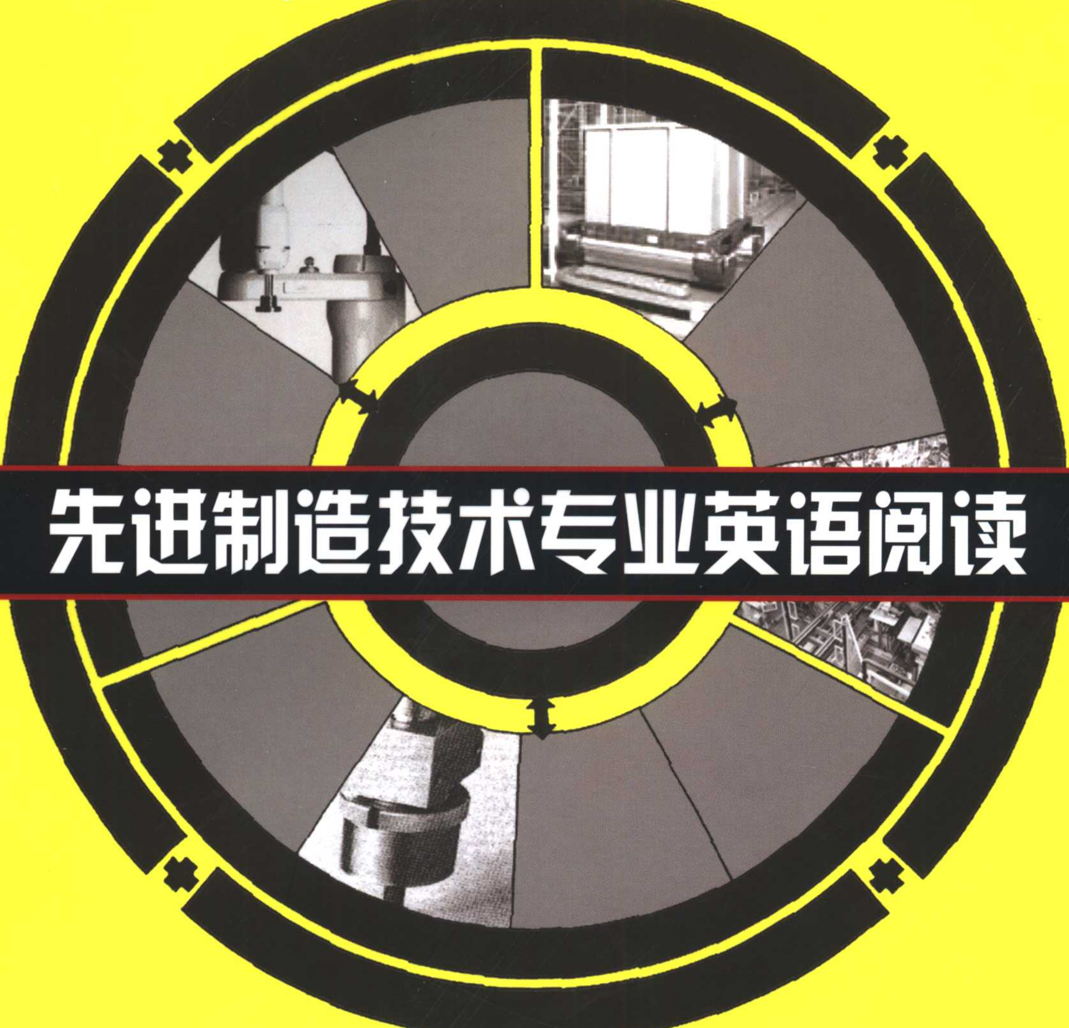

先进制造技术专业英语阅读

Reading of Advanced Mechanical Design and Manufacturing

屈利刚 主编

化学工业出版社

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前　　言

现代机械制造技术是在传统机械制造技术的基础上，融合了计算机技术、信息技术、自动控制技术等现代高新技术发展起来，并使传统的机械设计、制造两个分支学科形成了系统的现代设计和先进制造技术体系。

现代设计技术领域中，新的设计思想和方法不断出现，以计算机化为特征的设计技术在机械产品设计计算、工程绘图、数字仿真和数字化设计等技术的发展已取得长足的进步。很多关键技术已经在生产实际中得到应用，发挥重要作用，例如计算机辅助设计、计算机辅助工程、优化设计、反求工程、产品全生命周期技术等；以信息技术、工艺技术与管理技术相结合的先进制造模式也在国内外企业得到广泛的应用及普及，也形成了众多既联系又独立的技术分支，例如现代数控机床、工业机器人、计算机辅助制造、计算机辅助工艺规划、柔性制造系统、精益生产、企业资源规划、计算机集成制造系统、并行工程、敏捷制造、虚拟制造、智能制造及绿色制造等。随着科技的进步和市场的需求，现代制造技术的不断发展，在冷热加工之间，加工、检测、物流、装配过程之间，设计、材料应用、加工制造之间，其界限均逐渐淡化，逐步走向一体化。

为了满足高等学校机械专业本科生双语教学和科技工作者对现代机械制造技术英文资料学习的需要，我们编写了本书，内容主要包括现代设计技术和先进制造技术两个部分：第一部分由前 7 章构成，主要介绍现代设计技术，如优化设计、可靠性设计、计算机辅助设计、有限元分析等；第二部分主要介绍先进制造技术，包括计算机辅助制造、计算机辅助工艺规程、数控技术、柔性制造和集成制造、工业机器人、现代加工技术和新型工具技术等。

本书由沈阳航空工业学院屈利刚副教授担任主编，并和高航教授共同编写了第 1 章、第 3 章、第 6 章、第 7 章、第 15 章；第 8 章、第 9 章、第 10 章、第 13 章由郭建烨副教授编写；第 11 章、第 12 章、第 16 章由张艳丽编写；第 2 章、第 4 章、第 5 章、第 14 章由王霞编写。

大连理工大学高航教授为本书提供了大量的资料和帮助，在此特别表示感谢。

由于时间仓促和编者水平有限，书中难免有不妥之处，恳请广大读者批评指正。

编者

2006 年 7 月

Contents

Chapter 1 Outline of Mechanical Design and Manufacturing

1.1 An Overview of a Manufacturing Enterprise

For most enterprises, the long-term goal is to stay in business, grow, and make a profit. This is particularly true to manufacturing enterprises, which must understand the dynamic changes that are taking place in the business environment. The twenty-first century business environment can be characterized by expanding global competition and products of increasing variety and lower demand. The globalization of economic activity has brought about a sea change in the attitudes of customers. Customer individualism is certain to become the central theme of business. What we are going to witness is an era of mass customization. This means manufacturing products for the mass market in such a way that products are customized for each individual in that market. Recall that in the 1970s, the cost of products was the main lever for obtaining competitive advantage. Later in the 1980s, quality superseded cost and became an important competitive dimension. Now low unit cost and high quality of products no longer solely define competitive advantage. Today, the customer takes both minimum cost and high quality for granted. Factors such as delivery performance and customization and environmental issues such as waste generation are assuming a predominant role in defining the success of organizations in terms of increased market share and profitability. The question is, what can we do under these changing circumstances to stay in business and retain competitive advantages?

As a first step what is needed is the development of the right business strategy to meet the challenges of present and future markets. In doing so, a manufacturing organization has not only to understand what customers want but also to develop internal mechanisms to respond instantly to the changes demanded by customers. This requires a paradigm shift in everything our factories do. They must not only make use of state-of-the-art technologies and concepts but also think in the reverse direction. "Reverse direction" means building products that realize customer expectations. That is, when an organization is deciding about business plans, it has to address several questions. Will the customer find any change in what one does as a result of using this? Will the customer be able to define any benefit?

From the customer's point of view, a company has to respond to smaller and smaller market niches quickly with standardized products that will be built in lower and lower volume. In other words, we can say that a future successful manufacturing organization will be a virtual corporation that is instantaneously responsive to customer needs. This view has been shared by an industry-led consortium on twenty-first century manufacturing enterprise strategy.

The next step is to determine the right kind of resources to support the business strategy. This requires the right choice of people, technology, and business processes. What is further needed is a marriage of corporate strategies, technology, people, and business processes with a view to evolving policies so that all the functional organs of an organization (finance, sales and marketing, product engineering, manufacturing, and human resources) work in a synchronized manner to achieve corporate objectives. The obvious question then is, how should a manufacturing enterprise work?

We know that all the functional organs of a manufacturing enterprise, such as finance, sales and marketing, design and manufacturing, and human resources, continually receive feedback about products, product attributes, and market segments. Fig. 1.1 shows how customers play a pivotal role in defining the manufacturing enterprise. Corporate objectives such as growth in market share, profitability, work force stability, and other financial measures essentially emanate from the understanding of the marketplace. For example, marketing identifies a range of products,

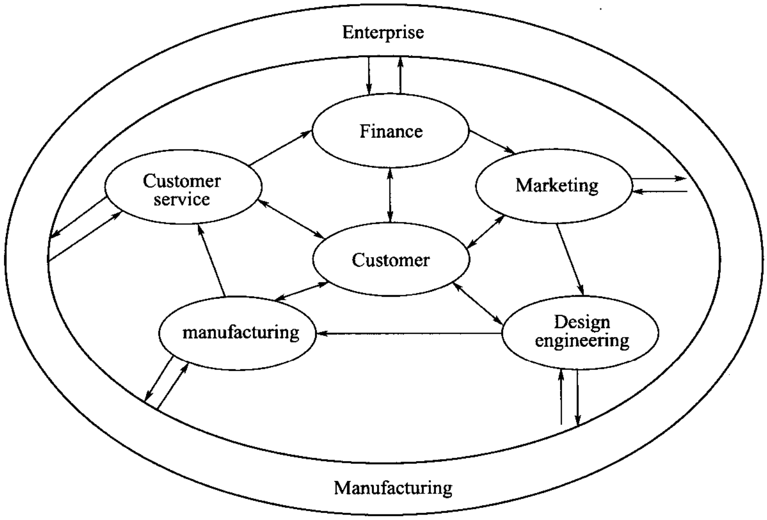

Fig. 1.1 Customer and manufacturing enterprise

product market segments, and new product ideas to satisfy customer needs. Can a company deliver the kinds of products needed to satisfy order-winning criteria such as cost, quality, lead time, and so on? The answer to this question lies with design and manufacturing, which explore various product design and manufacturing process options as well as assess infrastructure to see if they can satisfy the order-winning criteria. Obviously, the human resources, technology, finance, and business processes in the company play a major role in answering this question and their interaction with manufacturing is very important. Accordingly, the manufacturing strategy should evolve from collaborative decision making that satisfies the requirements of finance, sales and marketing, design and manufacturing, and human resources. Collaborative decision making is a way to achieve congruence between the corporate objectives, marketing goals, and manufacturing capabilities of a manufacturing enterprise. This process may lead to revised corporate objectives and marketing goals. What eventually emerges from this process will be an implemental product design and manufacturing plan. This plan will satisfy order-winning criteria considering the requirements of business segments represented by marketing, finance, strategic planning, human resources, and manufacturing management. A design and manufacturing plan is built considering such aspects as product and process definition, manufacturing planning and control, and factory automation. Integration of a complete enterprise would facilitate successful implementation of these plans in realizing the corporate goals. Information resource management, communications, and a common database are required for the integration of a complete enterprise.

As discussed earlier in this section, mass customization with high delivery performance, high quality, low cost, and environmentally conscious products is required for a manufacturing organization to remain successful in the twenty-first century. To support such a virtual organization for discrete products manufacturing, a thorough understanding of the concepts and technologies for the design and manufacturing of products is necessary.

Although the understanding of functional areas such as marketing, finance, and personnel is also important for the successful operation of a manufacturing enterprise, the scope of this book is limited to two major functional areas: design and manufacturing. Accordingly, this book provides a systems approach to understanding the concepts and technologies in computer integrated design and manufacturing systems. In later chapters we will discuss computer aided design (CAD), concurrent engineering (CE), computer aided process planning (CAPP), computer aided manufacturing (CAM), quality engineering, automated material handling, robotics, manufacturing planning and control, cellular manufacturing, just-in-time manufacturing (JIT), flexible manufacturing systems (FMS), and enterprise integration. Before starting our journey of understanding of these concepts and technologies, let us have a look at the recent past; it will be beneficial in placing and judging things in the right perspective.

1.2 Design and Manufacturing: A Historical Perspective

1.2.1 Design

Design and manufacturing are the core activities for realizing a marketable and profitable product. A number of evolutionary changes have taken place over the past couple of decades in the areas of both design and manufacturing. First we explore the developments in what is called CAD. The major focus in CAD technology development has been on latter representation completeness. Fig. 1.2 shows the evolution of mechanical CAD/CAM systems over the past three decades. First there was the development of a two-dimensional (2D) drafting system in the 1960s. Then the extension of 2D drafting systems to three-dimensional (3D) models led to the development of wire-frame-based modeling systems. However, it was not possible to represent higher order geometry data such as surface data. To bridge this gap, surface based models were developed in the early 1970s. Even though the surface models provided some higher level information, such as surface data for boundary representation, this was still not sufficient to represent solid or volume enclosure information. The need for solid modeling intensified with the development of application programs such as numerical control (NC) verification codes and automation mesh generation. A volume representation of the part is needed for performing topological validity checks. The solid modeling technology has evolved only since the mid-1970s. A large number of comprehensive software products are now available that enable integration of geometric modeling with design analysis and computer aided manufacturing.

These software products include Pro/Engineer from Parametric Technology Corporation, IDEAS from SDRC, Unigraphics from Electronic Data Systems, and MES from Intergraph Corporation, among many others.

The solid modeling schemes provide mechanisms for defining complete informational models. However, these schemes have an inherent weakness because they provide a low level representation of parts. That means that to model a part, the designer has to provide model description in terms of geometric and topological entities that constitute the model. For example, for a boundary representation of a part model, the designer has to specify curves and surfaces and their corresponding edges and faces or a Boolean combination of primitives for a constructive solid geometry (CSG)-based representation. For example, a solid model of a rotating shaft with one key stores information in terms of only edges and faces. Further

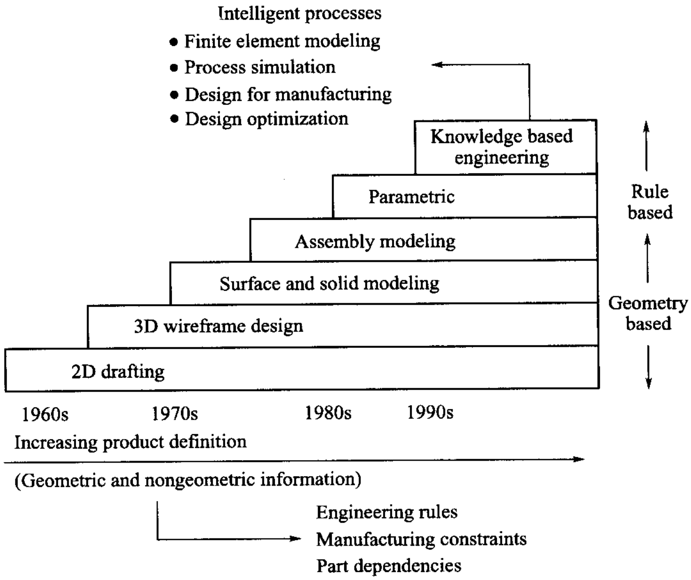

Fig. 1. 2 The development of mechanical CAD/CAM systems

developments in parametric modeling provide scope for a higher level of representation of model. These models provide only a higher level of abstraction of the underlying geometry and fail to capture the methodology used to design, configure, and assemble products.

The latest evolutionary development in the CAD/CAM industry has been knowledge-based engineering systems that can capture both geometric and non-geometric product information, such as engineering rules, part dependences, and manufacturing constraints, resulting in more complete informational product definitions. The commercial knowledge based system known as Intelligent-CAD (ICAD) is available from ICAD, Cambridge, Massachusetts. Because ICAD is based on the principles of object oriented modeling technology, it provides a development environment with powerful geometric and artificial intelligence CAD-based tools.

1.2.2 Manufacturing

Manufacturing is not just the transformation of raw materials into value-added outputs meeting specifications. It has a much broader meaning.

The CAM definition of manufacturing essentially captures this broad meaning: Manufacturing is a series of interrelated activities and operations involving design, material selection, planning, production, quality assurance, management, and marketing of discrete consumer and durable goods.

This definition of manufacturing lays a foundation for the need for systems thinking. That means that, given the complexities involved in manufacturing because of the large number of interrelated activities, there is need for coordinated efforts from every organ of an organization. Furthermore, for a manufacturing organization to remain competitive, it must deliver products to customers at the minimum possible cost, the best possible quality, and the minimum lead time starting from the product conception stage to final delivery, service, and disposal. This implies the notion of the product life cycle approach to design and manufacturing. To accomplish these objectives, a high level of integration is required among all these activities.

Present-day manufacturing activities may be classified in two broad categories: continuous-process and discrete-product production. The focus of this book is on discrete-product manufacturing systems. To satisfy the order-winning criteria of low cost, high quality, and quick delivery response in a discrete-product manufacturing environment requires the combination of the attributes of mass production with those of a job shop. It is important to realize that systems based on the job shop concept have high product flexibility. That is, these systems are capable of making a variety of parts with ease but overall productivity tends to be low. On the other hand, mass production systems are dedicated to one type of product, which makes them much less flexible, but their level of productivity is much higher than that of comparable job shops. To address the problem of low productivity while retaining high levels of flexibility, new types of systems have been developed. These are called flexible manufacturing systems. (FMS) rely heavily on computer controlled equipment such as computer numerical control (CNC) equipment, automated guided vehicles (AGVs), and robots. They are developed on the basis of group technology concepts making use of similarities in design attributes and manufacturing