有帮助。

Since 1940 the chemical industry has grown at a remarkable rate, although this has slowed significantly in recent years.The lion‟s share of this growth has been in the organic chemicals sector due to the development and growth of the petrochemicals area since 1950s.The explosives growth in petrochemicals in the 1960s and 1970s was largely due to the enormous increase in demand for synthetic polymers such as polyethylene, polypropylene, nylon, polyesters and epoxy resins.1940 年以来，化学工业一直以引人注目的速度飞速发展。尽管这种发展的速度近年来 已大大减慢。化学工业的发展由于 1950 年以来石油化学领域的研究和开发大部分在有机化 学方面取得。石油化工在 60 年代和 70 年代的迅猛发展主要是由于人们对于合成高聚物如聚 乙烯、聚丙烯、尼龙、聚脂和环氧树脂的需求巨大增加。The chemical industry today

is a very perse sector of manufacturing industry, within which it plays a central role.It makes thousands of different chemicals which the general public only usually encounter as end or consumer products.These products are purchased because they have the required properties which make them suitable for some particular application, e.g.a non-stick coating for pans or a weedkiller.Thus chemicals are ultimately sold for the effects that they produce.今天的化学工业已经是制造业中有着许多分支的部门，并且在制造业中起着核心的作 用。它生产了数千种不同的化学产品，而人们通常只接触到终端产品或消费品。这些产品被 购买是因为他们具有某些性质适合（人们）的一些特别的用途，例如，用于盆的不粘涂层或 一种杀虫剂。这些化学产品归根到底是由于它们能产生的作用而被购买的。2.Definition of the Chemical Industry At the turn of the century there would have been little difficulty in defining what constituted the chemical industry since only a very limited range of products was manufactured and these were clearly chemicals, e.g., alkali, sulphuric acid.At present, however, many intermediates to products produced, from raw materials like crude oil through(in some cases)many intermediates to products which may be used directly as consumer goods, or readily converted into them.The difficulty cones in deciding at which point in this sequence the particular operation ceases to be part of the chemical industry‟s sphere of activities.To consider a specific example to illustrate this dilemma, emulsion paints may contain poly(vinyl chloride)/ poly(vinyl acetate).Clearly, synthesis of vinyl chloride(or acetate)and its polymerization are chemical activities.However, if formulation and mixing of the paint, including the polymer, is carried out by a branch of the multinational chemical company which manufactured the ingredients, is this still part of the chemical industry of does it mow belong in the decorating industry? 2． 化学工业的定义 在本世纪初，要定义什么是化学工业是不太困难的，因为那时所生产的化学品是很有限 的，而且是非常清楚的化学品，例如，烧碱，硫酸。然而现在有数千种化学产品被生产，从 一些原料物质像用于制备许多的半成品的石油，到可以直接作为消费品或很容易转化为消费 品的商品。困难在于如何决定在一些特殊的生产过程中哪一个环节不再属于化学工业的活动 范畴。举一个特殊的例子来描述一下这种困境。乳剂漆含有聚氯乙烯/聚醋酸乙烯。显然，氯乙烯（或醋酸乙烯）的合成以及聚合是化学活动。然而，如果这种漆，包括高聚物，它的 配制和混合是由一家制造配料的跨国化学公司完成的话，那它仍然是属于化学工业呢还是应 当归属于装饰工业中去呢？

It is therefore apparent that, because of its persity of operations and close links in many areas with other industries, there is no simple definition of the chemical industry.Instead each official body which collects and publishes statistics on manufacturing industry will have its definition as to which operations are classified as the chemical industry.It is important to bear this in mind when comparing statistical information which is derived from several sources.因此，很明显，由于化学工业经营的种类很多并在很多领域与其它工业有密切的联系，所以不能对它下一个简单的定义。相反的每一个收集和出版制造工业统计数据的官方机构都 会对如何届定哪一类操作为化学工业有自己的定义。当比较来自不同途径的统计资料时，记 住这点是很重要的。3.The Need for Chemical Industry The chemical industry is concerned with converting raw materials, such as crude oil, firstly into chemical intermediates and then into a tremendous variety of other chemicals.These are then used to produce consumer products, which make our lives more comfortable or, in some cases such as pharmaceutical produces, help to maintain our well-being or even life itself.At each stage of these operations value is added to the produce and provided this added exceeds the raw material plus processing costs then a profit will

be made on the operation.It is the aim of chemical industry to achieve this.3． 对化学工业的需要 化学工业涉及到原材料的转化，如石油 首先转化为化学中间体，然后转化为数量众多 的其它化学产品。这些产品再被用来生产消费品，这些消费品可以使我们的生活更为舒适或 者作药物维持人类的健康或生命。在生产过程的每一个阶段，都有价值加到产品上面，只要 这些附加的价值超过原材料和加工成本之和，这个加工就产生了利润。而这正是化学工业要 达到的目的。It may seem strange in textbook this one to pose the question “do we need a chemical industry?” However trying to answer this question will provide(ⅰ)an indication of the range of the chemical industry’s activities,(ⅱ)its influence on our lives in everyday terms, and(ⅲ)how great is society’s need for a chemical industry.Our approach in answering the question will be to consider the industry‟s contribution to meeting and satisfying our major needs.What are these? Clearly food(and drink)and health are paramount.Other which we shall consider in their turn are clothing and(briefly)shelter, leisure and transport.在这样的一本教科书中提出： “我们需要化学工业吗？”这样一个问题是不是有点奇怪 呢？然而，先回答下面几个问题将给我们提供一些信息：（1）化学工业的活动范围，（2）化 学工业对我们日常生活的影响，（3）社会对化学工业的需求有多大。在回答这些问题的时候 我们的思路将要考虑化学工业在满足和改善我们的主要需求方面所做的贡献。是些什么需求 呢？很显然，食物和健康是放在第一位的。其它我们要考虑的按顺序是衣物、住所、休闲和 旅行。(1)Food.The chemical industry makes a major contribution to food production in at least three ways.Firstly, by making available large quantities of artificial fertilizers which are used to replace the elements(mainly nitrogen, phosphorus and potassium)which are removed as nutrients by the growing crops during modern intensive farming.Secondly, by manufacturing crop protection chemicals, i.e., pesticides, which markedly reduce the proportion of the crops consumed

by pests.Thirdly, by producing veterinary products which protect livestock from disease or cure their infections.(1)食物。化学工业对粮食生产所做的巨大贡献至少有三个方面。第一，提供大量可以 获得的肥料以补充由于密集耕作被农作物生长时所带走的营养成分。（主要是氮、磷和钾）。第二，生产农作物保护产品，如杀虫剂，它可以显著减少害虫所消耗的粮食数量。第三，生 产兽药保护家禽免遭疾病或其它感染的侵害。(2)Health.We are all aware of the major contribution which the pharmaceutical sector of the industry has made to help keep us all healthy, e.g.by curing bacterial infections with antibiotics, and even extending life itself, e.g.–blockers to lower blood pressure.（2）健康。我们都很了解化学工业中制药这一块在维护我们的身体健康甚至延长寿命 方面所做出的巨大贡献，例如，用抗生素治疗细菌感染，用 β-抗血栓降低血压。(3)Clothing.The improvement in properties of modern synthetic fibers over the traditional clothing materials(e.g.cotton and wool)has been quite remarkable.Thus shirts, dresses and suits made from polyesters like Terylene and polyamides like Nylon are crease-resistant, machine-washable, and drip-dry or non-iron.They are also cheaper than natural materials.衣物。在传统的衣服面料上，现代合成纤维性质的改善也是非常显著的。用聚脂如涤纶 或聚酰胺如尼龙所制作的 T 恤、上衣、衬衫抗皱、可机洗，晒干自挺或免烫，也比天然面 料便宜。Parallel developments in the discovery of modern synthetic dyes and the technology to “bond” them to the fiber has resulted in a tremendous increase in the variety of colors available to the fashion designer.Indeed they now span almost every color and hue of the visible spectrum.Indeed if a suitable shade is not available, structural modification of an existing dye to achieve this can readily be carried out, provided there is a satisfactory market for the product.与此同时，现代合成染料开发和染色技术的改善使得时装设计师们有大量的色彩

可以利 用。的确他们几乎利用了可见光谱中所有的色调和色素。事实上如果某种颜色没有现成的，只要这种产品确有市场，就可以很容易地通过对现有的色彩进行结构调整而获得。Other major advances in this sphere have been in color-fastness, i.e., resistance to the dye being washed out when the garment is cleaned.这一领域中另一些重要进展是不褪色，即在洗涤衣物时染料不会被洗掉。(4)Shelter, leisure and transport.In terms of shelter the contribution of modern synthetic polymers has been substantial.Plastics are tending to replace traditional building materials like wood because they are lighter, maintenance-free(i.e.they are resistant to weathering and do not need painting).Other polymers, e.g.urea-formaldehyde and polyurethanes, are important insulating materials for reducing heat losses and hence reducing energy usage.（4）住所，休闲和旅游。讲到住所方面现代合成高聚物的贡献是巨大的。塑料正在取 代像木材一类的传统建筑材料，因为它们更轻，免维护（即它们可以抵抗风化，不需油漆）。另一些高聚物，比如，脲甲醛和聚脲，是非常重要的绝缘材料可以减少热量损失因而减少能 量损耗。

Plastics and polymers have made a considerable impact on leisure activities with applications ranging from all-weather artificial surfaces for athletic tracks, football pitches and tennis courts to nylon strings for racquets and items like golf balls and footballs made entirely from synthetic materials.塑料和高聚物的应用对休闲活动有很重要的影响，从体育跑道的全天候人造篷顶，足球 和网球的经纬线，到球拍的尼龙线还有高尔夫球的元件，还有制造足球的合成材料。Likewise the chemical industry’s contribution to transport over the years has led to major improvements.Thus development of improved additives like anti-oxidants and viscosity index improves for engine oil has enabled routine servicing intervals to increase from 3000 to 6000 to 12000 miles.Research and development work has also resulted in improved lubricating oils and greases, and better brake fluids.Yet again the contribution of polymers and plastics has been very striking with the proportion of the total automobile derived from these materials—dashboard, steering wheel, seat padding and covering etc.—now exceeding 40%.多年来化学工业对旅游方面所作的贡献也有很大的提高。一些添加剂如抗氧化剂的开发 和发动机油粘度指数改进使汽车日产维修期限从 3000 英里延长到 6000 英里再到 12000 英 里。研发工作还改进了润滑油和油脂的性能，并得到了更好的刹车油。塑料和高聚物对整个 汽车业的贡献的比例是惊人的，源于这些材料—挡板，轮胎，坐垫和涂层等等—超过 40%。So it is quite apparent even from a brief look at the chemical industry’s contribution to meeting our major needs that life in the world would be very different without the products of the industry.Indeed the level of a country’s development may be judged by the production level and sophistication of its chemical industry.很显然简单地看一下化学工业在满足我们的主要需求方面所做的贡献就可以知道，没有 化工产品人类社会的生活将会多么困难。事实上，一个国家的发展水平可以通过其化学工业 的生产水平和精细程度来加以判断。4.Research and Development(R&D)in Chemical Industries One of the main reasons for the rapid growth of the chemical industry in the developed world has been its great commitment to, and investment in research and development(R&D).A typical figure is 5% of sales income, with this figure being almost doubled for the most research intensive sector, pharmaceuticals.It is important to emphasize that we are quoting percentages here not of profits but of sales income, i.e.the total money received, which has to pay for raw materials, overheads, staff salaries, etc.as well.In the past this tremendous investment has paid off well, leading to many useful and valuable products being introduced to the market.Examples include synthetic polymers like nylons and polyesters, and drugs and pesticides.Although the number of new products introduced to the market has declined significantly in recent years, and in times of recession the research department is usually one of the first to suffer cutbacks, the commitment to R&D remains at a very high level.4． 化学工业的研究和开发。发达国家化学工业飞速发展的一个重要原因就是它在研究和开发方面的投入和投资。通 常是销售收入的 5%，而研究密集型分支如制药，投入则加倍。要强调这里我们所提出的百 分数不是指利润而是指销售收入，也就是说全部回收的钱，其中包括要付出原材料费，企业 管理费，员工工资等等。过去这笔巨大的投资支付得很好，使得许多有用的和有价值的产品

被投放市场，包括一些合成高聚物如尼龙和聚脂，药品和杀虫剂。尽管近年来进入市场的新 产品大为减少，而且在衰退时期研究部门通常是最先被裁减的部门，在研究和开发方面的投 资仍然保持在较高的水平。The chemical industry is a very high technology industry which takes full advantage of the latest advances in electronics and engineering.Computers are very widely used for all sorts of applications, from automatic control of chemical plants, to molecular modeling of structures of new compounds, to the control of analytical instruments in the laboratory.化学工业是高技术工业，它需要利用电子学和工程学的最新成果。计算机被广泛应用，从化工厂的自动控制，到新化合物结构的分子模拟，再到实验室分析仪器的控制。Inpidual manufacturing plants have capacities ranging from just a few tones per year in the fine chemicals area to the real giants in the fertilizer and petrochemical sectors which range up to 500,000 tonnes.The latter requires enormous capital investment, since a single plant of this size can now cost $520 million!This, coupled with the widespread use of automatic control equipment, helps to explain why the chemical industry is capital-rather than labor-intensive.一个制造厂的生产量很不一样，精细化工领域每年只有几吨，而巨型企业如化肥厂和石 油化工厂有可能高达 500,000 吨。后者需要巨大的资金投入，因为一个这样规模的工厂要花 费 2 亿 5 千万美元，再加上自动控制设备的普遍应用，就不难解释为什么化工厂是资金密集 型企业而不是劳动力密集型企业。The major chemical companies are truly multinational and operate their sales and marketing activities in most of the countries of the world, and they also have manufacturing units in a number of countries.This international outlook for operations, or globalization, is a growing trend within the chemical industry, with companies expanding their activities either by erecting manufacturing units in other countries or by taking over companies which are already operating there.大部分化学公司是真正的跨国公司，他们在世界上的许多国家进行销售和开发市场，他 们在许多国家都有制造厂。这种国际间的合作理念，或全球一体化，是化学工业中发展的趋 势。大公司通过在别的国家建造制造厂或者是收购已有的工厂进行扩张。

Unit 2

Research and Development 研究和开发

Research and development, or R&D as it is commonly referred to, is an activity which is carried out by all sectors of manufacturing industry but its extent varies considerably, as we will see shortly.Let us first understand, or at least get a feel for, what the terms mean.Although the distinction between research and development is not always clear-cut, and there is often considerable overlap, we will attempt to separate them.In simple terms research can be thought of as the activity which produces new ideas and knowledge whereas development is putting those ideas into practice as new process and products.To illustrate this with an example, predicting the structure of a new molecule which would have a specific biological activity and synthesizing it

could be seen as research whereas testing it and developing it to the point where it could be marketed as a new drug could be described as the development part.研究和开发，或通常所称 R&D 是制造业各个部门都要进行的一项活动。我们马上可 以看到，它的内容变化很大。我们首先了解或先感觉一下这个词的含义。尽管研究和开发 的定义总是分得不很清楚，而且有许多重叠的部分，我们还是要试着把它们区分开来。简 单说来，研究是产生新思想和新知识的活动，而开发则是把这些思想贯彻到实践中得到新 工艺和新产品的行为。可以用一个例子来描述这一点，预测一个有特殊生物活性的分子结 构并合成它可以看成是研究而测试它并把它发展到可以作为一种新药推向市场这一阶段 则看作开发部分。1.Fundamental Research and Applied Research In industry the primary reason for carting out R&D is economic and is to strengthen and improve the company‟s position and profitability.The purpose of R&D is to generate and provide information and knowledge to reduce uncertainty, solve problems and to provide better data on which management can base decisions.Specific projects cover a wide range of activities and time scales, from a few months to 20 years.1． 基础研究和应用研究 在工业上进行研究和开发最主要的原因是经济利益方面，是为了加强公司的地位，提 高公司的利润。R&D 的目的是做出并提供信息和知识以减低不确定性，解决问题，以及向 管理层提供更好的数据以便他们能据此做出决定。特别的项目涵盖很大的活动范围和时间范 围，从几个月到 20 年。We can pick out a number of areas of R&D activity in the following paragraphs but if we were to start with those which were to spring to the mind of the academic, rather than the industrial, chemist then these would be basic, fundamental(background)or exploratory research and the synthesis of new compounds.This is also labeled “blue skies” research.我们可以在后面的段落里举出大量的 R&D 活动。但是如果我们举出的点子来源于研 究院而不是工业化学家的头脑，这就是基础的或探索性的研究 Fundamental research is typically associated with university research.It may be carried out for its own intrinsic interest and it will add to the total knowledge base but no immediate applications of it in the “real world” well be apparent.Note that it will provide a valuable

training in defining and solving problems, i.e.research methodology for the research student who carries it out under supervision.However, later “spin offs” from such work can lead to useful applications.Thus physicists claim that but for the study and development of quantum theory we might not have had computers and nuclear power.However, to take a specifically chemical example, general studies on a broad area such as hydrocarbon oxidation might provide information which would be useful in more specific areas such as cyclohexane oxidation for the production of nylon intermediates.基础研究通常与大学研究联系在一起，它可能是由于对其内在的兴趣而进行研究并 且这种研究能够拓宽知识范围，但在现实世界中的直接应用可能性是很小的。请注意，这种 以内就在提出和解决问题方面提供了极有价值的训练，比如，在指导下完成研究工作的学生 所接受的研究方法学（的训练）。而且，从这些工作中产生的“有用的副产品”随后也能带 来可观的使用价值。因此，物理学家宣称要不是量子理论的研究和发展我们可能仍然没有计 算机和核能量。不管怎样，举一个特殊的化学方面的例子吧，在各个领域如烃的氧化方面所 做的广泛的研究将为一些特殊的领域如环己烯氧化生成尼龙中间产物提供有用的信息。Aspects of synthesis could involve either developing new, more specific reagents for controlling particular functional group interconversions, i.e.developing synthetic methodology or complete synthesis of an entirely new molecule which is biologically active.Although the former is clearly fundamental the latter encompasses both this and applied aspects.This term „applied‟ has traditionally been more associated with research out in industrial

laboratories, since this is more focused or targeted.It is a consequence of the work being business driven.通过合成可以生产出一些新的、更特殊的试剂以控制特殊的官能团转换，即发展合 成方法或完成一些具有生物活性的新分子的合成。尽管前者显然属于基础性研究而后者则包 括基础研究和实用性研究两部分。所谓“实用性”习惯上是指与在工业实验室完成的研究联 系在一起的，因为它更具目的性，它是商业行为驱动的结果。Note, however, that there has been a major change in recent years as academic institutions have increasingly turned to industry for research funding, with the result that much more of their research effort is mow devoted to more applied research.Even so, in academia the emphasis generally is very much on the research rather than the development.然而，请注意。近几年有很大的变化，大学研究机构正越来越多地转向工业界寻求研 究经费，其结果就是他们的研究工作越来越多地是致力于实用研究。即使这样，学院工作的 重点通常还是在于研究而不是开发。2.Types of Industrial Research and Development The applied or more targeted type of research and development commonly carried out in industry can be of several types and we will briefly consider each.They are:(ⅰ)product development,(ⅱ)process development,(ⅲ)process improvement and(ⅳ)applications development.Even under these headings there are a multitude of aspects so only a typical example can be quoted in each case.The emphasis on each of these will vary considerably within the different sectors of the chemical industry.2．工业研究和开发的类型 通常在生产中完成的实用型的或有目的性的研究和开发可以分为好几类，我们对此 加以简述。它们是：（1）产品开发；（2）工艺开发；（3）工艺改进；（4）应用开发；每一类

下还有许多分支。我们.对每一类举一个典型的例子来加以说明。在化学工业的不同部门内 每类的工作重点有很大的不同。(1)Product development.Product development includes not only the discovery and development of a new drug but also, for example, providing a new longer-active anti-oxidant additive to an automobile engine oil.Development such as this have enabled servicing intervals to increase during the last decade from 3000 to 6000 to 9000 and now to 12000 miles.Note that most purchasers of chemicals acquire them for the effects that they produce i.e.a specific use.Teflon, or polytetrafluoroethylene(PTFE), may be purchased because it imparts a non-stick surface to cooking pots and pans, thereby making them easier to clean.(1)产品开发。产品开发不仅包括一种新药的发明和生产，还包括，比如说，给一种汽 车发动机提供更长时效的抗氧化添加剂。这种开发的产品已经使（发动机）的服务期限在最近的十年中从 3000 英里提高到 6000、9000 现在已提高到 12000 英里。请注意，大部分的买 家所需要的是化工产品能创造出来的效果，亦即某种特殊的用途。Tdflon，或称聚四氟乙烯（PTFE）被购买是因为它能使炒菜锅、盆表面不粘，易于清洗。(2)Process development.Process development covers not only developing a manufacturing process for an entirely new product but also a new process or route for an existing product.The push for the latter may originate for one or more of the following reasons: availability of new technology, change in the availability and/or cost of raw materials.Manufacture of vinyl chloride monomer is an example of this.Its manufacturing route has changed several times owing to changing economics, technology and raw materials.Another stimulus is a marked increase in demand and hence sales volume which can have a major effect on the economics of the process.The early days of penicillin manufacture afford a good example of this.（2）工艺开发。工业开发不仅包括为一种全新的产品设计一套制造工艺，还包括为现有 的产品设计新的工艺或方案。而要进行后者时可能源于下面的一个或几个原因： 新技术的利 用、原材料的获得或价格发生了变化。氯乙烯单聚物的制造就是这样的一个例子。它的制造 方法随着经济、技术和原材料的变化改变了好

几次。另一个刺激因素是需求的显著增加。因 而销售量对生产流程的经济效益有很大影响。Penicillin 早期的制造就为此提供了一个很好 的例子。The ability of penicillin to prevent the onset of septicemia in battle wounds during the Second World War(1939～1945)resulted in an enormous demand for it to be produced in quantity.Up until then it had only been produced in small amounts on the surface of the fermentation broth in milk bottles!An enormous R&D effort jointly in the U.S.and the U.K.resulted in two major improvements to the process.Firstly a different stain of the mould gave much better yields than the original Penicillium notatum.Secondly the major process development was the introduction of the deep submerged fermentation process.Here the fermentation takes place throughout the broth, provided sterile air is constantly, and vigorously, blown through it.This has enabled the process to be scaled up enormously to modern stainless steel fermenters having a capacity in excess of 50000 liters.It is salutary to note that in the first world war(1914～ 1919)more soldiers died from septicemia of their wounds than were actually killed outright on the battlefield!Penicillin 能预防战争中因伤口感染引发的败血症，因而在第二次世界大战（1939-1945）

中，penicillin 的需求量非常大，需要大量生产。而在那时，penicillin 只能用在瓶装牛奶表面 发酵的方法小量的生产。英国和美国投入了巨大的人力物力联合进行研制和开发，对生产流 程做出了两个重大的改进。首先用一个不同的菌株—黄霉菌代替普通的青霉，它的产量要比 后者高得多。第二个重大的流程开发是引进了深层发酵过程。只要在培养液中持续通入大量 纯化空气，发酵就能在所有部位进行。这使生产能力大大地增加，达到现代容量超过 5000 升的不锈钢发酵器。而在第一次世界大战中，死于伤口感染的士兵比直接死于战场上的人还 要多。注意到这一点不能不让我们心存感激。Process development for a new product depends on things such as the scale on which it is to be manufactured, the by-products formed and their removal/recovery, and required purity.Data will be acquired during this development stage using semi-technical plant(up to 100 liters capacity)which will be invaluable in the design of the actual manufacturing plant.If the plant is to be a very large capacity, continuously operating one, e.g.petrochemical or ammonia, then a pilot plant will first be built and operated to test out the process and acquire more data, these semi-technical or pilot plants will be required for testing, e.g., a pesticide, or customer evaluation, e.g., a new polymer.对一个新产品进行开发要考虑产品生产的规模、产生的副产品以及分离/回收，产品所 要求的纯度。在开发阶段利用中试车间（最大容量可达 100 升）获得的数据设计实际的制造 厂是非常宝贵的，例如石油化工或氨的生产。要先建立一个中试车间，运转并测试流程以获 得更多的数据。他们需要测试产品的性质，如杀虫剂，或进行消费评估，如一种新的聚合物。Note that by-products can has a major influence on the economics of a chemical process.Phenol manufacture provides a striking example of this.The original route, the benzenesulphonic acid route, has become obsolete because demand for its by-produce sodium sulfite(2.2 tons/l ton phenol)has dried up.Its recovery and disposal will therefore be an additional charge on the process, thus increasing the cost of the phenol.In contrast the cumene route owes its economic advantage over all the other routes to the strong demand for the by-product acetone(0.6 tons/l ton phenol).The sale of this therefore reduces the net cost of the phenol.注意，副产品对于化学过程的经济效益也有很大的影响。酚的生产就是一个有代表性的 例子。早期的方法，苯磺酸方法，由于它的副产品亚硫酸钠需求枯竭而变的过时。亚硫酸钠 需回收和废置成为生产过程附加的费用，增加了生产酚的成本。相反，异丙基苯方法，在经 济效益方面优于所有其他方法就在于市场对于它的副产品丙酮的迫切需求。丙酮的销售所得 降低了酚的生产成

本。A major part of the process development activity for a mew plant is to minimize, or ideally prevent by designing out, waste production and hence possible pollution.The economic and environmental advantages of this are obvious.对一个新产品进行工艺开发的一个重要部分是通过设计把废品减到最低，或尽可能地防 止可能的污染，这样做带来的经济利益和对环境的益处是显而易见的。Finally it should be noted that process development requires a big team effort between chemists, chemical engineers, and electrical and mechanical engineers to be successful.最后要注意，工业开发需要包括化学家、化学工程师、电子和机械工程师这样一支庞大 队伍的协同合作才能取得成功。

（3)Process improvement.Process improvement relates to processes which are already operating.It may be a problem that has arisen and stopped production.In this situation there is a lot of pressure to find a solution as soon as possible so that production can restart, since ‘down time’ costs money.（3）工艺改进。工艺改进与正在进行的工艺有关。它可能出现了某个问题使生产停止。在这种情形下，就面临着很大的压力要尽快地解决问题以便生产重新开始，因为故障期耗费 资财。down time: 故障期 More commonly, however, process improvement will be directed at improving the profitability of the process.This might be achieved in a number of ways.For example, improving the yield by optimizing the process, increasing the capacity by introducing a new catalyst, or lowering the energy requirements of the process.An example of the latter was the introduction of turbo compressors in the production of ammonia by the Haber process.This reduced utility costs(mainly electricity)from $6.66 to %0.56 per ton of ammonia produced.Improving the quality of the product, by process modification, may lead to new markets for the product.然而，更为常见的，工艺改进是为了提高生产过程的利润。这可以通过很多途径实现。例如通过优化流程提高产量，引进新的催化剂提高效能，或降低生产过程所需要的能量。可 说明后者的一个例子是在生产氨的过程中涡轮压缩机的引进。这使生产氨的成本（主要是电）从每吨 6.66 美元下降到 0.56 美元。通过工艺的改善提高产品质量也会为产品打开新的市场。In recent years, however, the most important process improvement activity has been to reduce the environmental impact of the process, i.e., to prevent the process causing any pollution.Clearly there have been two interlinked driving forces for this.Firstly, the public‟s concern about the safety of chemicals and their effect on the environment, and the legislation which has followed as a result of this.Secondly the cost to the manufacturer of having to treat waste(i.e., material which cannot be recovered and used r sold)so that it can be safely disposed of, say by pumping into a river.This obviously represents a charge on the process which will increase the cost of the chemical being made.The potential for improvement by reducing the amount of waste is self-evident.然而，近年来，最重要的工艺改进行为主要是减少生产过程对环境的影响，亦即防止生 产过程所引起的污染。很明显，有两个相关连的因素推动这样做。第一，公众对化学产品的 安全性及其对环境所产生影响的关注以及由此而制订出来的法律； 第二，生产者必须花钱对 废物进行处理以便它能安全地清除，比如说，排放到河水中。显然这是生产过程的又一笔费 用，它将增加所生产化学产品的成本。通过减少废物数量提高效益其潜能是不言而喻的。Note, however, with a plant which has already been built and is operating there are usually only very limited physical changes which can be made to the plant to achieve the above aims.Hence the importance, already mentioned, of eliminating waste production at the design stage of a new plant.Conserving energy and thus reducing energy cost has been another major preoccupation in recent years.然而，请注意，对于一个已经建好并正在运行的工厂来说，只能做一些有限的改变来达 到上述目的。因此，上

面所提到的减少废品的重要性应在新公厂的设计阶段加以考虑。近年 来另一个当务之急是保护能源及降低能源消耗。

(4)Applications development.Clearly the discovery of new applications or uses for a product can increase or prolong its profitability.Not only does this generate more income but the resulting increased scale of production can lead to lower unit costs and increased profit.An example is PVC whose early uses included records and plastic raincoats.Applications which came later included plastic bags and particularly engineering uses in pipes and guttering.（4）应用开发。显然发掘一个产品新的用处或新的用途能拓宽它的获利渠道。这不仅 能创造更多的收入，而且由于产量的增加使单元生产成本降低，从而使利润提高。举例来说，PVC 早期是用来制造唱片和塑料雨衣的，后来的用途扩展到塑料薄膜，特别是工程上所使 用的管子和排水槽。Emphasis has already been placed on the fact that chemicals are usually purchased for the effect, or particular use, or application which they have.This often means that there will be close liaison between the chemical companies‟ technical sales representatives and the customer, and the level of technical support for the customer can be a major factor in winning sales.Research and development chemists provide the support for these applications developments.An example is CF3CH3F.This is the first of the CFC replacements and has been developed as a extracting natural products from plant materials.In no way was this envisaged when the compound was first being made for use as a refrigerant gas, but it clearly is an example of applications development.我们已经强调了化学产品是由于它们的效果，或特殊的用途、用处而得以售出这个事实。这就意味着化工产品公司的技术销售代表与顾客之间应有密切的联系。对顾客的技术支持水平往往是赢得销售的一个重要的因素。进行研究和开发的化学家们为这些应用开发提供了帮 助。CH3CH3F 的制造就是一个例子。它最开始是用来做含氟氯烃的替代物作冷冻剂的。然 而近来发现它还可以用作从植物中萃取出来的天然物质的溶解剂。当它作为制冷剂被制造 时，固然没有预计到这一点，但它显然也是应用开发的一个例子。3.Variations in R&D Activities across the Chemical Industry Both the nature and amount of R&D carried out varies significantly across the various sectors of the chemical industry.In sectors which involve largescale production of basic chemicals and where the chemistry, products and technology change only slowly because the process are mature, R&D expenditure is at the lower end of the range for the chemical industry.Most of this will be devoted to process improvement and effluent treatment.Examples include ammonia, fertilizers and chloralkali production from the inorganic side, and basic petrochemical intermediates such a ethylene from the organic side.3．化工行业中研究与开发活动的变化 化学工业的不同部门所进行的 R&D 的性质与数量都有很大的变化。与大规模生产的基 础化工产品有关的部门中，化学产品和技术变化都很慢，因为流程已很成熟。R&D 经费支 出属于化工行业中低的一端，而且大部分的费用是用于过程改进和废水处理。无机方面的例 子有氨、肥料和氯碱的生产，有机方面的如乙烯等一些基础石油化学的中间产物。At the other end of the scale lie pharmaceuticals and pesticides(or plant protection products).Here there are immense and continuous efforts to synthesize new molecules which exert the desired, specific biological effect.A single company may generate 10,000 new compounds for screening each year.Little wonder that some inpidual pharmaceutical company‟s annual R&D

expenditure is now approaching $1000 million!Expressing this in a different way they spend in excess of 14% of sales income(note not profits)on R&D.不一样规模生产的是药品和除草

剂。人们付出了巨大而持续的努力以合成能产生所希望 的、特殊的生物作用的新分子。一家公司每年可能要合成 10,000 新化合物以供筛选。可以 想象一些医药公司其每年的 R&D 经费支出高达 100 亿美元。换句话说，他们把超过 14%的 销售收入投入在 R&D 上。

Unit 3 Typical Activities of Chemical Engineers 化学工程师的例行工作

The classical role of the chemical engineer is to take the discoveries made by the chemist in the laboratory and develop them into money--making, commercial-scale chemical processes.The chemist works in test tubes and Parr bombs with very small quantities of reactants and products(e.g., 100 ml), usually running “batch”, constant-temperature experiments.Reactants are placed in a small container in a constant temperature bath.A catalyst is added and the reactions proceed with time.Samples are taken at appropriate intervals to follow the consumption of the reactants and the production of products as time progresses.化学工程师经典的角色是把化学家在实验室里的发现拿来并发展成为能赚钱的、商业规 模的化学过程。化学家用少量的反应物在试管和派式氧弹中反应相应得到少量的生成物，所 进行的通常是间歇性的恒温下的实验，反应物放在很小的置于恒温水槽的容器中，加点催化 剂，反应继续进行，随时间推移，反应物被消耗，并有生成物产生，产物在合适的间歇时间 获得。By contrast, the chemical engineer typically works with much larger quantities of material and with very large(and expensive)equipment.Reactors can hold 1,000 gallons to 10,000 gallons or more.Distillation columns can be over 100 feet high and 10 to 30 feet in diameter.The capital investment for one process unit in a chemical plant may exceed $100 million!与之相比，化学工程师通常面对的是数量多得多的物质和庞大的（昂贵的）设备。反应 器可以容纳 1000 到 10,000 加仑甚至更多。蒸馏塔有 100 英尺多高，直径 10 到 30 英尺。化 工厂一个单元流程的投资可能超过 1 亿美元。The chemical engineer is often involved in “scaling up” a chemist-developed small-scale reactor and separation system to a very large commercial plant.The chemical engineer must work closely with the chemist in order to understand thoroughly the chemistry involved in the process and to make sure that the chemist gets the reaction kinetic data and the physical property data needed to design, operate, and optimize the process.This is why the chemical engineering curriculum contains so many chemistry courses.在把化学家研制的小型反应器及分离系统“放大”到很大的商业化车间时，通常需要化 学工程师的参与。为了彻底了解过程中的化学反应，化学工程师必须与化学家密切合作以确 保能得到所需要的反应的动力学性质和物理性质参数以进行设计、运转和优选流程。这就是 为什么化工课程要包括那么多的化学类课程的原因。The chemical engineer must also work closely with mechanical, electrical, civil, and metallurgical engineers in order to design and operate the physical equipment in a plant--the reactors, tanks, distillation columns, heat exchangers, pumps, compressors, Control and instrumentation devices, and so on.One big item that is always on such an equipment list is piping.One of the most impressive features f a typical chemical plant is the tremendous number of pipes running all over the site, literally hundreds of miles in many plants.These pipes transfer process materials(gases and liquids)into and out of the plant.They also carry utilities(steam, cooling water, air, nitrogen, and refrigerant)to the process units.化学工程师还必须与机械、电子、土木建筑和冶金工程师密切协作以设计和操作工厂的 机械设备—反应器、槽、蒸馏塔、热交换器、泵、压缩机、控制器和仪器设备等等。在这张 设备单上还有一大类是管子。化工厂最典型的特征之一就是数目庞大的管道贯穿所有生产 间。可以毫不夸张地说，在许多车间都有几百英里长的管道。这些管道输入和输出车

间的反 应物质进行传递，同时还可携带有用的东西（水蒸气、冷却水、空气、氧、冷却剂）进入操 作单元。To commercialize the laboratory chemistry, the chemical engineer is involved in development, design, construction, operation, sales, and research.The terminology used to label these functions is by no means uniform from company to company, but a rose by any other name is still a rose.Let us describe each of these functions briefly.It should be emphasized that the jobs we shall discuss are “typical” and “classical”, but are by no means the only things that chemical engineers do.The chemical engineer has a broad background in mathematics, chemistry, and physics.Therefore, he or she can, and does, fill a rich variety of jobs in industry, government, and academia.要把实验室研究商业化，化学工程师要参与进行开发、设计、建筑、操作、销售和研究 工作。各个公司用来表示这些工作的名词不完全一样，但万变不离其宗。让我们简单地把每 个工作描述一下。应该强调的是，我们所讨论的工作是“典型的”和“经典的”，但并不意 味着化学工程师只能做这些事。化学工程师在数学、化学和物理学方面都有很好的知识基础，因此，他或她能够而且确实适应工业、政府部门、大专院校等非常广泛的职业要求。1.Development Development is the intermediate step required in passing from a laboratory-size process to a commercial-size process.The “pilot-plant” process involved in development might involve reactors that are five gallons in capacity and distillation columns that are three inches in diameter.Development is usually part of the commercialization of a chemical process because the scale-up problem is a very difficult one.Jumping directly from test tubes to 10,000-gallon reactors can be a tricky and sometimes dangerous endeavor.Some of the subtle problems involved which are not at all obvious to the uninitiated include mixing imperfections, increasing radial temperature gradients, and decreasing ratios of heat transfer areas to heat generation rates.1.开发 开发工作是从实验室规模向商业化规模转化所必需的中间阶段。开发阶段所涉及的 “中 试”流程所使用的反应器容量为 5 加仑，蒸馏塔直径为 3 英寸。开发通常是化学流程商业化 的一部分。因为“放大”规模是一个非常困难的问题。直接从试管研制跳到在 10.000 加仑 反应器里生产是非常棘手的有时甚至是危险的工作。一些（在实验室研究阶段）根本不明显 的未加以考虑的细微问题，如混合不均匀，温度梯度辐射状升高，热交换面积逐渐降低以及 热交换速度下降等（在后一阶段变得影响很大）。The chemical engineer works with the chemist and a team of other engineers to design, construct, and operate the pilot plant.The design aspect involves specifying equipment sizes, configuration, and materials of construction.Usually pilot plants are designed to be quite flexible, so that a wide variety of conditions and configurations can be evaluated.化学工程师与化学家和其他一些工程师协作对中师车间进行设计、安装和运行，设计方 面包括确定设备的尺寸、结构、制造所用的材料。通常中师车间的设计是有很大的变通性的，以便能对各种情况和构造进行评估。Once the pilot plant is operational, performance and optimization data can be obtained in order to evaluate the process from an economic point of view.The profitability is assessed at each stage of the development of the process.If it appears that not enough money will be made to justify the capital investment, the project will be stopped.中试车间一旦开始运转，就能获得性能数据和选定最佳数值以便从经济学角度对流程进 行评价。对生产过程的每一个阶段可能获得的利润进行评定。如果结果显示投入的资金不能 有足够的回报，这项计划将被停止。The pilot plant offers the opportunity to evaluate materials of construction, measurement techniques, and process control strategies.The experimental findings in the pilot plant can be used to improve the design of the full-scale plant.中师车间还提供了评价设备制造材料、测量方法、流程控制技术的机会。中试车间的这 些实验数据对于工业装

置设计的改善能提供有用的帮助。2.Design Based on the experience and data obtained in the laboratory and the pilot plant, a team of engineers is assembled to design the commercial plant.The chemical engineer‟s job is to specify all process flow rates and conditions, equipment types and sizes, materials of construction, process configurations, control systems, safety systems, environmental protection systems, and other relevant specifications.It is an enormous responsibility.2． 设计 根据在实验室和中试车间获得的经验和数据，一组工程师集中起来设计工业化的车间。化学工程师的职责就是详细说明所有过程中的流速和条件，设备类型和尺寸，制造材料，流 程构造，控制系统，环境保护系统以及其它相关技术参数。这是一个责任重大的工作。The design stage is really where the big bucks are spent.One typical chemical process might require a capital investment of $50 to $100 million.That’s a lot of bread!And the chemical engineer is the one who has to make many of the decisions.When you find yourself in that position, you will be glad that you studied as hard as you did(we hope)so that you can bring the best possible tools and minds to bear on the problems.设计阶段是大把金钱花进去的时候。一个常规的化工流程可能需要五千万到一亿美元的 资金投入，有许多的事情要做。化学工程师是做出很多决定的人之一。当你身处其位时，你 会对自己曾经努力学习而能运用自己的方法和智慧处理这些问题感到欣慰。The product of the design stage is a lot of paper:(1)Flow sheets are diagrams showing all the equipment schematically, with all streams labeled and their conditions specified(flow rate, temperature, pressure, composition, viscosity, density, etc.)设计阶段的产物是很多图纸：（1）工艺流程图。是显示所有设备的图纸。要标出所有的流线和规定的条件（流速、温度、压力、构造、粘度、密度等）。

(2)P and I(Piping and Instrumentation)Drawings are drawings showing all pieces of equipment(including sizes, nozzle locations, and materials), all piping(including sizes, materials, and valves), all instrumentation(including locations and types of sensors, control valves, and controllers), and all safety systems(including safety valve and rupture disk locations and sizes, flare lines, and safe operating conditions).（2）管道及设备图。标明所有设备（包括尺寸、喷嘴位置和材料）、所有管道（包括大 小、控制阀、控制器）以及所有安全系统（包括安全阀、安全膜位置和大小、火舌管、安全 操作规则）。(3)Equipment specification Sheets are sheets of detailed information on all the equipment precise dimensions, performance criteria, materials of construction, corrosion allowances, operating temperatures, and pressures, maximum and minimum flow rates, and the like.These “spec sheets” are sent to the equipment manufacturers for price bids and then for building the equipment.（3）仪器设备说明书。详细说明所有设备准确的空间尺度、操作参数、构造材料、耐 腐蚀性、操作温度和压力、最大和最小流速以及诸如此类等等。这些规格说明书应交给中标 的设备制造厂以进行设备生产。3.Construction After the equipment manufacturers(vendors)have built the inpidual pieces of equipment, the pieces are shipped to the plant site(sometimes a challenging job of logistics, particularly for large vessels like distillation columns).The construction phase is the assembling of all the components into a complete plant.It starts with digging holes in the ground and pouring concrete for foundations for large equipment and buildings(e.g., the control room, process analytical laboratory, and maintenance shops).3． 建造 当设备制造把设备的所有部分都做好了以后，这些东西要运到工厂所在地（有时这是后 勤部门颇具挑战性的任务，尤其对象运输分馏塔这样大型的船只来说）。建造阶段要把所有 的部件装配成完整的工厂，首先要做的就是在地面打洞并倾入混凝土，为大型设备及建筑物 打下基础（比如控制室、流程分析实验室、维修车间）。After these initial activities, the major pieces of equipment and the

steel superstructure are erected.Heat exchangers, pumps, compressors, piping, instrument sensors, and automatic control valves are installed.Control system wiring and tubing are run between the control room and the plant.Electrical wiring, switches, and transformers are installed for motors to drive pumps and compressors.As the process equipment is being installed, it is the chemical engineer’s job to check that it is all hooked together properly and that each piece works correctly.完成了第一步，就开始安装设备的主要部分以及钢铁上层建筑。要装配热交换器、泵、压缩机、管道、测量元件、自动控制阀。控制系统的线路和管道连接在控制室和操作间之间。电线、开关、变换器需装备在马达上以驱动泵和压缩机。生产设备安装完毕后，化学工程师 的职责就是检查它们是否连接完好，每部分是否正常工作。This is usually a very exciting and rewarding time for most engineers.You are seeing your ideas being translated from paper into reality.Steel and concrete replace sketches and diagrams.Construction is the culmination of years of work by many people.You are finally on the launch pad, and the plant is going to fly or fizzle!The moment of truth is at hand.对大部分工程师来说这通常是一个令人激动、享受成功的时候。你将看到自己的创意由 图纸变为现实。钢铁和混凝土代替了示意图和表格。建筑是许多人多年辛劳的结果。你终于 站到了发射台上，工厂将要起飞还是最后失败。揭晓的那一刻即将到来。Once the check-out phase is complete, “startup” begins.Startup is the initial commissioning of the plant.It is a time of great excitement and round-the-clock activity.It is one of the best learning grounds for the chemical engineer.Now you find out how good your ideas and calculations really are.The engineers who have worked on the pilot plant and on the design are usually part of the startup team.测试阶段一旦完成，“运转阶段”就开始了。启动是工厂的首项任务，是令人兴奋的时 刻和日夜不停的工作。这是化学工程师最好的学习机会之一。现在你可以了解你的构思和计 算究竟有些什么好。参与中试车间和设计工作的工程师通常也是启动队伍中的人员。The startup period can require a few days or a few moths, depending on the newness of the technology, the complexity of the process, and quality of the engineering that has gone into the design.Problems are frequently encountered that require equipment modifications.This is time consuming and expensive: just the lost production from a plant can amount to thousands of dollars per day.Indeed, there have been some plants that have never operated, because of unexpected problems with control, corrosion, or impurities, or because of economic problem.启动阶段需要几天或几个月，根据设计所涉及工艺技术的新颖、流程的复杂程度以及工 程的质量而定。中间经常会遇到要求设备完善的问题。这是耗时耗财的阶段：仅仅每天从车 间出来的废品会高达数千美金。确实，曾经有些车间因为没有预计到的问题如控制、腐蚀、杂质或因为经济方面的问题而从来没有运转过。The engineers are usually on shift work during the startup period.There is a lot to learn in a short time period.Once the plant has been successfully operated at its rated performance, it is turned over to the operating or manufacturing department for routine production of products.在启动阶段，工程师们通常需轮流值班。在很短的时间里有很多的东西需要学习。一旦 车间按照设定程序成功运转，它就转变为产品的常规生产或制造部门。4.Manufacturing Chemical engineers occupy a central position in manufacturing.(or “operations” or “production,” as it is called in some companies).Plant technical service group are responsible for the technical aspects of running an efficient and safe plant.They run capacity and performance tests on the plant to determine where the bottlenecks are in the equipment, and then design modifications and additions to remove these bottlenecks.4． 制造 化学工程师在制造阶段占据中心的位置。车间技术服务部门负责车间有效而安全地运转 的技术方面。他们进行生产

量和性能测试以找出设备的瓶颈在哪，然后设计一些修正或附加 的东西以解决这些瓶颈。Chemical engineers study ways to reduce operating costs by saving energy, cutting raw

material consumption, and reducing production of off-specification products that require reprocessing.They study ways to improve product quality and reduce environmental pollution of both air and water.化学工程师研究一些方法节省能源，降低原材料消耗、减少不合要求的需进行处理的产 品的生产，以降低生产成本。他们还研究一些提高产品质量、减少空气和水中环境污染的措 施。In addition to serving in plant technical service, many engineers have jobs as operating supervisors.These supervisors are responsible for all aspects of the day-to-day operation of the plant, including supervising the plant operators who run the plant round the clock on a three-shift basis, meeting quality specifications, delivering products at agreed-upon times and in agreed-upon quantities, developing and maintaining inventories of equipment spare parts, keeping the plant well maintained, making sure safe practices are followed, avoiding excessive emissions into the local environment, and serving as spokespersons for the plant to the local community.除了提供技术服务外，许多工程师还负责生产监督。这些监督保证工厂日常生产的各个 方面正常进行。包括管理换班工作的操作工，满足质量要求，按期按量发出产品，生产并保 持设备备件的存储量，为车间设备维修，保证安全规则被遵守，避免过多排出废物污染环境，并且做工厂对当地社会的代言人。5.Technical sales Many chemical engineers find stimulating and profitable careers in technical sales.As with other sales positions, the work involves calling on customers, making recommendations on particular products to fill customer‟s needs, and being sure that orders are handled smoothly.The sales engineer is the company‟s representative and must know the company‟s product line well.The sales engineer‟s ability to sell can greatly affect the progress and profitability of the company.5． 技术销售 许多化学工程师发现在技术销售中充满了刺激性的、有利可图的机会。与其它的销售业 务一样，这项业务包括拜访客户，推荐一些特别的商品以满足客户的需要，并确保订单能顺 利完成。销售工程师是公司的代表，必须十分清楚公司的产品生产情况。销售工程师的销售 能力极大地影响公司的发展和利润。The marketing of many chemicals requires a considerable amount of interaction between engineers in the company producing the chemical and engineers in the company using the chemical.This interaction can take the form of advising on how to use a chemical or developing a new chemical in order to solve a specific problem of a customer.许多化工产品的市场开发需要制造化工产品公司的工程师与使用化工产品公司的工程 师密切合作。这种合作所采取的方式可以是对如何使用一种化学产品提出建议，或者是生产 出一种新的化学产品以解决客户的某个特殊的困难。When the sales engineer discovers problems that cannot be handled with confidence, he or she must be able to call on the expertise of specialists.The sales engineer may sometimes have to manage a joint effort among researchers from several companies who are working together to solve a problem.当销售工程师碰到他自己没有把握解决的问题时，他或她必须要请教专家。有时销售工

程师还需组织来自不同公司的研究人员共同努力来解决某个问题。6.Research Chemical engineers are engaged in many types of research.They work with the chemist in developing new or improved products.They develop new and improved engineering methods(e.g., better computer programs to simulate chemical processes, better laboratory analysis methods for characterizing chemicals, and new types of reactors ad separation systems).They work on improved sensors for on-line physical property measurements.They study alternative process

configurations and equipment.6． 研究 化学工程师能从事多种类型的研究工作。他们与化学家联合开发新的或革新的产品。他 们探索新的和改良的工程技术（比如更好的计算机程序以模拟化工工艺，更好的实验室分析 方法分析有代表性的化学产品，新型的反应和分离系统。）他们研究改进的传感器以进行物 理性质的在线检测，他们还研究单个流程结构和设备。Research engineers are likely to be found in laboratories or at desks working on problems.They usually work as members of a team of scientists and engineers.Knowledge of the process and common types of process equipment helps the chemical engineer make special contributions to the research effort.The chemical engineer‟s daily activities may sometimes closely resemble those of the chemist or physicist working on the same team.研究工程师可能是在实验室或办公桌前钻研难题。他们通常是一组科学家或工程师中的 一员。了解生产流程以及通常流程所使用的设备使化学工程师能在研究工作中做出突出的贡 献。化学工程师的日常工作有时颇似那些化学家和物理学家。

Unit 10

What Is Chemical Engineering? 什么是化学工程学

In a wider sense, engineering may be defined as a scientific presentation of the techniques and facilities used in a particular industry.For example, mechanical engineering refers to the techniques and facilities employed to make machines.It is predominantly based on mechanical forces which are used to change the appearance and/or physical properties of the materials being worked, while their chemical properties are left unchanged.Chemical engineering encompasses the chemical processing of raw materials, based on chemical and physico-chemical phenomena of high complexity.广义来讲，工程学可以定义为对某种工业所用技术和设备的科学表达。例如，机械工程 学涉及的是制造机器的工业所用技术和设备。它优先讨论的是机械力，这种作用力可以改变 所加工对象的外表或物理性质而不改变其化学性质。化学工程学包括原材料的化学过程，以 更为复杂的化学和物理化学现象为基础。Thus, chemical engineering is that branch of engineering which is concerned with the study of the design, manufacture, and operation of plant and machinery in industrial chemical processes.因此，化学工程学是工程学的一个分支，它涉及工业化化学过程中工厂和机器的设计、制造、和操作的研究。Chemical engineering is above all based on the chemical sciences, such as physical chemistry, chemical thermodynamics, and chemical kinetics.In doing so, however, it does not simply copy their findings, but adapts them to bulk chemical processing.The principal objectives that set chemical engineering apart from chemistry as a pure science, is “to find the most economical route of operation and to design commercial equipment and accessories that suit it best of all”.Therefore, chemical engineering is inconceivable without close ties with economics, physics, mathematics, cybernetics, applied mechanics, and other technical sciences.前述化学工程学都是以化学科学为基础的，如物理化学，化学热力学和化学动力学。然 而这样做的时候，它并不是仅仅简单地照搬结论，而是要把这些知识运用于大批量生产的化 学加工过程。把化学工程学与纯化学区分开来的首要目的是 “找到最经济的生产路线并设计 商业化的设备和辅助设备尽可能地适应它。”因此如果没有与经济学，物理学，数学，控制 论，应用机械以及其它技术的联系就不能想象化学工程会是什么样的。In its early days, chemical engineering was largely a descriptive science.Many of the early textbooks and manuals on chemical engineering were encyclopedias of the commercial production processes known at the time.Progress in science and industry has bought with it an impressive increase in the number of chemical manufactures.Today, petroleum for example serves as the source material for the production of

about 80 thousand chemicals.The expansion of the chemical process industries on the one hand and advances in the chemical and technical sciences on the other have made it possible to lay theoretical foundations for chemical processing.早期的化学工程学以描述性为主。许多早期的有关化学工程的教科书和手册都是那个时 候已知的商品生产过程的百科全书。科学和工业的发展使化学品的制造数量迅速增加。举例

来说，今天石油已经成为八万多种化学产品生产的原材料。一方面是化学加工工业扩张的要 求，另一方面是化学和技术水平的发展为化学工艺建立理论基础提供了可能。As the chemical process industries forged ahead, new data, new relationships and new generalizations were added to the subject-matter of chemical engineering.Many branches in their own right have separated from the main stream of chemical engineering, such as process and plant design, automation, chemical process simulation and modeling, etc.随着化学加工工业的发展，新的数据，新的关系和新的综论不断添加到化学工程学的目 录中。然后又从主干上分出许多的分支，如工艺和工厂设计，自动化，化工工艺模拟和模型，等等。1.A Brief Historical Outline Historically, chemical engineering is inseparable from the chemical process industries.In its early days chemical engineering which came into being with the advent of early chemical trades was a purely descriptive pision of applied chemistry.1． 简要的历史轮廓 从历史上来说，化学工程学与化学加工工业密不可分。在早期，化学工程学随着早期化学产 品交易的发展而出现，是应用化学的纯描述性的分支。The manufacture of basic chemical products on Europe appears to have begun in the 15th century when small, specialized businesses were first set up to turn out acids, alkalis, salts, pharmaceutical preparations, and some organic compounds.在欧洲，基础化学产品的制造出现在 15 世纪。一些小的、专门的企业开始创立，生产酸、碱、盐、药物中间体和一些有机化合物。For all the rhetoric of nineteenth-century academic chemists in Britain urging the priority of the study of pure chemistry over applied, their students who became works chemists were little more than qualitative and quantitative analysts.Before the 1880s this was equally true of German chemical firms, who remained content to retain academic consultants who pursued research within the university and who would occasionally provide the material for manufacturing innovation.By the 1880s, however, industrialists were beginning to recognize that the scaling up of consultants‟ laboratory preparations, and syntheses was a distinctly different activity from laboratory investigation.They began to refer to this scaling problem and its solution as “chemical engineering”—possibly because the mechanical engineers who had already been introduced into works to who seemed best able to understand the process involved.The academic dichotomy of head and hand died slowly.由于十九世纪英国的学院化学家强调纯化学的研究高于应用化学，他们的要成为工业化学 家的学生也只是定性和定量分析者。在 19 世纪 80 年代以前，德国的化学公司也是这样。他 们愿意聘请那些在大学里进行研究的人作顾问，这些人偶尔为制造的革新提供一些意见。然 而到了 80 年代，工业家们开始认识到要把顾问们在实验室的准备和合成工作进行放大是一 个与实验室研究截然不同的活动。他们开始把这个放大的问题以及解决的方法交给 “化学工 程师” —这可能是受到已经进入工厂的机械工程师的表现的启发。由于机械工程师熟悉所涉 及的加工工艺，是维修日益复杂化的工业生产中的蒸气机和高压泵的最合适的人选。学院研 究中头和手两分的现象逐渐消亡。

Unit operation.In Britain when in 1881 there was an attempt to name the new Society of Chemical industry as the “Society of Chemical engineers”, the suggestion was turned down.On

the other hand, as a result of growing pressure from the industrial sector the curricula of technical institutions began to reflect, at last, the need for chemical engineers rather than competent analysts.No longer was mere description of existing industrial processes to suffice.Instead the expectation was that the processes generic to various specific industries would be analyzed, thus making room for the introduction of thermodynamic perspectives, as well as those being opened up buy the new physical chemistry of kinetics, solutions and phases.单元操作。1881 年英国曾经准备把化学工业的一个新的协会命名为 “化学工程师协会”，这个建议遭到了拒绝。另一方面，由于受到来自工业界日益加重的压力，大学的课程开始体 现出除了培养分析工作者还要培养化学工程师的要求。现在仅仅对现有工业过程进行描述已 经不够了，需要对各种特殊工业进行工艺属性的分析。这就为引入热力学及动力学、溶液和 相等物理化学新思想提供了空间。A key figure in this transformation was the chemical consultant, George Davis(1850-1907), the first secretary of the Society of Chemical Industry.In 1887 Davis, then a lecture at the Manchester Technical School, gave a series of lectures on chemical engineering, which he defined as the study of “the application of machinery and plant to the utilization of chemical action on the large scale”.The course, which revolved around the type of plant involved in large-scale industrial operations such as drying, crashing, distillation, fermentation, evaporation and crystallization, slowly became recognized as a model for courses elsewhere, not only in Britain, but overseas.The first fully fledged course in chemical engineering in Britain was not introduced until 1909;though in America, Lewis Norton(1855-1893)of MIT pioneered a Davis-type course as early as 1888.在这个转变期，一位关键的人物是化学顾问 George Davis，化学工业协会的首任秘书。1887 年 Davis 那时是 Manchester 专科学校的一名讲师，做了一系列有关化学工程学的讲座。他把化学工程学定义为对“大规模化学生产中所应用的机器和工厂”的研究。这们课程包括 了大规模工业化操作的工厂的各种类型，如干燥、破碎、蒸馏、发酵、蒸发和结晶。后来逐 渐在别的地方而不仅仅在英国，而是国外，成为许多课程的雏形。英国直到 1909 年化学工 程学才成为一门较为完善的课程，而在美国，MIT 的 Lewis Norton 早在 1888 年就已率先开 出了 Davis 型课程。In 1915, Arthur D.Little, in a report on MIT’s programme, referred to it as the study of “unit operations” and this neatly encapsulated the distinctive feature of chemical engineering in the twentieth century.The reasons for the success of the Davis movement are clear: it avoided revealing the secrets of specific chemical processes protected by patents or by an owner‟s reticence—factors that had always seriously inhibited manufacturers from supporting academic programmes of training in the past.Davis overcame this difficulty by converting chemical industries “into separate phenomena which could be studied independently” and, indeed, experimented with in pilot plants within a university or technical college workshop.1915 年，Arthur D.little 在一份 MIT 的计划书中，提出了“单元操作”这个概念，这几 乎为二十世纪化学工程学的突出特点做了定性。Davis 这一倡议的成功原因是很明显的：它 避免了泄露特殊化学过程中受专利权或某个拥有者的保留权所保护的秘密。过去这种泄露已 经严重限制了制造者对学院研究机构训练计划的支持。Davis 把化学工业分解为“能独立进 行研究的单个的工序” 从而克服了这个困难。并且在大学或专科学校的工厂里用中试车间进

行了试验。In effect he applied the ethics of industrial consultancy by which experience was transmitted “from plant to plant and from process to process in such a way which did not compromise the private or specific knowledge which contributed to a given plant‟s profitability”.The concept of unit operations held that any chemical manufacturing process could be resolved into a coordinated series of operations such as pulverizing, drying, roasting, electrolyzing, and so

on.Thus, for example, the academic study of the specific aspects of turpentine manufacture could be replaced by the generic study of distillation, a process common to many other industries.A quantitative form of the unit operations concept emerged around 1920s, just in time for the nation‟s first gasoline crisis.The ability of chemical engineers to quantitatively characterize unit operations such as distillation allowed for the rational design of the first modern oil refineries.The first boom of employment of chemical engineers in the oil industry was on.他采用了工业顾问公司的理念，经验传递从一个车间到另一个车间，从一个过程到另一 个过程。这种方式不包含限于某个给定工厂的利润的私人的或特殊的知识。单元操作的概念 使每一个化学制造过程都能分解为一系列的操作步骤，如研末、干燥、烤干、电解等等。例 如，学校对松节油制造的特殊性质的研究可以用蒸馏属性研究来代替。这是一个对许多其它 工业制造也很普通的工艺过程。单元操作概念的定量形式大概出现在 1920 年，刚好是在第 一次全球石油危机出现的时候。化学工程师能赋予单元操作定量特性的能力使得他们合理地 设计了第一座现代炼油厂。石油工业第一次大量聘请化学工程师的繁荣时代开始了。During this period of intensive development of unit operations, other classical tools of chemical engineering analysis were introduced or were extensively developed.These included studies of the material and energy balance of processes and fundamental thermodynamic studies of multicomponent systems.在单元操作密集繁殖的时代，化学工程学另一些经典的分析手段也开始被引入或广泛发 展。这包括过程中材料和能量平衡的研究以及多组分体系中基础热力学的研究。Chemical engineers played a key role in helping the United States and its allies win World War Ⅱ.Theydeveloped routes to synthetic rubber to replace the sources of natural rubber that were lost to the Japanese early in the war.They provided the uranium-235 needed to build the atomic bomb, scaling up the manufacturing process in one step from the laboratory to the largest industrial plant that had ever been built.And they were instrumental in perfecting the manufacture of penicillin, which saved the lives of potentially hundreds of thousands of wounded soldiers.化学工程师在帮助美国及其盟国赢得第二次世界大战的胜利中起了关键的作用。他们发 展了合成橡胶的方法以代替在战争初期因日本的封锁而失去来源的天然橡胶。他们提供了制 造原子弹所需要的铀-235，把制造过程从实验室研究一步放大到当时最大规模的工业化工 厂，而他们在完善 penicillin 的生产工艺中也是功不可没，它挽救了几十万受伤士兵的生命。The Engineering Science Movement.Dissatisfied with empirical descriptions of process equipment performance, chemical engineers began to reexamine unit operations from a more fundamental point of view.The phenomena that take place in unit operations were resolved into sets of molecular events.Quantitative mechanistic models for these events were developed and used to analyze existing equipment.Mathematical models of processes and reactors were

developed and applied to capital-intensive U.S.industries such as commodity petrochemicals.工程学运动。由于不满意对工艺设备运行的经验描述，化学工程师开始从更基础的角度 再审视单元操作。发生在单元操作中的现象可以分解到分子运动水平。这些运动的定量机械 模型被建立并用于分析已有的仪器设备。过程和放应器的数学模型也被建立并被应用于资金 密集型的美国工业如石油化学工业。Parallel to the growth of the engineering science movement was the evolution of the core chemical engineering curriculum in its present form.Perhaps more than any other development, the core curriculum is responsible for the confidence with which chemical engineers integrate knowledge from many disciplines in the solution of complex problems.与工程学同时发展的是现在的化学工程课程设置的变化。也许与其它发展相比较，核心 课程为化学工程师运用综合技能解决复杂问题更加提供了信心。The core

curriculum provides a background in some of the basic sciences, including mathematics, physics, and chemistry.This background is needed to undertake a rigorous study of the topics central to chemical engineering, including: 核心课程固定了一些基础科学为背景，包括数学，物理，和化学。这些背景对于从事以 化学工程为中心的课题的艰苦研究是必须的，包括： Multicomponent thermodynamics and kinetics, Transport phenomena, Unit operations, Reaction engineering, Process design and control, and Plant design and systems engineering.多组分体系热力学及动力学 传输现象 单元操作 反应工程 过程设计和控制 工厂设计和系统工程 This training has enabled chemical engineers to become leading contributors to a number of interdisciplinary areas, including catalysis, colloid science and technology, combustion, electro-chemical engineering, and polymer science and technology.这种训练使化学工程师们成为了在许多学科领域做出了突出贡献的人，包括在催化学、胶体科学和技术、燃烧、电化学工程、以及聚合物科学和技术方面。2.Basic Trends In Chemical Engineering Over the next few years, a confluence of intellectual advances, technologic challenges, and economic driving forces will shape a new model of what chemical engineering is and what chemical engineering do.2.化学工程学的基本发展趋势 未来几年里，科学的进步，技术的竞争以及经济的驱动力将为化学工程是什么以及化学

工程能做什么打造一个新的模型。The focus of chemical engineering has always been industrial processes that change the physical state or chemical composition of materials.Chemical engineers engage in the synthesis, design, testing scale-up, operation, control and optimization of these processes.The traditional level of size and complexity at which they have worked on these problems might be termed the mesoscale.Examples of this scale include reactors and equipment for single processes(unit operations)and combinations of unit operations in manufacturing plants.Future research at the mesoscale will be increasingly supplemented by dimensions—the microscale and the dimensions of extremely complex systems—the macroscale.化学工程学的焦点一直是改变物体的物理状态或化学性质的工业过程。化学工程师致力 于这些过程的合成、设计、测试放大、操作、控制和优选。他们从事于解决的这些问题，传 统的规模水平和复杂程度可称之为中等的，这种规模的例子包括有单个过程（单元操作）所 使用的反应器和设备以及制造厂里单元操作的组合，未来的研究将在规模上逐渐进行补充。除了中等规模，还有微型的以及更为复杂的系统巨型的规模。Chemical engineers of the future will be integrating a wider range of scales than any other branch of engineering.For example, some may work to relate the macroscale of the environment to the mesoscale of combustion systems and the microscale of molecular reactions and transport.Other may work to relate the macroscale performance of a composite aircraft to the mesoscale chemical reactor in which the wing was formed, the design of the reactor perhaps having been influenced by studies of the microscale dynamics of complex liquids.未来的化学工程师将比任何其他分支的工程师在更为宽广的规模范围紧密协作。例如，有些人可能从事于了解大范围的环境与中等规模的燃烧系统以及微型的分子水平的反应和 传递之间的关系。另一些人则从事了解合成的飞机的的性能与机翼所用化学反应器及反应器 的设计和对此有影响的复杂流体动力学的研究工作。Thus, future chemical and engineers will conceive and rigorously solve problems on a continuum of scales ranging from microscale.They will bring new tools and insights to research and practice from other disciplines: molecular biology, chemistry, solid-state physics, materials science, and electrical engineering.And they will make increasing use of computers, artificial intelligence, and expert system in problem solving, in product and process design, and in manufacturing.因此，未

来的化学工程师们要准备好解决从微型的到巨型的规模范围内出现的问题。他 们要用来自其它学科的新的工具和理念来研究和实践：分子生物学，化学，固体物理学，材 料学和电子工程学。他们还将越来越多地使用计算机、人工智能以及专家系统来解决问题，进行产品和过程设计，生产制造。Two important development will be part of this unfolding picture of the discipline.Chemical engineers will become more heavily involved in product design as a complement to process design.As the properties of a product in performance become increasingly linked to the way in which it is processed, the traditional distinction between product and process design will become blurred.There will be a special design challenge in established and emerging industries that produce proprietary, differentiated products tailored to exacting performance specifications.These products are characterized by the need for rapid innovatory ad they are quickly superseded in the marketplace by newer products.在这个学科中还有两个重要的发展是我们前面没有提到的： 化学工程师将越来越多地涉及到对过程设计进行补充的产品设计中。因为产品所表现出 来的性能将逐渐与它被加工的途径挂钩。传统概念上产品设计与过程设计之间的区别将变得 模糊，不再那么明显。在已有的和新兴的工业中将出现一个特殊的设计竞争，那就是生产有 专利权的、有特点的产品以适应严格的性能指标。这些产品的特征是服从快速革新的需要，因而他们将在市场上很快地被更新的产品所取代。Chemical engineers will be frequent participants in multidisciplinary research efforts.Chemical engineering has a long history of fruitful interdisciplinary research with the chemical sciences, particularly industry.The position of chemical engineering as the engineering discipline with the strongest tie to the molecular sciences is an asset, since such sciences as chemistry, molecular biology, biomedicine, and solid-state physics are providing the seeds for tomorrow‟s technologies.Chemical engineering has a bright future as the “interfacial discipline”, that will bridge science and engineering in the multidisciplinary environments where these new technologies will be brought into being.化学工程师将经常性地介入到多学科领域的研究工程。化学工程师参与跨学科研究与化 学科学、特种工业进行合作具有悠久的历史。随着工程学与分子科学最紧密地联系在一起，化学工程学的地位也越来越崇高。因为如化学、分子生物学、生物医学以及固体物理这样的 科学都是为明天的科学技术提供种子，作为“界面科学”，化学工程学具有光明的未来，它 将在多学科领域中搭建科学和工程学之间的桥梁，而在这里将出现新的工业技术。

Unit 20 Material Science and Chemical Engineering 材料科学和化学工程

A few years ago, who would have dreamed that an aircraft could circumnavigate the earth without landing or refueling? Yet in 1986 the novel aircraft Voyager did just that.The secret of Voyager‟s long flight lies in advanced materials that did not exist a few years ago.Much of the airframe was constructed from strong, lightweight polymer-fiber composite sections assembled with durable, high-strength adhesive;the engine was lubricated with a synthetic multicomponent liquid designed to maintain lubricity for a long time under continuous operation.These special materials typify the advances being made by scientists and engineers to meet the demands of modern society.几年以前，谁会想到一架飞机可以绕地球航行而中途不需要着陆或添加燃料？而在 1986 年新型的飞机航海者就做到了这一点。航海者具备长途飞行能力的秘密就在于几年前 还没有出现的先进的材料。其机身大部分是由强度大、质量轻的聚合纤维用耐久的、高强度 的粘合剂组装而成的。而发动机润滑油是合成的多组分液体，可维持很长时间连续运转的润 滑性。这些特殊材料具有科学家和工程师们为满足现代社会的需求所发明 的先进技术。The future of industries such as transportation, communications, electronics, and energy conversion hinges on new and improved materials and the processing technologies required to produce them.Recent years have seen rapid advances in our understanding of how to combine substances into materials with special, high-performance properties and how to best use these materials in sophisticated designs.如运输、通讯、电子、能量转换这些工业的未来多依赖新的、先进的材料以及生产中所 需要的加工技术。近年来，在我们了解了如何把一些特殊的具有高性能的物质融入原材料并 且怎样最好地在复杂设计中使用这些材料后，这方面已有了很大的发展。The revolution in materials science and engineering presents both opportunities and challenges to chemical engineers.With their basic background in chemistry, physics, and mathematics and their understanding of transport phenomena, thermodynamics, reaction engineering, and process design, chemical engineers can bring innovative solutions to the problems of modern materials technologies.But it is imperative that they depart from the traditional “think big” philosophy of the profession;to participate effectively in modern materials science and engineering they must learn to “think small” the crucial phenomena in making modern advanced materials occur at the molecular and microscale levels, and chemical engineers must understand and learn to control such phenomena if they are to engineer the new products and processes for making them.This crucial challenge is illustrated in the selected materials areas described in the following sections.材料科学和工程的革命为化学工程师带来了机会，也带来了挑战。化学工程师凭借他们 在化学、物理和数学方面的知识基础以及他们对传输现象、动力学、反应工程和过程设计的 了解，能够创造性地解决现代材料技术中的问题。但是他们一定要摈弃掉传统职业理念中 “考 虑大的”这个习惯，要有效地投入现代材料科学和工程中必须要学会“从小处思考”。在制

造现代先进材料时的关键现象是发生在分子级和微观的水平。如果化学工程师要为这些新材 料设计新产品和工艺就必须了解并且学会控制这些现象。在下面选择介绍的几种材料领域里 我们将叙述这种困难的挑战。1.Polymers The modern era of polymer science belongs to the chemical engineer.Over the years, polymer chemists have invented a wealth of novel macromolecules and polymers.Yet understanding how these molecules can be synthesized and processed to exhibit their maximum theoretical properties is still a frontier for research.Only recently has modern instrumentation been developed to help us understand the fundamental interactions of macromolecules with themselves, with particulate solids, with organic and inorganic fibers, and with other surfaces.Chemical engineers are using these tools to probe the microscale dynamics of macromolecules.Using the insight gained from these techniques, they are manipulating macromolecular interactions both to develop improved processes and to create new materials.1．聚合物 现代聚合物科学的时代属于化学工程师。这些年来，聚合物化学家创造了大量的高分子 和聚合物。然而了解这些高分子是怎样被合成并加工以最大限度地具备理论性质仍然是研究 的前沿领域。一直到最近才开发了现代仪器帮助我们了解高分子之间、高分子与固体粒子、有机和无机纤维与其它界面之间的相互作用。化学工程师正使用这些工具探索高分子的微型 动力学现象，他们利用从这些技术中获得的知识，正在处理高分子间的反应以开发先进的工 艺并制造新的材料。The power of chemical processing for controlling materials structure on the microscale is illustrated by the current generation of high-strength polymer fibers, some of which have strength-to weigh ratios an order of magnitude greater than steel.This spontaneous orientation is the result of both the processing conditions chosen and the highly rigid linear molecular structure of the aramid polymer.During spinning, the

oriented regions in the liquid phases align with the fiber axis to give the resulting fiber high strength and rigidity.The concept of spinning fibers from anisotropic phases has been extended to both solutions and melts of newer polymers, such as polybenzothiazole, as well as traditional polymers such as polyethylene.Ultrahigh-strength fibers of polyethylene have been prepared by gel spinning.The same concept, controlling the molecular orientation of polymers to produce high strength, is also being achieved through other processes, such as fiber-stretching carried out under precise conditions.通过化学加工控制材料微型结构的能力可用现代高强度聚合纤维进行描述。一些聚合纤维 的强度-质量比比钢铁高一个数量级。它的自由取向是由所选择的加工条件以及芳香族聚酰 胺的高度刚性的线性分子结构所决定的。在纺丝时，液相中的定向部分是围绕纤维轴方向排 列而使得纤维具有高强度和高硬度，各向异性的纺丝纤维的概念则在新聚合物如聚苯并噻 唑、聚乙烯的溶解和熔融方面都有了延伸。超高强度的聚乙烯纤维是通过冻胶纺丝的方法制 备的。同样的，控制聚合物的分子取向以生产高强度产品也可以通过其它的工艺途径，如在 极其精确的条件下进行纤维拉伸而完成。In addition to processes that result in materials with specific high-performance properties, chemical engineers continue to design new processes for the low-cost manufacture of polymers.除了这些可以得到具有特别高性能的材料的加工过程，化学工程师们还设计一些新的工艺

过程以生产低成本的聚合物。2.Polymer Composites Polymer composites consist of high-modulus fibers embedded in and bonded to a continuous polymer matrix.These gibers may be shut, long, or continuous.They may be randomly oriented so that they impart greater strength or stiffness in all directions to the composite(isotropic composites), or they may be oriented in a specific direction so that the high-performance characteristics of the composite are exhibited preferentially along one axis of the material(anisotropic composites).These latter fiber composites are based on the principle of one-dimensional microstructural reinforcement by disconnected, tension-bearing “cables” or “rods”.2．聚合复合材料 复合材料包括在一个聚合物母体上嵌入或粘合上高强度或高模数纤维。这些纤维可能是短 的、长的或连续的。它们可能是随意取向的而使复合材料在所有方向上都具有较大的强度或 硬度，也可能沿某个特殊方向取向而使复合材料的高性能优先沿着某个轴线表现出来。后者 是根据一向微结构加固的原理，通过不连贯的、拉伸支撑电缆线或电缆条达到目的。To achieve a material with improved properties(e.g., strength, stiffness, or toughness)in more than one dimension, composite laminates can be formed by bonding inpidual sheets of anisotropic composite in alternating orientations.Alternatively, two-dimensional reinforcement can be achieved in a single sheet by using fabrics of high-performance fibers that have been woven with enough bonding in the crossovers that the reinforcing structure acts as a connected net or trusswork.One can imagine that an interdisciplinary collaboration between chemical engineers and textile engineers might lead to ways of selecting the warp, woof, and weave in fabrics of high-strength fibers to end up with trussworks for composites with highly tailored dimensional distributions of properties.要得到在多个方向上具有优良性能的材料，可以通过改变角度粘结各向异性的复合片得到 合成板。另一方面，两向强化的材料可以通过把高性能的纤维编织成一个平面，面上有足够 的粘结力而使加固结构表现得就像联结起来的网或桁架。你可以想象，化学工程师和纺织工 程师之间的学术合作将有利于选择经线、纬线和高强度纤维的编织方法，以得到高选择性能 分布的桁架型的复合材料。First-generation polymer composites(e.g., fiberglass)used thermosetting epoxy polymers reinforced with randomly oriented short glass fibers.The filled epoxy resin could be cured into a permanent shape in a mold to give lightweight, moderately

strong shapes.第一代聚合合成材料（如玻璃纤维）使用热固性环氧树脂聚合物。它是用任意取向的短玻 璃纤维进行强化的。环氧树脂填充在一个模型中被塑化成永久的形状而得到轻质的、强度适 当的模制塑胶。The current generation of composites is being made by hand laying woven glass fabric onto a mold or perform, impregnating it with resin, and curing to shape.Use of these composites was pioneered for certain types of military aircraft because the lighter airframes provided greater cruising range.Today, major components for aircraft and spacecraft are manufactured in this manner as are an increasing number of automobile components.The current generation of composites are being used in automotive and truck parts such as body panels, hoods, trunk lids，ducts, drive shafts, and fuel tanks.In such applications, they exhibit a better strength-to-weight ratio than metals, as well as improved corrosion resistance.For example, a polymer composite automobile hood is slightly lighter than one of aluminum and more than twice as light as one of steel.The level of energy required to manufacture this hood is slightly lower than that required for steel and about 20 percent of that for aluminum;molding and tooling costs are lower and permit more rapid model changeover to accommodate new designs.现代复合材料是用手工把编织好的玻璃纤维放到模具或预型件中，然后用树脂灌注，固化 成型后制得的。这些复合材料最先是使用在某些型号的军用飞机上。因为比较轻的机身使飞 行巡航范围增大。今天，飞机和航空飞船的大部分部件都是这样制造的，而且汽车也正在加 入到这个行列。现代复合材料正被应用于小汽车和载重卡车的车身面板、车棚、后行李箱盖、管道、驱动轴和燃料罐。在这些应用中，复合材料表现出比金属更好的强度-质量比和更优 良的抗腐蚀性。例如，一种聚合复合材料制成的汽车车棚比用铝质的轻一点，比钢铁的轻两 倍，但这种方法所需能量比钢铁的低一点，比铝的低 20%。模塑和刀具加工的成本也比较 低，使模型的改变可以更快而适应新设计的要求。The mechanical strength exhibited by these composites is essentially that of the reinforcing glass fibers, although this is often compromised by structural defects.Engineering studies are yielding important information about how the properties of these structures are influenced by the nature of the glass-resin interface and by structural voids and similar defects and how microdefects can propagate into structural failure.These composites and the information gained from studying them have set the stage for the next generation of polymer composites, based on high-strength fibers such as the aramids.这些复合材料表现出来的机械强度主要是由强化玻璃纤维决定的，尽管结构缺陷会使强度 减弱。工程学研究正提供重要的信息说明材料结构是如何受到玻璃树脂的界面性质、构造空 隙和类似缺陷的影响以及这些微缺陷是如何扩散产生构造裂缝的。这些复合材料以及从对它 们的研究中获得的信息使人类进入到生产第二代聚合复合材料的阶段，即以高强度纤维如芳 香族聚酰胺为基础的复合材料。3.Advanced Ceramics For most people, the word “ceramics” conjures up the notion of things like china, pottery, tiles, and bricks.Advanced ceramics differ from these conventional ceramics by their composition, processing, and microstructure.For example: 3．现代陶瓷 对大多数人来说，“陶瓷”这个词会让人联想到瓷器、陶器、砖、瓦这些东西。现代陶 瓷以它们的组成、加工过程和微细结构区别于这些传统的陶瓷。例如： Conventional ceramics are made from natural raw materials such as clay or silica;advanced ceramics require extremely pure man-made starting materials such as silicon carbide, silicon nitride, zirconium oxide, or aluminum oxide and may also incorporate sophisticated additives to produce specific microstructures.传统的陶瓷是用天然的原料如粘土或硅石制成的。现代陶瓷则要求非常纯的人造原料如 碳化硅、氮化硅、氧化锆或氧化铝，可能还要渗入一些复杂的添加剂来产生

特殊的微结构。Conventional ceramics initially take shape on a potter’s wheel or by slip casting and are fired

(sintered)in kilns;advanced ceramics are formed and sintered in more complex processes such as hot isostatic pressing.传统陶瓷是先在陶工轮上或粉浆浇注成型，然后在窑里烧结定型。现代陶瓷是用更为复 杂的工艺过程如高温静压成型法来定型的。The microstructure of conventional ceramics contains flaws readily visible under optical microscopes;the microstructure of advanced ceramics is far more uniform and typically is examined for defects under electron microscopes capable of magnifications of 50,000 times or more.传统陶瓷的微结构容易形成在光学显微镜下就可以看见的裂痕。而现代陶瓷的微结构则 要均匀得多，一般要在 5 万倍或更大倍数的电子显微镜下才能检查出瑕疵来。Advanced ceramics have a wide range of application.In many cases, they do not constitute a final product in themselves, but are assembled into components critical to the successful performance of some other complex system.Commercial applications of advanced ceramics can be seen in cutting tools, engine nozzles, components of turbines and turbochargers, tiles for space vehicles, cylinders to store atomic and chemical waste, gas and oil drilling valves, motor plates and shields, and electrodes for corrosive liquids.现代陶瓷的应用范围更为广泛。在很多情况下，现代陶瓷并未直接成为最终产品，而是组 合在一些复杂的系统中成为优良性能的关键部分。现代陶瓷的商业应用可以在切削工具、发 动机喷嘴、涡轮和涡轮增压器的元件、太空舱的瓦面、储藏原子和化学废物的圆柱体、气体 和石油钻探阀、电动极板和防护罩以及腐蚀性液体中的电极等等方面看见。4.Ceramic Composites Like polymer composites, ceramic composites consist of high-strength of high-modulus fibers embedded in a continuous matrix.Fibers may be in the form of “whiskers” of substances such as silicon carbide or aluminum oxide that are grown as single crystals and that therefore have fewer defects than the same substances in a bulk ceramic.Fibers in a ceramic composite serve to block crack propagation;a growing crack may be deflected to a fiber or might pull the fiber from the matrix.Both processes absorb energy, slowing the propagation of the crack.The strength, stiffness, and toughness of a ceramic composite is principally a function of the reinforcing fibers, but the matrix makes its own contribution to these properties.The ability of the composite material to conduct heat and current is strongly influenced by the inductivity of the matrix.The interaction between the fiber and the matrix is also important to the mechanical properties of the composite material and is mediated by the chemical compatibility between fiber and matrix at the fiber surface.A prerequisite for adhesion between these two materials is that the matrix, in its fluid form, be capable of wetting the fibers.Chemical bonding between the two components can then take place.4．陶瓷合成材料 像聚合复合材料一样，陶瓷复合材料也包括在连续的基质上嵌入高强度或高模数的纤 维。纤维可以是碳化硅或氧化铝以“晶须”的形式出现，然后生长为单个晶体。这与同样的 物质直接嵌入在大块陶瓷上相比较所产生裂纹较少。陶瓷复合体上的纤维可以阻碍裂纹的扩 散。正在生长的裂纹会向纤维处偏移或使纤维脱离基质。这两个过程都要吸收能量，从而减

慢了裂纹的扩散。陶瓷复合材料的强度、硬度和韧性主要取决于强化纤维，但是基质也会对 这些性质产生影响。复合材料的导热和导电性能受基质传导系数的影响很大。纤维和基质之 间的相互作用对复合材料机械性能的影响也很大，并可通过纤维表面纤维和基质间的化学兼 容性进行调整，这两种物质粘合在一起的前提就是基质以流体形态存在时能润湿纤维。两种 组分间形成了化学键。As with advanced ceramics, chemical reactions play a

crucial role in the fabrication of ceramic composites.Both defect-free ceramic fibers and optimal chemical bonds between fiber and matrix are required for these composites to exhibit the desired mechanical properties in use.Engineering these chemical reactions in reliable manufacturing processes requires the expertise of chemical engineers.与现代陶瓷的产生一样，化学反应在陶瓷复合材料的加工制造中也充当了关键的角色。这些复合材料要求无瑕疵的陶瓷纤维、纤维和母体间有最适当的作用力，这才能在使用中展 现所预想的机械性能。在实际的制造过程中设计这样的化学反应要求化学工程师具备专业的 知识。5.Composite Liquids A final important class of composite materials is the composite liquids.Composite liquids are highly structured fluids based either on particles or droplets in suspension, surfactants, liquid crystalline phases, or other macromolecules.A number of composite liquids are essential to the needs of modern industry and society because they exhibit properties important to special end uses.Examples include lubricants, hydraulic traction fluids, cutting fluids, and oil-drilling muds.Paints, coatings, and adhesives may also be composite liquids.Indeed, composite liquids are valuable in any case where a well-designed liquid state is absolutely essential for proper delivery and action.5．复合液体 最后一类重要的复合材料是复合液体。复合液体是高结构液体，以悬浮液、表面活性剂、液晶相或其它大分子与固体微粒或液滴组成。许多复合液体对现代工业和社会都是必不可少 的，因为它们表现出来的性质对一些特殊用途是非常重要的。这些用途包括润滑剂、水力牵 引液体以及油田钻井泥浆，油漆、涂料和粘合剂也可能是合成液体。确实，在任何情况下，如果好的液体状态对某种传递和反应是重要的，那么合成液体就是有价值的。Chemical engineers have long been involved with materials science and engineering.This involvement will increase as new materials are developed whose properties depend strongly on their microstructure and processing history.Chemical engineers will probe the nature of microstructure—how it is formed in materials and what factors are involved in controlling it.They will provide a new fusion between the traditionally separate areas of materials synthesis and materials processing.And they will bring new approaches to the problems of fabricating and repairing complex materials systems.化学工程师长期涉足材料科学和工程学研究工作。随着新材料的开发，其性质越来越依 赖微结构和加工过程，研究程度也将深入。化学工程师将探索微结构的本质—它是如何在材 料中形成的，哪些因素可以用来控制它。他们将采用新的方式把传统的分离开来的材料合 成和材料加工融合起来。他们还将用新方法解决构造的问题，修复复杂的材料系统。

Unit 21 Chemical Industry and Environment 化学工业与环境

How can we reduce the amount of waste that is produced? And how we close the loop by redirecting spent materials and products into programs of recycling? All of these questions must be answered through careful research in the coming years as we strive to keep civilization in balance with nature.我们怎样才能减少产生废物的数量？我们怎样才能使废弃物质和商品纳入循环使用的 程序？所有这些问题必须要在未来的几年里通过仔细的研究得到解决，这样我们才能保持文 明与自然的平衡。1.Atmospheric Chemistry Coal-burning power plants, as well as some natural processes, deliver sulfur compounds to the stratosphere, where oxidation produces sulfuric acid particles that reflect away some of the incoming visible solar radiation.In the troposphere, nitrogen oxides produced by the combustion of fossil fuels combine with many organic molecules under the influence of sunlight to produce urban smog.The volatile hydrocarbon isoprene, well known as a building block of synthetic rubber, is also produced naturally in forests.And the chlorofluorocarbons, better known as CFCs, are inert in automobile

air conditioners and home refrigerators but come apart under ultraviolet bombardment in the mid-stratosphere with devastating effect on the earth‟s stratospheric ozone layer.The globally averaged atmospheric concentration of stratospheric ozone itself is only 3 parts in 10 million, but it has played a crucial protective role in the development of all biological life through its absorption of potentially harmful shout-wavelength solar ultraviolet radiation.1．大气化学 燃煤发电厂像一些自然过程一样，也会释放硫化合物到大气层中，在那里氧化作用产 生硫酸颗粒能反射入射进来的可见太阳辐射。在对流层，化石燃料燃烧所产生的氮氧化物在 阳光的影响下与许多有机物分子结合产生都市烟雾。挥发的碳氢化合物异戊二烯，也就是众 所周知的合成橡胶的结构单元，可以在森林中天然产生含氯氟烃。我们所熟悉的 CFCs，在 汽车空调和家用冰箱里是惰性的，但在中平流层内在紫外线的照射下回发生分解从而对地球 大气臭氧层造成破坏，全球大气层中臭氧的平均浓度只有 3ppm，但它对所有生命体的生长 发育都起了关键的保护作用，因为是它吸收了太阳光线中有害的短波紫外辐射。During the past 20 years, public attention has been focused on ways that mankind has caused changes in the atmosphere: acid rain, stratospheric zone depletion, greenhouse warming, and the increased oxidizing capacity of the atmosphere.We have known for generations that human activity has affected the nearby surroundings, but only gradually have we noticed such effects as acid rain on a regional then on an intercontinental scale.With the problem of ozone depletion and concerns about global warming, we have now truly entered an era of global change, but the underlying scientific facts have not yet been fully established.在过去的二十年中，公众的注意力集中在人类对大气层的改变： 酸雨、平流层臭氧空洞、温室现象，以及大气的氧化能力增强，前几代人已经知道，人类的活动会对邻近的环境造成 影响，但意识到像酸雨这样的效应将由局部扩展到洲际范围则是慢慢发现的。随着臭氧空洞 问题的出现，考虑到对全球的威胁，我们已真正进入到全球话改变的时代，但是基本的科学

论据还没有完全建立。2.Life Cycle Analysis Every stage of a product’s life cycle has an environmental impact, starting with extraction of raw materials, continuing through processing, manufacturing, and transportation, and concluding with consumption and disposal or recovery.Technology and chemical science are challenged at every stage.Redesigning products and processes to minimize environmental impact requires a new philosophy of production and a different level of understanding of chemical transformations.Environmentally friendly products require novel materials that are reusable, recyclable, or biodegradable;properties of the materials are determined by the chemical composition and structure.To minimize waste and polluting by-products, new kinds of chemical process schemes will have to be developed.Improved chemical separation techniques are needed to enhance efficiency and to remove residual pollutants, which in turn will require new chemical treatment methods in order to render them harmless.Pollutants such as radioactive elements and toxic heavy metals that cannot be readily converted into harmless materials will need to be immobilized in inert materials so that they can be safely stored.Finally, the leftover pollution of an earlier, less environmentally aware era demands improved chemical and biological remediation techniques.2．生命周期分析 产品生命循环周期的每一个阶段都会对环境造成影响。从原材料的提取，到加工、制造 和运输的过程，最后到被消耗和丢弃或回收，每一个阶段都对工艺学和化学提出了挑战。重 新设计产品和过程以减少对环境的影响需要新的生产原理和在不同的水平层面上理解化学 变化，对环境友善的产品要求有新的原料，它们应是可再使用的，可循环的，或者可生物降 解的。物质的性质是由其化学组成和结构决定的，要减少废品和有污染的副产品，就要开发 新的化学工艺

线路，已开发的化学分离技术需要有效地提高以分离出剩余的污染物，这反过 来又要求新的化学处理方法使它们变得无害。而诸如放射性元素和那些不容易转化为无害物 质的重金属污染物则需要把它们固定为惰性物质以便能安全地储放。还有最后一点，早期的 污染残留物，对环境污染程度尚未很意识到的一些物质要求进一步用化学和生物的修复技术 进行处理。Knowledge of chemical transformations can also help in the discovery of previously unknown environmental problems.The threat to the ozone layer posed by CFCs was correctly anticipated through fundamental studies of atmospheric chemistry, eventually leading to international agreements for phasing out the production of these otherwise useful chemicals in favor of equally functional but environmentally more compatible alternatives.On the other hand, the appearance of the ozone hole over the Antarctic came as a surprise to scientists and only subsequently was traced to previously unknown chlorine reactions occurring at the surface of nitric acid crystals in the frigid Antarctic stratosphere.Thus it is critically important to improve our understanding of the chemical processes in nature, whether they occur in fresh water, saltwater, soil, subterranean environments, or the atmosphere.了解化学反应的机理可以帮助我们发现以前不知道的环境问题，CFCs 对臭氧层造成的 威胁能够正确地预防要得益于大气化学的基础研究。由此导致了国际上一致同意逐步取消这 些产品的生产。而代之以作用相同但对环境更为友善的其它产品。另一方面，南极上空臭氧 空洞的出现使科学家们大为震惊，随后才发现了以前所不了解的南极寒冷的平流层内硝酸晶 体表面所发生的氯原子的反应。这对我们进一步了解自然界中所发生的化学反应过程是非常

重要的。不管这些反应是发生在淡水中，海水中，土壤里，地下环境或是大气中。3.Manufacturing with Minimal Environmental Impact Discharge of waste chemicals to the air, water, or ground not only has a direct environmental impact, but also constitutes a potential waste of natural resources.Early efforts to lessen the environmental impact of chemical processes tended to focus on the removal of harmful materials from a plant‟s waste stream before it was discharged into the environment.But this approach addresses only half of the problem;for an ideal chemical process, no harmful by-products would be formed in the first place.Any discharges would be at least as clean as the air and water that were originally taken into the plant, and such a process would be “environmentally benign”.3．对环境影响最小的生产 把废物排放到空气、水或土壤中不仅对环境造成了直接的影响，还是对自然资源的一个 潜在的浪费。早期减少化学过程对环境本文由LebronJame6贡献

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Unit 1

Chemical Industry 化学工业

Before reading the text below, try to answer following question: 1.When did the modern chemical industry start? 2.Can you give a definition for the chemical industry? 3.What are the contribution which the chemical industry has made to meet and satisfy our needs? 4.Is the chemical industry capital-or labor-intensive? Why? 1.Origins of the Chemical Industry Although the use of chemicals dates back to the ancient civilizations, the evolution of what we know as the modern chemical industry started much more recently.It may be considered to have begun during the Industrial Revolution, about 1800, and developed to provide chemicals roe use by other industries.Examples are alkali for soapmaking, bleaching powder for cotton, and silica and sodium carbonate for glassmaking.It will be noted that these are all inorganic chemicals.The

organic chemicals industry started in the 1860s with the exploitation of William Henry Perkin‟s discovery if the first synthetic dyestuff—mauve.At the start of the twentieth century the emphasis on research on the applied aspects of chemistry in Germany had paid off handsomely, and by 1914 had resulted in the German chemical industry having 75% of the world market in chemicals.This was based on the discovery of new dyestuffs plus the development of both the contact process for sulphuric acid and the Haber process for ammonia.The later required a major technological breakthrough that of being able to carry out chemical reactions under conditions of very high pressure for the first time.The experience gained with this was to stand Germany in good stead, particularly with the rapidly increased demand for nitrogen-based compounds(ammonium salts for fertilizers and nitric acid for explosives manufacture)with the outbreak of world warⅠin 1914.This initiated profound changes which continued during the inter-war years(1918-1939).1． 化学工业的起源 尽管化学品的使用可以追溯到古代文明时代，我们所谓的现代化学工业的发展却是非常近代（才开始的）。可以认为它起源于工业革命其间，大约在 1800 年，并发展成为为其它工 业部门提供化学原料的产业。比如制肥皂所用的碱，棉布生产所用的漂白粉，玻璃制造业所 用的硅及 Na2CO3.我们会注意到所有这些都是无机物。有机化学工业的开始是在十九世纪 六十年代以 William Henry Perkin 发现第一种合成染料—苯胺紫并加以开发利用为标志的。20 世纪初，德国花费大量资金用于实用化学方面的重点研究，到 1914 年，德国的化学工业 在世界化学产品市场上占有 75%的份额。这要归因于新染料的发现以及硫酸的接触法生产 和氨的哈伯生产工艺的发展。而后者需要较大的技术突破使得化学反应第一次可以在非常高 的压力条件下进行。这方面所取得的成绩对德国很有帮助。特别是由于 1914 年第一次世界 大仗的爆发，对以氮为基础的化合物的需求飞速增长。这种深刻的改变一直持续到战后（1918-1939）。date bake to/from: 回溯到 dated: 过时的，陈旧的 stand sb.in good stead: 对。很有帮助。

Since 1940 the chemical industry has grown at a remarkable rate, although this has slowed significantly in recent years.The lion‟s share of this growth has been in the organic chemicals sector due to the development and growth of the petrochemicals area since 1950s.The explosives growth in petrochemicals in the 1960s and 1970s was largely due to the enormous increase in demand for synthetic polymers such as polyethylene, polypropylene, nylon, polyesters and epoxy resins.1940 年以来，化学工业一直以引人注目的速度飞速发展。尽管这种发展的速度近年来 已大大减慢。化学工业的发展由于 1950 年以来石油化学领域的研究和开发大部分在有机化 学方面取得。石油化工在 60 年代和 70 年代的迅猛发展主要是由于人们对于合成高聚物如聚 乙烯、聚丙烯、尼龙、聚脂和环氧树脂的需求巨大增加。The chemical industry today is a very perse sector of manufacturing industry, within which it plays a central role.It makes thousands of different chemicals which the general public only usually encounter as end or consumer products.These products are purchased because they have the required properties which make them suitable for some particular application, e.g.a non-stick coating for pans or a weedkiller.Thus chemicals are ultimately sold for the effects that they produce.今天的化学工业已经是制造业中有着许多分支的部门，并且在制造业中起着核心的作 用。它生产了数千种不同的化学产品，而人们通常只接触到终端产品或消费品。这些产品被 购买是因为他们具有某些性质适合（人们）的一些特别的用途，例如，用于盆的不粘涂层或 一种杀虫剂。这些化学产品归根到底是由于它们能产生的作用而被购买的。2.Definition of the Chemical Industry At the turn of the century there would have been little difficulty in defining what constituted the chemical industry since only a very limited range of products was manufactured

and these were clearly chemicals, e.g., alkali, sulphuric acid.At present, however, many intermediates to products produced, from raw materials like crude oil through(in some cases)many intermediates to products which may be used directly as consumer goods, or readily converted into them.The difficulty cones in deciding at which point in this sequence the particular operation ceases to be part of the chemical industry‟s sphere of activities.To consider a specific example to illustrate this dilemma, emulsion paints may contain poly(vinyl chloride)/ poly(vinyl acetate).Clearly, synthesis of vinyl chloride(or acetate)and its polymerization are chemical activities.However, if formulation and mixing of the paint, including the polymer, is carried out by a branch of the multinational chemical company which manufactured the ingredients, is this still part of the chemical industry of does it mow belong in the decorating industry? 2． 化学工业的定义 在本世纪初，要定义什么是化学工业是不太困难的，因为那时所生产的化学品是很有限 的，而且是非常清楚的化学品，例如，烧碱，硫酸。然而现在有数千种化学产品被生产，从 一些原料物质像用于制备许多的半成品的石油，到可以直接作为消费品或很容易转化为消费 品的商品。困难在于如何决定在一些特殊的生产过程中哪一个环节不再属于化学工业的活动 范畴。举一个特殊的例子来描述一下这种困境。乳剂漆含有聚氯乙烯/聚醋酸乙烯。显然，氯乙烯（或醋酸乙烯）的合成以及聚合是化学活动。然而，如果这种漆，包括高聚物，它的 配制和混合是由一家制造配料的跨国化学公司完成的话，那它仍然是属于化学工业呢还是应 当归属于装饰工业中去呢？

It is therefore apparent that, because of its persity of operations and close links in many areas with other industries, there is no simple definition of the chemical industry.Instead each official body which collects and publishes statistics on manufacturing industry will have its definition as to which operations are classified as the chemical industry.It is important to bear this in mind when comparing statistical information which is derived from several sources.因此，很明显，由于化学工业经营的种类很多并在很多领域与其它工业有密切的联系，所以不能对它下一个简单的定义。相反的每一个收集和出版制造工业统计数据的官方机构都 会对如何届定哪一类操作为化学工业有自己的定义。当比较来自不同途径的统计资料时，记 住这点是很重要的。3.The Need for Chemical Industry The chemical industry is concerned with converting raw materials, such as crude oil, firstly into chemical intermediates and then into a tremendous variety of other chemicals.These are then used to produce consumer products, which make our lives more comfortable or, in some cases such as pharmaceutical produces, help to maintain our well-being or even life itself.At each stage of these operations value is added to the produce and provided this added exceeds the raw material plus processing costs then a profit will be made on the operation.It is the aim of chemical industry to achieve this.3． 对化学工业的需要 化学工业涉及到原材料的转化，如石油 首先转化为化学中间体，然后转化为数量众多 的其它化学产品。这些产品再被用来生产消费品，这些消费品可以使我们的生活更为舒适或 者作药物维持人类的健康或生命。在生产过程的每一个阶段，都有价值加到产品上面，只要 这些附加的价值超过原材料和加工成本之和，这个加工就产生了利润。而这正是化学工业要 达到的目的。It may seem strange in textbook this one to pose the question “do we need a chemical industry?” However trying to answer this question will provide(ⅰ)an indication of the range of the chemical industry’s activities,(ⅱ)its influence on our lives in everyday terms, and(ⅲ)how great is society’s need for a chemical industry.Our approach in answering the question will be to consider the industry‟s contribution to meeting and satisfying our major needs.What are these? Clearly food(and drink)and health are paramount.Other which we shall consider in their

turn are clothing and(briefly)shelter, leisure and transport.在这样的一本教科书中提出： “我们需要化学工业吗？”这样一个问题是不是有点奇怪 呢？然而，先回答下面几个问题将给我们提供一些信息：（1）化学工业的活动范围，（2）化 学工业对我们日常生活的影响，（3）社会对化学工业的需求有多大。在回答这些问题的时候 我们的思路将要考虑化学工业在满足和改善我们的主要需求方面所做的贡献。是些什么需求 呢？很显然，食物和健康是放在第一位的。其它我们要考虑的按顺序是衣物、住所、休闲和 旅行。(1)Food.The chemical industry makes a major contribution to food production in at least three ways.Firstly, by making available large quantities of artificial fertilizers which are used to replace the elements(mainly nitrogen, phosphorus and potassium)which are removed as nutrients by the growing crops during modern intensive farming.Secondly, by manufacturing crop protection chemicals, i.e., pesticides, which markedly reduce the proportion of the crops consumed

by pests.Thirdly, by producing veterinary products which protect livestock from disease or cure their infections.(1)食物。化学工业对粮食生产所做的巨大贡献至少有三个方面。第一，提供大量可以 获得的肥料以补充由于密集耕作被农作物生长时所带走的营养成分。（主要是氮、磷和钾）。第二，生产农作物保护产品，如杀虫剂，它可以显著减少害虫所消耗的粮食数量。第三，生 产兽药保护家禽免遭疾病或其它感染的侵害。(2)Health.We are all aware of the major contribution which the pharmaceutical sector of the industry has made to help keep us all healthy, e.g.by curing bacterial infections with antibiotics, and even extending life itself, e.g.?–blockers to lower blood pressure.（2）健康。我们都很了解化学工业中制药这一块在维护我们的身体健康甚至延长寿命 方面所做出的巨大贡献，例如，用抗生素治疗细菌感染，用 β-抗血栓降低血压。(3)Clothing.The improvement in properties of modern synthetic fibers over the traditional clothing materials(e.g.cotton and wool)has been quite remarkable.Thus shirts, dresses and suits made from polyesters like Terylene and polyamides like Nylon are crease-resistant, machine-washable, and drip-dry or non-iron.They are also cheaper than natural materials.衣物。在传统的衣服面料上，现代合成纤维性质的改善也是非常显著的。用聚脂如涤纶 或聚酰胺如尼龙所制作的 T 恤、上衣、衬衫抗皱、可机洗，晒干自挺或免烫，也比天然面 料便宜。Parallel developments in the discovery of modern synthetic dyes and the technology to “bond” them to the fiber has resulted in a tremendous increase in the variety of colors available to the fashion designer.Indeed they now span almost every color and hue of the visible spectrum.Indeed if a suitable shade is not available, structural modification of an existing dye to achieve this can readily be carried out, provided there is a satisfactory market for the product.与此同时，现代合成染料开发和染色技术的改善使得时装设计师们有大量的色彩可以利 用。的确他们几乎利用了可见光谱中所有的色调和色素。事实上如果某种颜色没有现成的，只要这种产品确有市场，就可以很容易地通过对现有的色彩进行结构调整而获得。Other major advances in this sphere have been in color-fastness, i.e., resi影响的工作主要集中在工厂废气排放如环境之前有害 物质的分离，但这种思路只考虑了问题的一半。因为一个理想的化学过程，也就是没有有害 的副产品产生的过程应在一开始就建立好，任何排放物至少应像进入到工厂内的空气和水一 样干净。这样的过程才可以称是“与环境友善的”。Increasing concern over adverse health effects has put a high priority on eliminating or reducing the amounts of potentially hazardous chemicals used in industrial processes.The best course of action is to find replacement chemicals that work as well but are less hazardous.If a substitute cannot be found for a hazardous chemical, then a promising alternative strategy is to develop a process for generating it on-site and only in the amount needed at the time.对健康有害影响的关

注逐渐升级，人们首先考虑到如何消除或减少工业过程中所用有害 化学物质的数量。最好的方法是寻找替代的化学产品，它们能起到一样的作用但毒害性较小。如果不能寻找到一种有毒化学物质的替代品，那么比较好的战略思想是开发一种就地生产的 工艺，而且只生产当时所需要的那么多的数量。Innovative new chemistry has begun delivering environmentally sound processes, that use energy and raw materials more efficiently.Recent advances in catalysis, for example, permit chemical reactions to e run at lower temperatures and pressures.This change, in turn, reduces the energy demands of the processes and simplifies the selection of construction materials for the processing facility.Novel catalysts are also being uses to avoid the production of unwanted by-products.革新的化学方法已开始设计对环境合理的工艺过程，以便更为有效的使用能量和原材 料。例如，催化剂方面的近期进展使化学反应可以在较低的温度和压力下进行。反过来，这 种改变又减少了这些过程的能量需求，简化了制造加工设备对构成材料的选择，新的催化剂 还用于避免生产不希望的副产品。4.Control of Power Plant Emissions Coal-, oil-, and natural-gas-fired power generation facilities contribute to the emissions of carbon monoxide, hydrocarbons, nitrogen oxides, and a variety of other undesired by-products such as dust and traces of mercury.A rapidly increasing array of technologies are now available to reduce the emissions of unwanted species to meet national or local standards.Chemists and chemical engineers have made major contributions to the state of the art, and catalytic science is

playing a critical role in defining the leading edge.4.发电厂排放物的控制 通过燃煤、燃油和燃烧天然气产生能量的设备都会排放出一氧化碳、碳氢化合物、氮氧化物以及许多其它不受欢迎的副产物如灰尘和痕量的汞。现在可以采用一系列不断 发展的技术来减少不希望有的物质的排放以适应国家和地区标准的要求。化学家和化学 工程师对工业水平的进步做出了巨大的贡献。而催化科学为开辟这些前沿领域正在扮演 重要的角色。The simultaneous control of more than one pollutant is the aim of some recently developed catalyst or sorbent technologies.For example, catalytic methods allow carbon monoxide to be oxidized at the same time that nitrogen oxides are being chemically reduced in gas turbine exhaust.Other research efforts are aimed at pilot-plant evaluation of the simultaneous removal of sulfur and nitrogen oxides from flue gas by the action of a single sorbent and without the generation of massive volumes of waste products.同时控制多种污染物是近年来开发先进的催化剂或吸附剂技术的目的。例如，催化方法 可以使汽车尾气中 CO 氧化的同时，还原氮的氧化物。另一些研究工作则定位于在中试阶段 通过一种吸附剂的作用同时去除烟道气中的硫和氮氧化物，而不会产生大量的废物。5.Environmentally Friendly Products Increased understanding of the fate of products in the environment had led scientists to design “greener” products.A significant early example comes from the detergent industry in the 1940s and 1950s, new products were introduced that were based on synthetic surfactants called branched alkylbenzene sulfonates.These detergents had higher cleaning efficiency, but it was subsequently discovered that their presence in waste water caused foaming in streams and rivers.The problem was traced to the branched alkylbenzene sulfonates;unlike the soaps used previously, these were not sufficiently biodegraded by the microbes in conventional sewage treatment plants.An extensive research effort to understand the appropriate biochemical processes permitted chemists to design and synthesize another new class of surfactants, linear alkylbenzene sulfonateas,.The similarity in molecular structure between these new compounds and the natural fatty acids of traditional soaps allowed the microorganisms to degrade the new formulations, and the similarity to the branched

alkybenzene sulfonates afforded outstanding detergent performance.5． 对环境友善的产品 对产品在环境中的变化越来越了解使得科学家们开始设计“绿色”产品。一个重要的例子 来自 1940-1950s 的洗涤剂工业。当时以支链烷基苯磺酸盐为表面活性剂的新产品被引入。这些洗涤剂洗涤效率更高。但其后发现这些物质残留在废水中在河面上形成泡沫。问题追溯 到这些支链的烷基苯磺酸盐： 它不像以前人们所使用的肥皂。它不能被传统污水处理厂的细 菌所有效地生物降解。经过深入的研究工作了解了生物化学过程使化学家们设计和合成了另 一类新型的表面活性剂，为直链烷基苯磺酸盐。这些新的化合物与传统肥皂中的脂肪酸有相 似的分子结构，因而微生物可以降解这些组分，而它与支链烷基苯磺酸盐的相似性又使其具 有卓越的洗涤性能。Novel biochemistry is also helping farmers reduce the use of insecticides.Cotton plants, for example, are being genetically modified to make them resistant to the cotton bollworm.A single gene from a naturally occurring bacterium, when transferred into cotton plants, prompts the plant

to produce a protein that is ordinarily produced by the bacterium.When the bollworm begins to eat the plant, the protein kills the ins4ct by interrupting its digestive processes.新的生物化学也正在帮助农民减少使用杀虫剂.例如,棉作物可以通过改变基因而具备对 棉螟蛉的抵抗力.天然存在的细菌中一个基因当被转移到棉作物中时,能够祖师作物产生一种 原来有细菌产生的蛋白质.当螟蛉虫开始吃作物时,这种蛋白质通过切断螟蛉的消化过程从而 杀死害虫.6.Recycling Increasing problems associated with waste disposal have combined with the recognition that some raw material exist in limited supply to dramatically increase interest in recycling.Recycling of metals and most paper is technically straightforward, and these materials are now commonly recycled in many areas around the world.Recycling of plastics presents greater technical challenges.Even after they are separated from other types of waste, different plastic materials must be separated from each other.Even then, the different chemical properties of the various types of plastic will require the development of a variety of recycling processes.6.处理 越来越多的环境问题与废物的排放有关,而一些原材料又存在供给有限的问题.这二者的 联系引起了人们对处理这一课题越来越大的兴趣.金属和大多数纸张的处理从技术上来说是 简单的,这些物质在世界很多地方都已普遍进行了处理.塑料的处理则面临着较大的技术方面 的挑战.即使把它们与其它类型的废品分离开来以后，不同种类的塑料还需要再彼此分离。即使如此，不同类型的塑料具有不同的化学性质，因而也需要开发不同的处理工艺.Some plastics can be recycled by simply melting and molding them or by dissolving them in an appropriate solvent and then reformulating them into a new plastic material.Other materials require more complex treatment, such as breaking down large polymer molecules into smaller subunits that can subsequently be used as building blocks for new polymers.Indeed, a major program to recycle plastic soft drink bottles by this route is now in use.一些塑料可以通过简单地熔化注塑或用合适的溶剂进行分解再重新塑造成新塑料的方 法进行处理。比如，把大的聚合物分子裂解成较小的亚单元,再以此作为新聚合物的结构单 元。确实，用这种方法处理软塑料瓶的计划正在进行中。A great deal of research by chemists and chemical engineers will be needed to successfully develop the needed recycling technologies.In some cases, it will be necessary to develop entirely new polymers with molecular structures that are more amenable to the recycling process.化学家和化学工程师们所做的大量的研究工作需要被成功地开发为所需要的处理技术。有时，也需要开发一些全新的聚合材料.它们具有更容易进行处理的分子结构.7.Separation and Conversion for Waste Reduction New processes are needed to separate waste components requiring special disposal from those that can be recycled or disposed of by

normal means.Development of these processes will require extensive research to obtain a fundamental understanding of the chemical phenomena involved.7.通过分离和转换减少废物量 把一些需要进行特殊处理的成分从那些可用常规方法处理或处置的废物中分离出来需

要新的工艺过程。而开发这些过程则需要深入研究以从根本上了解所涉及的化学现象.Metal-bearing spent acid waste.Several industrial processes produce acidic waste solutions in large quantities.Could this waste be separated into clean water, reusable acid, and a sludge from which the metals could be recovered? Such processes would preserve the environment, and their costs could be competitive with disposal costs and penalties.含金属离子的酸性废水.一些工业过程产生了大量的酸性废水.这些废水可以分离成干净 的水、可再利用的酸、以及可从中提取出可回收金属的淤渣吗？这样的处理过程既可以保护 环境，所需费用又与处置废水所需成本及罚款相差无几。Industrial waste treatment.The hazardous organic components in industrial wastewater could be destroyed with thermocatalytic or photocatalytic processes.A promising line of research employs “supercritical” water at high temperatures and pressures.Under these conditions, water exhibits very different chemical and physical properties.It dissolves reactions of many materials that are nearly inert under normal conditions.工业废水处理。工业废水中的有害有机物能被热催化或光催化的过程破坏。一项前景很 好的研究工作是利用高温高压下的超临界水。在这种条件下，水表现出截然不同的物理和化 学性质，它可以溶解并有助于那些在常态下的水中几乎是惰性的物质发生反应。High-level nuclear waste.Substantial savings would be achieved if the volume and complexity of nuclear waste requiring storage could be significantly reduced;this reduction would require economic separation of the radioactive components from the large volumes of other materials that accompany the nuclear waste.The hazardous chemical waste mighty then be disposed of separately.The dispose of nuclear waste will require major research and development efforts over many years.高辐射的核废料。如果需要储藏的核废料其数量和组成能够显著地减少，就可以节省一 大笔的费用。这种减少需要用经济的方法把放射性成分与大量其它与核废料共存的物质分离 开来，这样有害的化学废料就可以分别地进行处置，核废料的处置仍将需要今后许多年进行 大量的研究和开发工作。Membrane technology.Separations involving semi permeable membranes offer considerable promise.These membranes, usually sheets of polymers, are impervious to some kinds of chemicals but not to others.Such membranes are used to purify water, leaving behind dissolved salts and providing clean drinking water.Membrane separations are also applicable to gases and are being used for the recovery of minor components in natural gas, to enhance the heating value of natural gas by removal of carbon dioxide, and for the recovery of nitrogen from air.Research challenges include the development of membranes that are chemically and physically more resilient, that are less expensive to manufacture, and that provide better separation efficiencies to reduce processing costs.膜技术。应用半渗透性薄膜进行分离大有希望获得成功。这些膜通常是片状聚合物。能 够让一些化学物质通过而不让另一些物质通过。这些膜常用来纯化水，阻挡住一些溶解的盐 类提供干净的饮用水。膜分离技术stance to the dye being washed out when the garment is cleaned.这一领域中另一些重要进展是不褪色，即在洗涤衣物时染料不会被洗掉。(4)Shelter, leisure and transport.In terms of shelter the contribution of modern synthetic polymers has been substantial.Plastics are tending to replace traditional building materials like wood because they are lighter, maintenance-free(i.e.they are resistant to weathering and do not need painting).Other polymers, e.g.urea-formaldehyde and polyurethanes, are important insulating materials for reducing heat losses and hence reducing energy usage.（4）

住所，休闲和旅游。讲到住所方面现代合成高聚物的贡献是巨大的。塑料正在取 代像木材一类的传统建筑材料，因为它们更轻，免维护（即它们可以抵抗风化，不需油漆）。另一些高聚物，比如，脲甲醛和聚脲，是非常重要的绝缘材料可以减少热量损失因而减少能 量损耗。

Plastics and polymers have made a considerable impact on leisure activities with applications ranging from all-weather artificial surfaces for athletic tracks, football pitches and tennis courts to nylon strings for racquets and items like golf balls and footballs made entirely from synthetic materials.塑料和高聚物的应用对休闲活动有很重要的影响，从体育跑道的全天候人造篷顶，足球 和网球的经纬线，到球拍的尼龙线还有高尔夫球的元件，还有制造足球的合成材料。Likewise the chemical industry’s contribution to transport over the years has led to major improvements.Thus development of improved additives like anti-oxidants and viscosity index improves for engine oil has enabled routine servicing intervals to increase from 3000 to 6000 to 12000 miles.Research and development work has also resulted in improved lubricating oils and greases, and better brake fluids.Yet again the contribution of polymers and plastics has been very striking with the proportion of the total automobile derived from these materials—dashboard, steering wheel, seat padding and covering etc.—now exceeding 40%.多年来化学工业对旅游方面所作的贡献也有很大的提高。一些添加剂如抗氧化剂的开发 和发动机油粘度指数改进使汽车日产维修期限从 3000 英里延长到 6000 英里再到 12000 英 里。研发工作还改进了润滑油和油脂的性能，并得到了更好的刹车油。塑料和高聚物对整个 汽车业的贡献的比例是惊人的，源于这些材料—挡板，轮胎，坐垫和涂层等等—超过 40%。So it is quite apparent even from a brief look at the chemical industry’s contribution to meeting our major needs that life in the world would be very different without the products of the industry.Indeed the level of a country’s development may be judged by the production level and sophistication of its chemical industry.很显然简单地看一下化学工业在满足我们的主要需求方面所做的贡献就可以知道，没有 化工产品人类社会的生活将会多么困难。事实上，一个国家的发展水平可以通过其化学工业 的生产水平和精细程度来加以判断。4.Research and Development(R&D)in Chemical Industries One of the main reasons for the rapid growth of the chemical industry in the developed world has been its great commitment to, and investment in research and development(R&D).A typical figure is 5% of sales income, with this figure being almost doubled for the most research intensive sector, pharmaceuticals.It is important to emphasize that we are quoting percentages here not of profits but of sales income, i.e.the total money received, which has to pay for raw materials, overheads, staff salaries, etc.as well.In the past this tremendous investment has paid off well, leading to many useful and valuable products being introduced to the market.Examples include synthetic polymers like nylons and polyesters, and drugs and pesticides.Although the number of new products introduced to the market has declined significantly in recent years, and in times of recession the research department is usually one of the first to suffer cutbacks, the commitment to R&D remains at a very high level.4． 化学工业的研究和开发。发达国家化学工业飞速发展的一个重要原因就是它在研究和开发方面的投入和投资。通 常是销售收入的 5%，而研究密集型分支如制药，投入则加倍。要强调这里我们所提出的百 分数不是指利润而是指销售收入，也就是说全部回收的钱，其中包括要付出原材料费，企业 管理费，员工工资等等。过去这笔巨大的投资支付得很好，使得许多有用的和有价值的产品

被投放市场，包括一些合成高聚物如尼龙和聚脂，药品和杀虫剂。尽管近年来进入市场 的新 产品大为减少，而且在衰退时期研究部门通常是最先被裁减的部门，在研究和开发方面的投 资仍然保持在较高的水平。The chemical industry is a very high technology industry which takes full advantage of the latest advances in electronics and engineering.Computers are very widely used for all sorts of applications, from automatic control of chemical plants, to molecular modeling of structures of new compounds, to the control of analytical instruments in the laboratory.化学工业是高技术工业，它需要利用电子学和工程学的最新成果。计算机被广泛应用，从化工厂的自动控制，到新化合物结构的分子模拟，再到实验室分析仪器的控制。Inpidual manufacturing plants have capacities ranging from just a few tones per year in the fine chemicals area to the real giants in the fertilizer and petrochemical sectors which range up to 500,000 tonnes.The latter requires enormous capital investment, since a single plant of this size can now cost $520 million!This, coupled with the widespread use of automatic control equipment, helps to explain why the chemical industry is capital-rather than labor-intensive.一个制造厂的生产量很不一样，精细化工领域每年只有几吨，而巨型企业如化肥厂和石 油化工厂有可能高达 500,000 吨。后者需要巨大的资金投入，因为一个这样规模的工厂要花 费 2 亿 5 千万美元，再加上自动控制设备的普遍应用，就不难解释为什么化工厂是资金密集 型企业而不是劳动力密集型企业。The major chemical companies are truly multinational and operate their sales and marketing activities in most of the countries of the world, and they also have manufacturing units in a number of countries.This international outlook for operations, or globalization, is a growing trend within the chemical industry, with companies expanding their activities either by erecting manufacturing units in other countries or by taking over companies which are already operating there.大部分化学公司是真正的跨国公司，他们在世界上的许多国家进行销售和开发市场，他 们在许多国家都有制造厂。这种国际间的合作理念，或全球一体化，是化学工业中发展的趋 势。大公司通过在别的国家建造制造厂或者是收购已有的工厂进行扩张。

Unit 2

Research and Development 研究和开发

Research and development, or R&D as it is commonly referred to, is an activity which is carried out by all sectors of manufacturing industry but its extent varies considerably, as we will see shortly.Let us first understand, or at least get a feel for, what the terms mean.Although the distinction between research and development is not always clear-cut, and there is often considerable overlap, we will attempt to separate them.In simple terms research can be thought of as the activity which produces new ideas and knowledge whereas development is putting those ideas into practice as new process and products.To illustrate this with an example, predicting the structure of a new molecule which would have a specific biological activity and synthesizing it could be seen as research whereas testing it and developing it to the point where it could be marketed as a new drug could be described as the development part.研究和开发，或通常所称 R&D 是制造业各个部门都要进行的一项活动。我们马上可 以看到，它的内容变化很大。我们首先了解或先感觉一下这个词的含义。尽管研究和开发 的定义总是分得不很清楚，而且有许多重叠的部分，我们还是要试着把它们区分开来。简 单说来，研究是产生新思想和新知识的活动，而开发则是把这些思想贯彻到实践中得到新 工艺和新产品的行为。可以用一个例子来描述这一点，预测一个有特殊生物活性的分子结 构并合成它可以看成是研究而测试它并把它发展到可以作为一种新药推向市场这一阶段 则看作开发部分。1.Fundamental Research and Applied Research In industry the primary reason for

carting out R&D is economic and is to strengthen and improve the company‟s position and profitability.The purpose of R&D is to generate and provide information and knowledge to reduce uncertainty, solve problems and to provide better data on which management can base decisions.Specific projects cover a wide range of activities and time scales, from a few months to 20 years.1． 基础研究和应用研究 在工业上进行研究和开发最主要的原因是经济利益方面，是为了加强公司的地位，提 高公司的利润。R&D 的目的是做出并提供信息和知识以减低不确定性，解决问题，以及向 管理层提供更好的数据以便他们能据此做出决定。特别的项目涵盖很大的活动范围和时间范 围，从几个月到 20 年。We can pick out a number of areas of R&D activity in the following paragraphs but if we were to start with those which were to spring to the mind of the academic, rather than the industrial, chemist then these would be basic, fundamental(background)or exploratory research and the synthesis of new compounds.This is also labeled “blue skies” research.我们可以在后面的段落里举出大量的 R&D 活动。但是如果我们举出的点子来源于研 究院而不是工业化学家的头脑，这就是基础的或探索性的研究 Fundamental research is typically associated with university research.It may be carried out for its own intrinsic interest and it will add to the total knowledge base but no immediate applications of it in the “real world” well be apparent.Note that it will provide a valuable training in defining and solving problems, i.e.research methodology for the research student who carries it out under supervision.However, later “spin offs” from such work can lead to useful applications.Thus physicists claim that but for the study and development of quantum theory we might not have had computers and nuclear power.However, to take a specifically chemical example, general studies on a broad area such as hydrocarbon oxidation might provide information which would be useful in more specific areas such as cyclohexane oxidation for the production of nylon intermediates.基础研究通常与大学研究联系在一起，它可能是由于对其内在的兴趣而进行研究并 且这种研究能够拓宽知识范围，但在现实世界中的直接应用可能性是很小的。请注意，这种 以内就在提出和解决问题方面提供了极有价值的训练，比如，在指导下完成研究工作的学生 所接受的研究方法学（的训练）。而且，从这些工作中产生的“有用的副产品”随后也能带 来可观的使用价值。因此，物理学家宣称要不是量子理论的研究和发展我们可能仍然没有计 算机和核能量。不管怎样，举一个特殊的化学方面的例子吧，在各个领域如烃的氧化方面所 做的广泛的研究将为一些特殊的领域如环己烯氧化生成尼龙中间产物提供有用的信息。

Aspects of synthesis could involve either developing new, more specific reagents for controlling particular functional group interconversions, i.e.developing synthetic methodology or complete synthesis of an entirely new molecule which is biologically active.Although the former is clearly fundamental the latter encompasses both this and applied aspects.This term „applied‟ has traditionally been more associated with research out in industrial laboratories, since this is more focused or targeted.It is a consequence of the work being business driven.通过合成可以生产出一些新的、更特殊的试剂以控制特殊的官能团转换，即发展合 成方法或完成一些具有生物活性的新分子的合成。尽管前者显然属于基础性研究而后者则包 括基础研究和实用性研究两部分。所谓“实用性”习惯上是指与在工业实验室完成的研究联 系在一起的，因为它更具目的性，它是商业行为驱动的结果。Note, however, that there has been a major change in recent years as academic institutions have increasingly turned to industry for research funding, with the result that much more of their research effort is mow devoted to more applied research.Even so, in ac也用来提纯制造厂出来的废水。膜分离还可以用在气体方 面，用来回收天然气中的微量组分。通过清除 CO 提高天然气的热值，以及从空气中得到氮 气。研

究中的难点包括开发化学和物理学方面更有弹性的膜。这样可以使制造费用不那么贵，39

并且可以提供更好的分离效率以降低分离成本。Biotechnology.Scientists have turned to nature for help in destroying toxic substances.Some microorganisms in soil, water, and sediments can adapt their diets to a wide variety of organic chemicals;they have been used for decades in conventional waste treatment systems.Researchers are now attempting t coax even higher levels of performance from these gifted microbes by carefully determining the optimal physical, chemical, and nutritional conditions for their existence.Their efforts may lead to the design and operation of a new generation of biological waste treatment facilities.A major advance in recent years is the immobilization of such microorganisms in bioreactors, anchoring them in a reactor while they degrade waste materials.Immobilization permits high flow rates that would flush out conventional reactors, and the use of new, highly porous support materials allows a significant increase in the number of microorganisms for each reactor.生物技术。科学家们已经向自然界寻求帮助战胜有毒物质。土壤、水和沉积物中的一些 微生物能以许多有机化学物质为食。数十年来它们一直被用于传统的水处理系统。研究者们 正通过仔细测量微生物生存的最佳物理、化学和营养条件致力于处理强度更高的对象。他们 的工作可能导致设计和生产新一代生物废水处理设备。近年来的一个很大的进展是生物反应 器内微生物的固定。即把微生物固定在反应器内降解废物。这种固定可以允许有更高的流速。传统反应器内流速过高会冲走微生物。新的多孔载体的使用也使每个反应器中微生物的数量 明显提高。

Excel in Your Engineering

When I reflect on my 20-plus years of experience as a chemical engineer, I realize how wonderful my profession is.As engineers, we provide the essential link between technology and humanity.Our job is to make the world better for its human inhabitants while protecting the environment.And we fulfill our mission amongst the demands and guidelines of the business world.But sometimes we get so bogged down in the everyday aspects of our jobs that we lose sight of the big picture.We forget to appreciate engineering—though it is challenging, creative, interesting, significant, and even fun.For example, there‟s nothing like getting engrossed in a tough technical problem and coming up with a neat solution.Do you find yourself hurrying to the office because you look forward to working? Do you ever wake up in the middle of the night thinking about a problem and lie there working out the details of a brilliant solution? Do you get up to write notes so you won‟t forget your breakthrough in the morning? Engineering can be that wonderful.And being involved in your work doesn‟t mean you‟re a nut or a workaholic.We should like what we do: Enjoying something and doing it well is a “chicken-and-egg” situation.We tend to like activities we perform well, and to be good at things we enjoy.So here‟s some advice for both enjoying and improving your engineering work.1.Enhance technical skills Engineering provides many opportunities to develop existing skills and to learn new ones.In fact, we have to keep learning or we atrophy--that‟s the nature of any profession.The ability to grow is one reward of a good job.As your interests and involvements change, and as technology changes, you need to keep learning.2.Hone interpersonal skills Not all the development opportunities relate to technical matters.Successful engineering practice is strongly dependent on interpersonal and communications skills.It‟s important to learn about people, motivation, organizational behavior, written and oral communication and visual aids.With these skills as with any others, practice makes perfect(or at least very proficient).In addition, remember that we are also

“business people” and, as such, should keep up on trends in the business world, particularly in our industry.These communications skills can help develop relations both within and outside the company.Activities outside of the workplace can be good opportunities for enhancing nontechnical skills.They can help you improve interpersonal, leadership and communication capabilities.For example, it‟s easy to get into leadership positions in volunteer organizations.All you have to do is attend some meetings and show that you‟re willing to help out, and soon you‟ll move right into whatever you want to do.3.Do the whole job You‟re probably familiar with the concept of “completed staff work”(CSW).According to this concept, a subordinate presents his or her boss with solutions, or at least options, rather than problems.The reasoning is that the person closes to the problem is better prepared than anyone—even the boss—to make a decision and to implement it.Decision are best made at the

lowest practical level.Before passing your work on to the boss, try to make the work as complete as you can.That means not only writing the report, but also the cover letter and any transmittal notes it will need to flow smoothly through channels.Think through any political ramifications and make appropriate contacts to preclude problems.Anticipate questions and prepare for them.If your boss looks good, you look good.By maximizing the quality and quantity of your work, you maximize your value to your employer.Learn to do many things well.Be the engineer who can write a project proposal, plan and perform experiments, design equipment, analyze data, develop a mathematical model, write and present results, and bring in the next job.If you do it yourself—or lead others in doing it—or you will be indispensable.4.see the big picture Many engineers with little experience view their job too narrowly.They‟re content to just do what they‟re asked.They may be creative in carrying out designated tasks, and they may see some minor extensions of it, but they don‟t explore widely enough.But the “big picture” is not just the concern of higher-level people.Everything that happens in the company affects all of its employees.In turn, each employee can contribute to the well being of the company.You can get involved in long-range planning, business development, and persification into new products or services.The people who are already involved in these matters will welcome your help.Although you might start out with a small role, you will soon be contributing more and more.Such efforts often begin by demanding a little more of your personal time, but are later sanctioned by your supervisors as you prove your capability.5.Be a leader There‟s always a need for leadership of technical activities, and many engineers are suited to this.Leaders aren‟t born;leadership skills are developed.Leadership is different from management.For example, consider a large group of people in a jungle;their task is to cut a path through the underbrush.Managers recruit the workers, teach them how to use a machete, provide them with appropriate clothing, arrange their transportation to the job site and ensure that they are fed.But the leader is the one at the front of the group, showing them where to cut the path.Pr perhaps the leader tells the group that this is the wrong jungle and they need to go elsewhere.Managers take charge f administrative, executive and business matters.They supervise employees‟ work to make sure that operations are flowing smoothly.Leaders, on the other hand, are those who break ground, bring in new technologies, and point the way toward innovation.You don‟t have to have any assigned management responsibility to be a leader.People respond to leaders—with or without prestigious titles.As a matter of fact, you may be able to develop true leadership skills better if you don‟t have administrative responsibilities.When you don‟t have jurisdictional authority over people, you find other ways to

influence them.Instead of ordering people to do things, you make them want to do them—and that is the best way.6.Be a mentor As we gain experience, we can help younger engineers develop their potential.People pick up a lot of their attitudes toward work, approaches to problems, and working methods from their

senior colleagues.If you are a senior engineer, your impact on new employees is particularly strong and important.New engineer should be able to take a sufficiently broad view of their jobs and not limits themselves.It is rewarding to accomplish work through others, to see them develop into stronger engineers and move into positions of more responsibility.Sometimes part of your success as an engineer may be hiring or training someone who goes on to do things you can do yourself.You can help a promising engineer with capabilities beyond your own.And if you have a hand in developing someone who goes on to a really high position in your company, be proud of your accomplishment.7.Beware of persions A multifaceted profession, engineering involves other disciplines.But think about your chosen path before becoming involved in a peripheral area.For example, many engineers become enamored with computers.Today is personal computers can certainly enhance out productivity.Remember, however, that a computer is a tool just like a telephone or a calculator.Do not let yourself value the means over the end.If you are working on computer tasks that support personnel can do more efficiently, you are probably not employing your time well.Some engineers are so fascinated to computers that they have in reality shifted from being engineers to being computer scientists.There‟s certainly merit in doing what you enjoy, but issue a caution.Remember that you had good reasons for going into engineering in the first place, and if you drift into another area, you may later find it difficult to return to your engineering duties.Management is another popular persion.For some engineers, going into management is a positive move.Management is challenging and rewarding, and many engineers are well suited to it.In addition, having an engineer-turned-manager is helpful to the other engineers.Moving in and out of management position, especially in the lower levels of management, can actually be good for an engineer‟s career.However, the longer you stay in management, the more you run the risk of no longer being able to return to engineering.Most engineers who move into lower-level management positions are wise to regard them as a temporary persion from their true profession.8.Keep fit Good health is essential to doing a good job.When you‟re fit, you have more energy and feel better generally.Thus you can put more onto your work, a well as into there aspects of your life.Because most engineers have predominantly sedentary jobs, it is important to eat carefully and get enough exercise.9.Enjoy your profession As professional engineers, we need to keep developing and broadening our skills.We need to expand the scope of our work and reach the full potential we have, to the benefit of both ourselves and our employer.For most engineers, the best job security is being able to do high-quality engineering work, which is always in great demand.Finally, we should relish the varied challenges and excitement that constitute engineering at its best.43

Curriculum of chemical engineering

As chemical engineering knowledge developed, it was inserted into university courses and curricula.Before World WarⅠ , chemical engineering programs were distinguishable from chemistry programs in that they contained courses in engineering drawing, engineering thermodynamics, mechanics, and hydraulics taken from engineering departments.Shortly after

World WarⅠthe first text in unit operations was published.Courses in this area became the core of chemical engineering teaching.By the mid-1930s, chemical engineering programs included courses in(1)stoichiometry(using material and energy conservation ideas to analyze chemical process steps),(2)chemical processes or “unit operations”,(3)chemical engineering laboratories “in which equipment was operated and tested”, and(4)chemical plant design(in which cost factors were combined with technical elements to arrive at preliminary plant designs).The student was still asked to take the core chemistry courses, including general, analytical, organic, and physical chemistry.However, in addition, he or she took courses in mechanical drawing, engineering mechanics, electric circuits, metallurgy, and thermo-dynamics with other engineers.Since World War Ⅱ chemical engineering has develop rapidly.As new disciplines have proven useful, they have been added to the curriculum.Chemical engineering thermodynamics became generally formulated and taught by about 1945.By 1950, courses in applied chemical kinetics and chemical reactor design appeared.Process control appeared as an undergraduate course in about 1955ademia the emphasis generally is very much on the research rather than the development.然而，请注意。近几年有很大的变化，大学研究机构正越来越多地转向工业界寻求研 究经费，其结果就是他们的研究工作越来越多地是致力于实用研究。即使这样，学院工作的 重点通常还是在于研究而不是开发。2.Types of Industrial Research and Development The applied or more targeted type of research and development commonly carried out in industry can be of several types and we will briefly consider each.They are:(ⅰ)product development,(ⅱ)process development,(ⅲ)process improvement and(ⅳ)applications development.Even under these headings there are a multitude of aspects so only a typical example can be quoted in each case.The emphasis on each of these will vary considerably within the different sectors of the chemical industry.2．工业研究和开发的类型 通常在生产中完成的实用型的或有目的性的研究和开发可以分为好几类，我们对此 加以简述。它们是：（1）产品开发；（2）工艺开发；（3）工艺改进；（4）应用开发；每一类 下还有许多分支。我们.对每一类举一个典型的例子来加以说明。在化学工业的不同部门内 每类的工作重点有很大的不同。(1)Product development.Product development includes not only the discovery and development of a new drug but also, for example, providing a new longer-active anti-oxidant additive to an automobile engine oil.Development such as this have enabled servicing intervals to increase during the last decade from 3000 to 6000 to 9000 and now to 12000 miles.Note that most purchasers of chemicals acquire them for the effects that they produce i.e.a specific use.Teflon, or polytetrafluoroethylene(PTFE), may be purchased because it imparts a non-stick surface to cooking pots and pans, thereby making them easier to clean.(1)产品开发。产品开发不仅包括一种新药的发明和生产，还包括，比如说，给一种汽 车发动机提供更长时效的抗氧化添加剂。这种开发的产品已经使（发动机）的服务期限在最近的十年中从 3000 英里提高到 6000、9000 现在已提高到 12000 英里。请注意，大部分的买 家所需要的是化工产品能创造出来的效果，亦即某种特殊的用途。Tdflon，或称聚四氟乙烯

（PTFE）被购买是因为它能使炒菜锅、盆表面不粘，易于清洗。(2)Process development.Process development covers not only developing a manufacturing process for an entirely new product but also a new process or route for an existing product.The push for the latter may originate for one or more of the following reasons: availability of new technology, change in the availability and/or cost of raw materials.Manufacture of vinyl chloride monomer is an example of this.Its manufacturing route has changed several times owing to changing economics, technology

and raw materials.Another stimulus is a marked increase in demand and hence sales volume which can have a major effect on the economics of the process.The early days of penicillin manufacture afford a good example of this.（2）工艺开发。工业开发不仅包括为一种全新的产品设计一套制造工艺，还包括为现有 的产品设计新的工艺或方案。而要进行后者时可能源于下面的一个或几个原因： 新技术的利 用、原材料的获得或价格发生了变化。氯乙烯单聚物的制造就是这样的一个例子。它的制造 方法随着经济、技术和原材料的变化改变了好几次。另一个刺激因素是需求的显著增加。因 而销售量对生产流程的经济效益有很大影响。Penicillin 早期的制造就为此提供了一个很好 的例子。The ability of penicillin to prevent the onset of septicemia in battle wounds during the Second World War(1939～1945)resulted in an enormous demand for it to be produced in quantity.Up until then it had only been produced in small amounts on the surface of the fermentation broth in milk bottles!An enormous R&D effort jointly in the U.S.and the U.K.resulted in two major improvements to the process.Firstly a different stain of the mould gave much better yields than the original Penicillium notatum.Secondly the major process development was the introduction of the deep submerged fermentation process.Here the fermentation takes place throughout the broth, provided sterile air is constantly, and vigorously, blown through it.This has enabled the process to be scaled up enormously to modern stainless steel fermenters having a capacity in excess of 50000 liters.It is salutary to note that in the first world war(1914～ 1919)more soldiers died from septicemia of their wounds than were actually killed outright on the battlefield!Penicillin 能预防战争中因伤口感染引发的败血症，因而在第二次世界大战（1939-1945）中，penicillin 的需求量非常大，需要大量生产。而在那时，penicillin 只能用在瓶装牛奶表面 发酵的方法小量的生产。英国和美国投入了巨大的人力物力联合进行研制和开发，对生产流 程做出了两个重大的改进。首先用一个不同的菌株—黄霉菌代替普通的青霉，它的产量要比 后者高得多。第二个重大的流程开发是引进了深层发酵过程。只要在培养液中持续通入大量 纯化空气，发酵就能在所有部位进行。这使生产能力大大地增加，达到现代容量超过 5000 升的不锈钢发酵器。而在第一次世界大战中，死于伤口感染的士兵比直接死于战场上的人还 要多。注意到这一点不能不让我们心存感激。Process development for a new product depends on things such as the scale on which it is to be manufactured, the by-products formed and their removal/recovery, and required purity.Data will be acquired during this development stage using semi-technical plant(up to 100 liters capacity)which will be invaluable in the design of the actual manufacturing plant.If the plant is to be a very large capacity, continuously operating one, e.g.petrochemical or ammonia, then a pilot plant will first be built and operated to test out the process and acquire more data, these

semi-technical or pilot plants will be required for testing, e.g., a pesticide, or customer evaluation, e.g., a new polymer.对一个新产品进行开发要考虑产品生产的规模、产生的副产品以及分离/回收，产品所 要求的纯度。在开发阶段利用中试车间（最大容量可达 100 升）获得的数据设计实际的制造 厂是非常宝贵的，例如石油化工或氨的生产。要先建立一个中试车间，运转并测试流程以获 得更多的数据。他们需要测试产品的性质，如杀虫剂，或进行消费评估，如一种新的聚合物。Note that by-products can has a major influence on the economics of a chemical process.Phenol manufacture provides a striking example of this.The original route, the benzenesulphonic acid route, has become obsolete because demand for its by-produce sodium sulfite(2.2 tons/l ton phenol)has dried up.Its recovery and disposal will therefore be an additional charge on the process, thus increasing the cost of the phenol.In contrast

the cumene route owes its economic advantage over all the other routes to the strong demand for the by-product acetone(0.6 tons/l ton phenol).The sale of this therefore reduces the net cost of the phenol.注意，副产品对于化学过程的经济效益也有很大的影响。酚的生产就是一个有代表性的 例子。早期的方法，苯磺酸方法，由于它的副产品亚硫酸钠需求枯竭而变的过时。亚硫酸钠 需回收和废置成为生产过程附加的费用，增加了生产酚的成本。相反，异丙基苯方法，在经 济效益方面优于所有其他方法就在于市场对于它的副产品丙酮的迫切需求。丙酮的销售所得 降低了酚的生产成本。A major part of the process development activity for a mew plant is to minimize, or ideally prevent by designing out, waste production and hence possible pollution.The economic and environmental advantages of this are obvious.对一个新产品进行工艺开发的一个重要部分是通过设计把废品减到最低，或尽可能地防 止可能的污染，这样做带来的经济利益和对环境的益处是显而易见的。Finally it should be noted that process development requires a big team effort between chemists, chemical engineers, and electrical and mechanical engineers to be successful.最后要注意，工业开发需要包括化学家、化学工程师、电子和机械工程师这样一支庞大 队伍的协同合作才能取得成功。（3)Process improvement.Process improvement relates to processes which are already operating.It may be a problem that has arisen and stopped production.In this situation there is a lot of pressure to find a solution as soon as possible so that production can restart, since ‘down time’ costs money.（3）工艺改进。工艺改进与正在进行的工艺有关。它可能出现了某个问题使生产停止。在这种情形下，就面临着很大的压力要尽快地解决问题以便生产重新开始，因为故障期耗费 资财。down time: 故障期 More commonly, however, process improvement will be directed at improving the profitability of the process.This might be achieved in a number of ways.For example, improving the yield by optimizing the process, increasing the capacity by introducing a new catalyst, or lowering the energy requirements of the process.An example of the latter was the introduction of turbo compressors in the production of ammonia by the Haber process.This reduced utility costs

(mainly electricity)from $6.66 to %0.56 per ton of ammonia produced.Improving the quality of the product, by process modification, may lead to new markets for the product.然而，更为常见的，工艺改进是为了提高生产过程的利润。这可以通过很多途径实现。例如通过优化流程提高产量，引进新的催化剂提高效能，或降低生产过程所需要的能量。可 说明后者的一个例子是在生产氨的过程中涡轮压缩机的引进。这使生产氨的成本（主要是电）从每吨 6.66 美元下降到 0.56 美元。通过工艺的改善提高产品质量也会为产品打开新的市场。In recent years, however, the most important process improvement activity has been to reduce the environmental impact of the process, i.e., to prevent the process causing any pollution.Clearly there have been two interlinked driving forces for this.Firstly, the public‟s concern about the safety of chemicals and their effect on the environment, and the legislation which has followed as a result of this.Secondly the cost to the manufacturer of having to treat waste(i.e., material which cannot be recovered and used r sold)so that it can be safely disposed of, say by pumping into a river.This obviously represents a charge on the process which will increase the cost of the chemical being made.The potential for improvement by reducing the amount of waste is self-evident.然而，近年来，最重要的工艺改进行为主要是减少生产过程对环境的影响，亦即防止生 产过程所引起的污染。很明显，有两个相关连的因素推动这样做。第一，公众对化学产品的 安全性及其对环境所产生影响的关注以及由此而制订出来的法律； 第二，生产者必须花钱对 废物进行处理以便它能安全地清除，比如说，排放到河水中。显然这是生

产过程的又一笔费 用，它将增加所生产化学产品的成本。通过减少废物数量提高效益其潜能是不言而喻的。Note, however, with a plant which has already been built and is operating there are usually only very limited physical changes which can be made to the plant to achieve the above aims.Hence the importance, already mentioned, of eliminating waste production at the design stage of a new plant.Conserving energy and thus reducing energy cost has been another major preoccupation in recent years.然而，请注意，对于一个已经建好并正在运行的工厂来说，只能做一些有限的改变来达 到上述目的。因此，上面所提到的减少废品的重要性应在新公厂的设计阶段加以考虑。近年 来另一个当务之急是保护能源及降低能源消耗。(4)Applications development.Clearly the discovery of new applications or uses for a product can increase or prolong its profitability.Not only does this generate more income but the resulting increased scale of production can lead to lower unit costs and increased profit.An example is PVC whose early uses included records and plastic raincoats.Applications which came later included plastic bags and particularly engineering uses in pipes and guttering.（4）应用开发。显然发掘一个产品新的用处或新的用途能拓宽它的获利渠道。这不仅 能创造更多的收入，而且由于产量的增加使单元生产成本降低，从而使利润提高。举例来说，PVC 早期是用来制造唱片和塑料雨衣的，后来的用途扩展到塑料薄膜，特别是工程上所使 用的管子和排水槽。Emphasis has already been placed on the fact that chemicals are usually purchased for the effect, or particular use, or application which they have.This often means that there will be close liaison between the chemical companies‟ technical sales representatives and the customer, and the

level of technical support for the customer can be a major factor in winning sales.Research and development chemists provide the support for these applications developments.An example is CF3CH3F.This is the first of the CFC replacements and has been developed as a extracting natural products from plant materials.In no way was this envisaged when the compound was first being made for use as a refrigerant gas, but it clearly is an example of applications development.我们已经强调了化学产品是由于它们的效果，或特殊的用途、用处而得以售出这个事实。这就意味着化工产品公司的技术销售代表与顾客之间应有密切的联系。对顾客的技术支持水平往往是赢得销售的一个重要的因素。进行研究和开发的化学家们为这些应用开发提供了帮 助。CH3CH3F 的制造就是一个例子。它最开始是用来做含氟氯烃的替代物作冷冻剂的。然 而近来发现它还可以用作从植物中萃取出来的天然物质的溶解剂。当它作为制冷剂被制造 时，固然没有预计到这一点，但它显然也是应用开发的一个例子。3.Variations in R&D Activities across the Chemical Industry Both the nature and amount of R&D carried out varies significantly across the various sectors of the chemical industry.In sectors which involve largescale production of basic chemicals and where the chemistry, products and technology change only slowly because the process are mature, R&D expenditure is at the lower end of the range for the chemical industry.Most of this will be devoted to process improvement and effluent treatment.Examples include ammonia, fertilizers and chloralkali production from the inorganic side, and basic petrochemical intermediates such a ethylene from the organic side.3．化工行业中研究与开发活动的变化 化学工业的不同部门所进行的 R&D 的性质与数量都有很大的变化。与大规模生产的基 础化工产品有关的部门中，化学产品和技术变化都很慢，因为流程已很成熟。R&D 经费支 出属于化工行业中低的一端，而且大部分的费用是用于过程改进和废水处理。无机方面的例 子有氨、肥料和氯碱的生产，有机方面的如乙烯等一些基础石油化学的中间产物。At the other end of the scale lie pharmaceuticals and pesticides(or plant protection products).Here there are immense and continuous efforts to synthesize new molecules

which exert the desired, specific biological effect.A single company may generate 10,000 new compounds for screening each year.Little wonder that some inpidual pharmaceutical company‟s annual R&D expenditure is now approaching $1000 million!Expressing this in a different way they spend in excess of 14% of sales income(note not profits)on R&D.不一样规模生产的是药品和除草剂。人们付出了巨大而持续的努力以合成能产生所希望 的、特殊的生物作用的新分子。一家公司每年可能要合成 10,000 新化合物以供筛选。可以 想象一些医药公司其每年的 R&D 经费支出高达 100 亿美元。换句话说，他们把超过 14%的 销售收入投入在 R&D 上。

Unit 3 Typical Activities of Chemical Engineers 化学工程师的例行工作

The classical role of the chemical engineer is to take the discoveries made by the chemist in the laboratory and develop them into money--making, commercial-scale chemical processes.The chemist works in test tubes and Parr bombs with very small quantities of reactants and products(e.g., 100 ml), usually running “batch”, constant-temperature experiments.Reactants are placed in

a small container in a constant temperature bath.A catalyst is added and the reactions proceed with time.Samples are taken at appropriate intervals to follow the consumption of the reactants and the production of products as time progresses.化学工程师经典的角色是把化学家在实验室里的发现拿来并发展成为能赚钱的、商业规 模的化学过程。化学家用少量的反应物在试管和派式氧弹中反应相应得到少量的生成物，所 进行的通常是间歇性的恒温下的实验，反应物放在很小的置于恒温水槽的容器中，加点催化 剂，反应继续进行，随时间推移，反应物被消耗，并有生成物产生，产物在合适的间歇时间 获得。By contrast, the chemical engineer typically works with much larger quantities of material and with very large(and expensive)equipment.Reactors can hold 1,000 gallons to 10,000 gallons or more.Distillation columns can be over 100 feet high and 10 to 30 feet in diameter.The capital investment for one process unit in a chemical plant may exceed $100 million!与之相比，化学工程师通常面对的是数量多得多的物质和庞大的（昂贵的）设备。反应 器可以容纳 1000 到 10,000 加仑甚至更多。蒸馏塔有 100 英尺多高，直径 10 到 30 英尺。化 工厂一个单元流程的投资可能超过 1 亿美元。The chemical engineer is often involved in “scaling up” a chemist-developed small-scale reactor and separation system to a very large commercial plant.The chemical engineer must work closely with the chemist in order to understand thoroughly the chemistry involved in the process and to make sure that the chemist gets the reaction kinetic data and the physical property data needed to design, operate, and optimize the process.This is why the chemical engineering curriculum contains so many chemistry courses.在把化学家研制的小型反应器及分离系统“放大”到很大的商业化车间时，通常需要化 学工程师的参与。为了彻底了解过程中的化学反应，化学工程师必须与化学家密切合作以确 保能得到所需要的反应的动力学性质和物理性质参数以进行设计、运转和优选流程。这就是 为什么化工课程要包括那么多的化学类课程的原因。The chemical engineer must also work closely with mechanical, electrical, civil, and metallurgical engineers in order to design and operate the physical equipment in a plant--the reactors, tanks, distillation columns, heat exchangers, pumps, compressors, Control and instrumentation devices, and so on.One big item that is always on such an equipment list is piping.One of the most impressive features f a typical chemical plant is the tremendous number of pipes running all over the site, literally hundreds of miles in many plants.These pipes transfer process materials(gases and liquids)into and out of the plant.They also carry utilities(steam, cooling water, air, nitrogen, and refrigerant)to the process units.化学工程师还必须与机械、电

子、土木建筑和冶金工程师密切协作以设计和操作工厂的 机械设备—反应器、槽、蒸馏塔、热交换器、泵、压缩机、控制器和仪器设备等等。在这张 设备单上还有一大类是管子。化工厂最典型的特征之一就是数目庞大的管道贯穿所有生产 间。可以毫不夸张地说，在许多车间都有几百英里长的管道。这些管道输入和输出车间的反 应物质进行传递，同时还可携带有用的东西（水蒸气、冷却水、空气、氧、冷却剂）进入操 作单元。To commercialize the laboratory chemistry, the chemical engineer is involved in development，design, construction, operation, sales, and research.The terminology used to label these functions is by no means uniform from company to company, but a rose by any other name is still a rose.Let us describe each of these functions briefly.It should be emphasized that the jobs we shall discuss are “typical” and “classical”, but are by no means the only things that chemical engineers do.The chemical engineer has a broad background in mathematics, chemistry, and physics.Therefore, he or she can, and does, fill a rich variety of jobs in industry, government, and academia.要把实验室研究商业化，化学工程师要参与进行开发、设计、建筑、操作、销售和研究 工作。各个公司用来表示这些工作的名词不完全一样，但万变不离其宗。让我们简单地把每 个工作描述一下。应该强调的是，我们所讨论的工作是“典型的”和“经典的”，但并不意 味着化学工程师只能做这些事。化学工程师在数学、化学和物理学方面都有很好的知识基础，因此，他或她能够而且确实适应工业、政府部门、大专院校等非常广泛的职业要求。1.Development Development is the intermediate step required in passing from a laboratory-size process to a commercial-size process.The “pilot-plant” process involved in development might involve reactors that are five gallons in capacity and distillation columns that are three inches in diameter.Development is usually part of the commercialization of a chemical process because the scale-up problem is a very difficult one.Jumping directly from test tubes to 10,000-gallon reactors can be a tricky and sometimes dangerous endeavor.Some of the subtle problems involved which are not at all obvious to the uninitiated include mixing imperfections, increasing radial temperature gradients, and decreasing ratios of heat transfer areas to heat generation rates.1.开发 开发工作是从实验室规模向商业化规模转化所必需的中间阶段。开发阶段所涉及的 “中 试”流程所使用的反应器容量为 5 加仑，蒸馏塔直径为 3 英寸。开发通常是化学流程商业化 的一部分。因为“放大”规模是一个非常困难的问题。直接从试管研制跳到在 10.000 加仑 反应器里生产是非常棘手的有时甚至是危险的工作。一些（在实验室研究阶段）根本不明显 的未加以考虑的细微问题，如混合不均匀，温度梯度辐射状升高，热交换面积逐渐降低以及 热交换速度下降等（在后一阶段变得影响很大）。The chemical engineer works with the chemist and a team of other engineers to design, construct, and operate the pilot plant.The design aspect involves specifying equipment sizes, configuration, and materials of construction.Usually pilot plants are designed to be quite flexible, so that a wide variety of conditions and configurations can be evaluated.化学工程师与化学家和其他一些工程师协作对中师车间进行设计、安装和运行，设计方 面包括确定设备的尺寸、结构、制造所用的材料。通常中师车间的设计是有很大的变通性的，以便能对各种情况和构造进行评估。Once the pilot plant is operational, performance and optimization data can be obtained in order to evaluate the process from an economic point of view.The profitability is assessed at each stage of the development of the process.If it appears that not enough money will be made to justify the capital investment, the project will be stopped.中试车间一旦开始运转，就能获得性能数据和选定最佳数值以便从经济学角度对流程进 行评价。对生产过程的每一个阶段可能获得的利润进行评定。如果结果显示投入的资金不能

有足够的回报，这项计划将被停止。The pilot plant offers the opportunity to evaluate materials of construction, measurement techniques, and process control strategies.The experimental findings in the pilot plant can be used to improve the design of the full-scale plant.中师车间还提供了评价设备制造材料、测量方法、流程控制技术的机会。中试车间的这 些实验数据对于工业装置设计的改善能提供有用的帮助。2.Design Based on the experience and data obtained in the laboratory and the pilot plant, a team of engineers is assembled to design the commercial plant.The chemical engineer’s job is to specify all process flow rates and conditions, equipment types and sizes, materials of construction, process configurations, control systems, safety systems, environmental protection systems, and other relevant specifications.It is an enormous responsibility.2． 设计 根据在实验室和中试车间获得的经验和数据，一组工程师集中起来设计工业化的车间。化学工程师的职责就是详细说明所有过程中的流速和条件，设备类型和尺寸，制造材料，流 程构造，控制系统，环境保护系统以及其它相关技术参数。这是一个责任重大的工作。The design stage is really where the big bucks are spent.One typical chemical process might require a capital investment of $50 to $100 million.That‟s a lot of bread!And the chemical engineer is the one who has to make many of the decisions.When you find yourself in that position, you will be glad that you studied as hard as you did(we hope)so that you can bring the best possible tools and minds to bear on the problems.设计阶段是大把金钱花进去的时候。一个常规的化, and digital computer use began to develop about 1960.The idea that the various unit operations depended on common mechanisms of heat, mass, and momentum transfer developed about 1960.Consequently, courses in transport phenomena assumed an important position as an underlying, unifying basis for chemical engineering education.New general disciplines that have emerged in the last two decades include environmental and safety engineering, biotechnology, and electronics manufacturing processing.There has been an enormous amount of development in all fields, much of it arising out of more powerful computing and applied mathematics capabilities.1.Science and Mathematics Courses Chemistry Chemical engineers continue to need background in organic, inorganic and physical chemistry, but also should introduced to the principles of instrumental analysis and biochemistry.Valuable conceptual material should be strongly emphasized in organic chemistry including that associated with biochemical process.Much of thermodynamic is more efficiently taught in chemical engineering, and physical chemistry should include the foundations of thermodynamic.Physics.Biology.Biology has emerged from the classification stage, and modern molecular biology holds great promise for application.Future graduates will become involved with applying this knowledge at some time in their careers.44

A special course is required on the functions and characteristics of living cells with some emphasis on genetic engineering as practiced with microorganisms.Materials Science.Course work should include the effects of microstructure on physical, chemical, optical, magnetic and electronic properties of solids.Fields of study should encompass ceramics, polymers, semiconductors, metals, and composites.Mathematics.Computer Instruction.Although students should develop reasonable proficiency in programming, the main thrust should be that use of standard software including the merging of various programs to accomplish a given task.Major emphasis should be on how to analyze and solve problems with existing software including that for simulation to evaluate and check such software with thoroughness and precision.Students

should learn how to critically evaluate programs written by others.All courses involving calculations should make extensive use of the computer and the latest software.Such activity should be more frequent as students progress in the curriculum.Adequate computer hardware and software must be freely available to the student through superior centralized facilities and/or inpidual PC‟s.Development of professionally written software for chemical engineering should be encouraged.2.Chemical engineering courses Thermodynamics.The important concepts of the courses should be emphasized;software should e developed to implement the concepts in treating a wide variety of complex, yet interesting, problems in a reasonable time.The value of analysis of units and dimensions in checking problems should continue to be emphasized.Examples in thermodynamics should involve problems from a variety of industries so that the subject comes alive and its power in decision making is clearly emphasized.Kinetics, Catalysis, and Reactor Design and Analysis.This course also needs a broad variety of real problems, not only design but also diagnostic and economic problems.Real problems involve real compounds and the chemistry related to them.Existing software for algebraic and differential equation solving make simulation and design calculation on many reactor systems quite straightforward.Shortcut estimating methods should be emphasized in addition to computer calculations.The increased production of specialties make batch ad semibatch reactor more important, and scale-up of laboratory studies is an important technique in the fast-moving specialties business.3.Unit Operations The unit operations were conceived as an organized means for discussing the many kind of equipment-oriented physical processes required in the process industries.This approach continues to be valid.Over the years some portions have bee given separate status such as transport phenomena and separations while some equipment and related principles have not been included

in the required courses, as is the case with polymer processing, an area in which all chemical engineers should have some knowledge.Transport phenomena principles can be made more compelling by using problems form a wide range of industries that can be analyzed and solved using the principles taught.Some efficiency may be gained by teaching several principles and procedures for developing specifications and selection the large number of equipment items normally purchased off-the-shelf or as standard design.A great deal of time can be saved in addressing designed equipped such as fractionators and absorbers be emphasizing rigorous computer calculations and the simplest shortcut procedures.Most intermediate calculation procedures and graphical methods should be eliminated unless they have real conceptual value.Process Control.This course should emphasize control strategy and precise measurement in addition to theory.Some hands-on experience using current practices of computer control with industrial-type consoles should be encouraged.Computer simulation of processes for demonstration of control principles and techniques can be most valuable, but contact with actual control devices should not be ignored.Chemical engineering laboratories.Creative problem solving should be emphasized.Reports should be written as briefly as possible;they should contain an executive summary with clearly drawn conclusions and brief observations and explanations with graphical rather than tabular representation of data.A great deal of such graphing can be done in the laboratory on computers with modern graphics capabilities.Detailed calculations should be included in an appendix.Some part of the laboratory should be structured to relate to product development, Design/Economics In the design course in engineering, students learn the techniques of complex problem solving and decision making within a framework of

economic analysis.The very nature of processes requires a system approach‟ the ability to analyze a total system is one of the special attributes of chemical engineers that will continue to prove most sought after in a complex technological world.Because of the greater persity of interests and job opportunities, some consideration should be given to providing a variety of short design problem of greatest personal interest.The design approach can be most valuable in diagnosing plant problems, and some practice in this interesting area should be provided.Rigorous economic analysis and predictive efforts should be required in all decision processes.Safety and environmental considerations should also be emphasized.Modern simulation tools should be made available to the students.Other Engineering Courses.The electrical engineering courses should emphasize application of microprocessors, lasers, sensing devices, and control systems as well as the traditional areas of circuits and motors.The course should provide insight into the principles on which each subject is based.46

Remaining courses in engineering mechanics and engineering drawing should be considered for their relevance to current and future chemical engineering practice.4.Other courses Economics and Business courses.It is difficult to find a single course in economics or business departments that covers the various needs of engineers.The qualitative ability of engineers makes it possible to teach following topics in a single-semester course—in many cases in the Chemical Engineering Department: business economics, project economic analysis, economic theory, marketing and market studies, and national and global economics.Humanities and Social Science Courses.It is important to understand the origins of one‟s own culture as well as that of others.Communication Course.Since improved communication skills require continuous attention, the following requirements may be useful: Oral presentations in at least one course each year.Several literature surveys in the junior and senior years.Introduce computer-based communication systems.Area of Specialization.The elective areas should be generous in hours to maximize freedom of choice.Each department will have to consider its own and its total university resources and strenghs as well as the quality and preparation of its students.The suggested areas are: Life sciences and applications Materials sciences and applications Catalysis and electrochemical science and applications Separations technology Computer applications technology Techniques of product development and marketing Polymer technology Each of these areas should be strongly career-oriented.The interest in a given area will depend on opportunities perceived by the students.47

1构体的形成。大部分这些化合物只是满足实验室好奇心或学术兴

趣。然而，其 他剩余的达几千种，是商业和实践兴趣。因此，可以预料到这些化学物质的来源很广。虽然 对无机化学品 如此，但是奇怪的是，大多数有机化学品来源于一种资源，即原油（石油）。1.无机化学品 Table1-1 无机化学品的主要来源 因为“无机化学品”这个词（术语）涉及到（cover，包括、涵盖）的是除碳以外所有元素构 成的化合物。其来源的多样性并不很大（见表1-1）。一些较重要的来源是金属矿（包括重要的金属铁和 铝）以及盐和海 水（用于生产氯、钠、氢氧化钠和碳酸钠）。在这些情况下，至少两种不同的元素化合以一 种稳定的化合 物在一起。因此，如果要得到单个元素（也就是金属），那么提取过程除了纯物理的分离方 法以外，还必 须涉及到化学处理（过程）。金属矿或无机矿很少以纯物质的形式存在，因此，处理过程的 第一步通常是：（将无机矿中）从不要的固体

如粘土或沙石中分离出来。固体筛分后经压碎和研磨，利用颗 粒尺寸差异可 以完成一些物理分离。下一步骤则取决于所需矿物的本质及其特征。例如，铁矿常在磁分离 器利用他们的 磁性加以分离。泡沫浮选是另一种广泛应用的分离技术。在该技术中，所需要的矿物，以细 小颗粒形式存 在，借助被水溶液润湿能力的差异而与其他矿物加以分离。常加入表面活性剂（抗润湿剂），这些典型的 分子，一头为非极性部分（如长碳氢链），另一头为极性部分（如-NH2）。该极性基团与 矿物相吸，形成不 牢固的键；而碳氢基团与水相斥而阻止矿物被润湿，因而矿物能浮选。相反，其他固体物质 很容易被润湿 而沉在水溶液中。搅拌溶液或液体中鼓泡以产生泡沫能大大促进表面活性剂包裹的矿物的漂 浮，这些矿物 从容器中溢出到收集容器中，在收集容器，矿物得到回收。显然，该过程成功的关键在于，为所处理矿物 选择一种高选择的特定的表面活性剂。2 有机化合物 相比于无机化学品来自于众多不同的资源（这一点我们已经明白了），商业上的一些重要的 有机化合 物基本上来源单一。如今，所有有机化合物的99%以上，可以通过石化工艺过程从原油（石 油）和天然气 得到。这是一种有趣的情形— — 该情形一直在改变，而且将来也会变化，因为从技术上讲，相同的化学品 可以从其他原料得到。尤其是脂肪族化合物，可以通过由碳水化合物的发酵所得的乙醇加以 生产，另一方 面，芳香族化合物可以从煤焦油中分离得到。煤焦油是煤炭化工过程的副产物。动植物油脂，是为数不多的脂肪族化合物的特定的资源，这些脂肪族化合物包括长链脂肪酸（如正十八酸）和长链醇（如正十二烷 醇）。化石燃料（即石油、天然气和煤）的形成要花上百万年，一旦用掉就不能被替换，因此，它 们称之为 不可再生的资源。这与来自于植物的碳水化合物恰恰相反，碳水化合物能够较快被更新。一 种较为普遍应 用的资源为蔗糖— — 一旦作物被收割和土地被清理，又可以种植和收割新的作物，通常少 于一年。因此，碳氢化合物可称为可再生资源。据估计，植物原料（干重）的总的年产量为 1\*1011 吨。化石燃料－天然气、原油和煤，主要用作为能源，而不是作为有机化合物的资源。例如，各种石油分馏物的气体，用于家用烹调和取暖、用作为汽车用的汽油、加热建筑物重 燃油，或用于在工业处理以产生 的蒸汽。通常，一桶原油的8%用于化学品的生产。下列数据可以说明，为什么化学工业在 原油的使用方 面与燃料或能源消耗的工业展开着竞争。显然，若我们愿意使用可代替化石燃料的其他能源，那么这些可替代能源可以利用的，同时，我们自 信地预料到在不久的将来，可以用上其他的可替代能源。因此，有必要要去保存宝贵的石油 供应以用于化 学品的生产。“处理石油的最后一件事情是将之燃烧”该说法是有根据的。注意到这件事很有 趣且有益的： 早在1894 年门捷列夫（发现元素周期表之俄国科学家）就向当局报道，“石油是太宝贵的资 源而不能将之 燃烧掉，应该将之以化学品资源加以保存。” 来自于碳水化合物（植物茎杆）的有机化学物质，职务的主要成分是碳水化合物，碳水化合 物组成职 务的结构。它们为多糖（如纤维素和淀粉），大量的淀粉存在于食物（如谷类、大米和马铃 薯）之中，纤 维素是组成细胞壁的主要物质，因而广泛存在，可以从木材、棉花等中得到。因此，来自于 碳水化合物的 化学品的潜力是相当大的，而且该原料可再生。从碳水化合物得到化学物质的主要途径是通过发酵过程。然而发酵过程不能利用多糖（如维 素和淀 粉），因此，淀粉必须先收到酸性或酶水解反应生成更简单的糖类（单糖或二糖（如蔗糖），这些较为简单 的糖是发酵过程中的）合适的起始原料。发酵过程是利用单细胞的微生物（一般有酵母菌、真菌、细菌或霉菌）生产特殊化学品。有 些发酵农 家已用了上千年。最著名的例子为，谷物发酵生产含酒精的饮料。直到1950 年，该方法才 成为生产脂肪 族有机化学品的最普遍的途径。因为生产的乙醇脱水生成乙烯，而乙烯是合成大量脂肪族化 合物的关键中 间体。尽管用此方法生产的化学品有所减少，但是用这种方法生产汽车燃料方面存在大量的 兴趣。

**第五篇：专业心理学（范文模版）**

专业心理学:研究和实践

超出理论取向:在专业心理学出现统一的科学框架

Melchert Timothy p.在线首次发表,2024年5月7日。doi:10.1037 / a002831

1引文

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超出理论取向:在专业心理学出现了一个统一的科学框架

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心理学作为一门基础的和应用的学科已经取得了非常巨大的成功，尽管在理论阵营和学校思想方面仍然还存在着持续的矛盾。到目前为止，最有影响力的心理学临床实践方法仍是传统的理念取向。尽管他们在很大程度上是不完整也不充分的。本文阐述了这些矛盾的原因，然后讨论了在这些问题之上的专业的一体化的科学框架。过时的理论框架对一个以科学实验为基础的专业来说是不合适的，并且专业心理学需要考虑系统过渡到一个全面的科学方法来理解人类发展、运转、行为改变。

关键词:统一的理论,理论导向,生物心理社会、专业心理学、心理科学

心理学作为一门基础的和应用的学科已经取得了非常巨大的成功，自从19世纪晚期建立以来，这个领域总体上已经对社会科学，教育，卫生保健、公共政策、组织和企业,甚至文化上都产生过主要的影响。它帮助转变社会对心理健康以及心理功效的理解。而且心理治疗已经给无数遭受心理缺陷和痛苦的人提供了帮助。专业的心理实践也引人注目。在第一部为心理学家制定的法律颁布以前，心理学家在美国只扮演一个小角色，60年后牌照的心理学家人数超过了85000。

尽管其有着非凡的增长和许多成就，但是这个领域要在性格的理解，精神病理学以及行为的改变等方面为心理学的临床实践提供一个坚定明确的基础并达成共识是极具挑战性的。科学的解释证实过很多的心理现象，但其他方面的人类心理学的复杂性已经很难解开。目前只是用概述的形式理解，这对常是心理治疗焦点的更高水平更复杂的过程来说是非常正确的。许多感觉、知觉、认知、情感、学习和发展的基本流程已经被详细了解,但对许多像人的个性发展，精神病得起因，行为的改变，以及治疗效果等复杂过程的解释是很不完整的。在专业心理学(PP)上,到目前为止理解人格,精神病理学和心理疗法最具影响力的方法是传统的理论取向。标准教科书覆盖这种材料通常采取按时间顺序排列方法回顾这些取向。从 弗洛伊德理论到后来发展起来的通过心理动力学、行为,人文、认知、系统性、多元文化和综合方法。400多种发展起来的理论在关注的焦点和内容上有很大的差异。一些理论主要关注的是人格与精神病理学而不太强调心理治疗的过程。然而其他一些则主要关注的是心理治

疗的过程和方法。这些理论中最早的弗洛伊德的精神分析法，它是全面、深入地试图解释所有这些因素,最终也是最受争议的。

这些理论取向在PP教育和实践方面继续发挥非常重要角色。例如,尽管它是显然不可能 学到大量的细节,学习一个或更多的通常被认为是必需的实地训练。应用于APPIC的实习要求申请人完成以下问答题：“请描述你的理论取向以及这如何影响你的概念形成和构思”美国逻辑协会(APA)评估工作小组也支持这种方法。他们注意到构思和完成一件事并能运用至少一部分心理取向的能力对证实临床的应用技能来说是非常重要的。美国心理认证委员会的指导与准则也通过注明：“认证指导方针和原则是专门用于允许一个程序广泛的组织通过定义其哲学或模型的训练,来确定它训练的原则、目标、想要的结果和方法。

传统理论方向已经在专业心理教育和实践上扮演了重要角色。这个领域的整个历史是如何的有争议是引人注目的。这些不同方向的批判和缺点是众所周知的。标准的本科和研究生教材通常讨论他们作为理论的教材。甚至目前最具影响力的单一方法,认知-行为治疗来解释心理疗法改变(如。,卡兹丁,2024)。(看到的部分遵循进一步讨论了这些问题。)被广泛认为是不充分的。

专业心理学传统的理论取向可能普遍被认为在人格，精神病理学和行为的改变上没有提供完整的解释。然而，他们却在这个领域扮演着主要的角色。事实上，这对许多学生来说将是困难的，有天赋和实践能力的心理学家们来构思理论概念时并不是建立在这些取向上。然而，从一个科学的视角来看这个实践的合理性是显然不正确的。如果这些方向被普遍认为是不完整也不充分的，那这对临床医师选择一种或者更多传统理论方向来作为他们临床理论实践指导合不合适呢？而且这些时间被包含进了专业内主要的组织结构中，对于加强这些专业的科学基于何种基础提出?本文探讨了这些问题的起源和性质，使之过渡到一个统一的以科学为基础的实践方法。

为了阐明这个问题的意义，这篇文章首先简要的回答了与心理学专业理论实践相关的传统方法，然后检测了这个领域的理论基础令人困惑的背后的原因，接下来这篇文章探讨了解决这个问题综合而科学的方法的特征。依靠已经得出的理论框架运用于教育，实践和研究对一个建立在科学基础之上的学科来说是不合适的，而且更具批判性的是专业心理学仍在重新检测这些问题同时更新建立于其上的科学基础。

专业心理学理论上的冲突和混乱

作为学科准则，心理学的一个显著特征是不断增长的理解心理学现象的方法。从一开始，最主要的争论是理解心理学最合适的方法。1879年，建立了第一个心理学实验室的威廉冯特认为更高的认知过程甚至不应该调查了,因为他们使用可用的实验方法的理解太复杂了。他的学生们仅仅只被允许学习基本的经验像基础知觉，组织和感受。到了世纪之交,西格蒙德弗洛伊德是倡导一种截然不同的方法来理解人类心理学。,围绕着的角色无意识的。1913年,约翰·沃森提出了另一个彻底不同的角度来看,敦促他的同事们放弃他们在意识上的兴趣,而是关注行为。很多理解人类心理的不同的方法仍然在这些年不断增长。托马斯·库恩(1962)指出这种理论增殖和竞争是因为自然科学在他们年轻和断定心理学有一个类似的“不成熟”和preparadigmatic阶段的物理科学的特征是在17世纪。

这种心理专业理论方法的增长仍然持续到了现在。新的折衷和综合方法继续下去要开发(参见Norcross说,2024),以及全新的方法如积极心理疗法(塞利格曼,拉希德，2024),附件疗法(沃林,2024)关系型心理疗法(Magnavita,2024),和连贯性治疗(埃克& Hulley,2024)。另外，没有 一种个人的方法成为了最主要的方法，调查通常发现拥护者数量最多的一个取向，即使是一种折中的或综合的方法，也仍是极少数的，通常少于标准的三分之一。近年来，理论阵营之间强烈的争吵和矛盾开始减少。但是不同理论方向间的分歧仍然很大。

除了理论阵营内的矛盾，也有一些其他的争论和分裂反应了这个领域理论基础上的疑惑，1976年,全国心理学专业学校委员会离开APA因为教育培训模式的根本差异。1988年，许多心理学者对APA所强调的实践大失所望，形成了APA的断绝。经验上的支持治疗运动在PP迅速成为有争议的在1995年APA部门12个工作组推动和传播心理过程应用的概念后。恢复孩子性虐待记忆的争议在1990年变得如此强烈的,以至于被称作“记忆战争”(Loftus &戴维斯,2024;第470页),一个心理学历史上矛盾最激烈的时期，关注最近也转向不光彩的或危害性的疗法。Norcross和Koocher,Garofalo(2024)进行了一个调查纹理几十个治疗和问专家关于他们不光彩的程度。他们发现25种治疗平均都介于“可能名誉扫地”和“当然名誉扫地”(如性重新定位治疗,认为场疗法,reparenting疗法)。心理学上理论营地和学校的思想争议和冲突如此普遍而且了几十年以致许多心理学家似乎接受他们作为自然地领域一个正常的特点。然而，许多心理学界的领军人一直担心这个领域变得如此的混乱和破碎会导致它将不能再继续作为一个学术纪律。Driver-Linn指出：“认知心理学被分离和不确定围攻是无处不在的。

专业心理学基础理论和概念混乱的原因

在专业心理学基础理论和概念混乱的原因上有一个很大的共识。这些原因对识别解决冲突来说是非常重要的，因而他们在下面将被简要的回顾。有四个问题对理解为什么这个学科理论发展是如此复杂是非常重要的。

许多理论取向的哲学基础

专业心理学历史上重要的理论取向的哲学基础通常是众所周知的。虽然所涉及的细节非常复杂，基本的问题可以很容易地总结。许多这些取向根据基本假设或者采用人类特征的不同视角作为第一准则。这些哲学的基本方式的出发点上的矛盾，导致了在人类心理和行为理解上不可调和的分歧。坚持这些方向往往涉及接受其基本哲学假设或世界观作为反对深信科学证据的作用来检查其有效性。因此，不同理论的拥护者之间的分歧有时像哲学或政治纠纷而不是科学的。

Nonfalsifiability心理学理论

从科学的角度来看，许多心理学传统的理论取向遭受第二次批判的弱点。据称该机制所涉及的个性化发展，精神病理学或行为的变化在整个理论上有很大的不同。尽管如此，这些理论几乎都被用于发生在个体案例的结果。它是因此很难反驳一个特定的理论可以解释任何特定的结果（波普尔，1963年）。学生学习这些专业时通常被建议选择基于适合自己的性格和世界观的理论而不是建立在评估这些问题合乎逻辑的科学分析的基础上。（如科尔西尼2024，特拉斯科特，2024）第一个解释这个问题性质的哲学家是卡尔·波普尔（1902-1994）。1919年，作为维也纳的一个年轻的学生，他听到了弗洛伊德和爱因斯坦展示他们的作品，并对他们的理论都留下了非常深刻的印象。然而他也注意到了它们之间的根本区别。（波普尔，1963）弗洛伊德提出了他的理论并使之可以证实，而爱因斯坦的理论测试如果不可以被检验，则他的理论就是错的。波普尔指出，许多理论，如弗洛伊德或马克思主义是只能确认和不能反驳的。因此，他认为他们是低等的理论。波普尔认为，科学理论必须是可以反驳的，此外，真正的理论测试可以反驳他们的尝试。

人的心理的复杂性

心理学复杂的进化理论也不能被理解如果不喜欢这个复杂而庞大的相关理论体系。极度的复杂性记忆种类繁多的心理现象是心理学成为了一个迷人的研究领域，但他也是极具挑战性的。人类的大脑几乎是不可思议的复杂。在区区3磅重的器官内，大约有100亿神经元与平均1000个突触连接进行我们自己的个人历史，我们家族的历史，甚至的进化史。同时在共同发生的潜意识和意识水平也不断交互的形成甚至创造自己的环境。事实上，人类的心理似乎是人类曾经尝试理解的最复杂的心理现象。生物学家理查德·道金斯（Richard Dawkins）指出，“。。我们动物是最复杂和最完美的设计作品在已知的宇宙中“（1976年，第二十二）威尔逊说：“已存在的最复杂的系统是生物系统，而生物系统中最复杂的现象就是人类的心理。

一些传统的理论取向的主要批评主要集中在未能充分纳入生物和社会文化发展和运作的影响上。从科学的角度来看，所有层次上的自然器官对理解人类心理来说都是非常重要的。没有关于人类发展及作用的理论是完整的，但这并不强调生物之间（例如，遗传学，神经生理学，身体健康，疾病），心理（例如，认知，情感，行为），和社会文化（例如，家庭，社区，文化，宗教，教育，社会经济因素）间相互作用对人的心理的影响。然而心理学传统的理论取向，常常在这个方面是不全面的。

现有的科学工具的力量和准确度

用另一种批判性的眼光来理解与科学工具检测现象的能力和准确性相关的科学理论的发展。这些工具在心里学科的发展中所起的作用是众所周知的。但其重要性在社会科学中却常常被低估。科学的进步是直接依赖于这些工具，以及最重要的一些已被概念化而不是技术化。例如，在代数和符号发明以前知道13世纪欧洲的数学一直都使用文字书写。复杂得多的计算然后进行科学的的商业的转换最后才得出结果。四个世纪以后，牛顿和莱布尼茨的微积分的发明被证明是有用的，科学再次转化。使用微积分迅速导致主要认识的重力，热，光，声，流体动力学，电和磁本质的进步。统计数据和先进数学模型近期的发展有转化了各种现象，使他们能够被调查和解释。

科学的进步还严重依赖的技术手段的发展。例如，哥白尼在1543年提出地心说的假设，但他的假设一直都没有得到证实，直到伽利略于1609年建立了他的第一个望远镜于1609年。每个望远镜技术的进一步推进，经过数百年往往导致了解宇宙方面重要的进展。该显微镜一直是所发明的最通用的和变化的科学仪器之一。列文虎克（1632-1723）的最早期的仪器，能够实现270倍的放大倍率，并成为观察到原生动物，细菌，精子，血球和通过毛细血管进行血液循环的第一人。显微镜下一个革命性的进步在20世纪30年代使用电子束代替光束允许非常小的物体，如病毒，染色体，观察到了核酸（包括脱氧核糖核酸），生物又转化了一次。

许多科学的最新进展，显然是不可能没有电子计算机。脑成像技术，遗传学的进展，和粒子物理学，例如，需要大量高度精密的技术的数据处理设备。最近的“大科学”项目，如人类基因计划和大型强子对撞机将会产生比人类所有以前收集的数据更科学的数据。这样的能力，甚至改变了这些科学领域的方式。而不再使用传统的方法。这可以概括为“假说，设计和运行实验，分析结果，“新方法涉及”假说，查找答案数据库“（Lesk，2024年，第1页）。

最近有关仪器仪表，测量和数学模型的进步特别是对神经科学是一个革命性的影响。例如，高时空分辨率的脑磁图脑扫描使得精确的测量神经元之间的活动成为可能。不是从，“自下而上”的角度来调查心理现象，而是从一个神经元的连接下，“自上而下”的模式。如情报的组织，通过因素分析IQ测试数据，在一个模型上同时结合自下而上和自上而下的方法为第一次调查全面，详细的，多层次的模型提供可能。

由于心理现象的复杂性和可用来研究他们的有限的科学工具，不难理解科学是现在才开始解开更复杂心理性质的过程。回想起来，将会有大量关于生物科学，复杂的人类心理很多不同的解释是不可避免的。就相当物理学还年轻时，有很多不同的解释关于重力，电，磁，热，光，声音（库恩，1962）。由于缺乏一个单一的科学范式来理解心理现象。库恩总结心理学是“不成熟”的科学。这种方式强调心理欠发达国家在该领域的理论，但没有强调不发达的原因。专业心理学可能仍在发展阶段，但原因主要涉及的复杂性的题材和可用的有限的科学工具，不很复杂的现象，自然会在更复杂的现象之前被描述和解释。如果人类的心灵和大脑确实是宇宙中最复杂的系统，那么相比起其他较不复杂的自然现象来说在这一方面了解更少也是自然而然的。由于上述原因，传统的理论取向一直无法充分解释人的心理的复杂性。心理科学一直在推进并稳步增长，但是。目前该领域面临的问题是，是否充分拥有先进的心理科学的解决方案。

是一个统一的心理学理论解决办法吗？

发现了一个单一的一体化的理论成功解释人的发展，功能和行为的变化显然会带来专业心理学preparadigmatic阶段的发展。最近几十年里，对建立一个统一的理论已经有很多的要求。然而，对于为什么这样一个理论不太可能在将来出现也有明确的原因。其他的科学的经历给了解释。

物理是最古老的科学（超过2千年老）肯定已经成功地解释了广泛的从非常小的（例如，亚原子的自然现象粒子）到非常大的（例如，宇宙）自然现象。虽然有这些成就，物理学至今也还没建立一个统一的理论来解释物质和能量。事实上，物理世界批判的重要方面是从粒子物理学的水平到宇宙（例如，95％的宇宙是由“暗物质”和“暗能量”的有关其中很少是众所周知，兰德尔，2024）。发现了一个物质和能量的统一理论被许多人视为物理学的最终目标，但实现这一目标，该领域仍有一个很长的路要走（米切尔，2024年）。

生物学是一门比物理学年轻的科学，但也很成功。在1859年达尔文物种起源出现以前，生物基本上是一个描述性科学。自然选择经过20世纪30年代和20世纪40年代才被赋予完整的意义。现代进化理论仍在继续发展（拉尔森，2024年），显然许多生物过程仍待发现。让人振奋的是西布朗代谢标度理论可能使生物学建立在一个统一的理论之下，但这种可能还亟待证实。

尽管是非常成熟的，成功的学科，物理学和生物学至今还没建立一个统一的理论来解释其领域内的现象。与此相反，心理学是一个非常年轻的学科，调查非常复杂的现象。功率和精确的科学工具一直在推进，但很明显，解开复杂的人类心理，仍有许多工作有待完成，没有理由期望在物理学或生物学建立起一个统一的理论前心理学先建立。

然而，至关重要的是认识到一个统一的心理学的理论是没有必要离开背后preparadigmatic的过去。现在在物理，化学，生物等领域都没有一个统一的理论，但这些领域却都被视为扎实的科学。在一个被认为科学的特定领域，也是没有必要解释所有现象的。就拿药物来说，当然，成功的生物医药科学是令人印象深刻的。尽管如此，仍待发现的也是很多的。例如，还有许多不知起因和如何治疗的特发疾病（如阿尔茨海默氏症和帕金森氏病，大部分癫痫发作，多发性硬化症，类风湿性关节炎，I型糖尿病）。许多医疗程序关于药物的制造及推广是否会带来更大危害的安全性的关注也在不断增长。

医药在美国达到“引爆点“时，最明显的转变主要在1910年亚伯拉罕·弗莱克斯纳提

交了他的国家医学教育报告使之从艺术到科学。在19世纪结束时，生物学已经取得了许多重要的进步和医学实践的转化。1878年，巴斯德介绍了细菌感染的理论，并在接下来的一年测试了第一次疫苗接种。医疗器械灭菌已引入并日益普及朝着这个世纪的末端。为了评估美国的医疗教育是否有充分的科学基础，弗莱克斯纳几乎参观了所有美国和加拿大的168所药物学校，并给他们评定了等级。他极具影响力的报告，包括他的评定等级和对个别学校的严厉批评，其中几个学校最后倒闭了。在未来的几十年里，42％的学校关闭，留下的则增加了他们的录取标准，实验室和临床培训要求（希亚特和斯托克顿，2024年）。

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