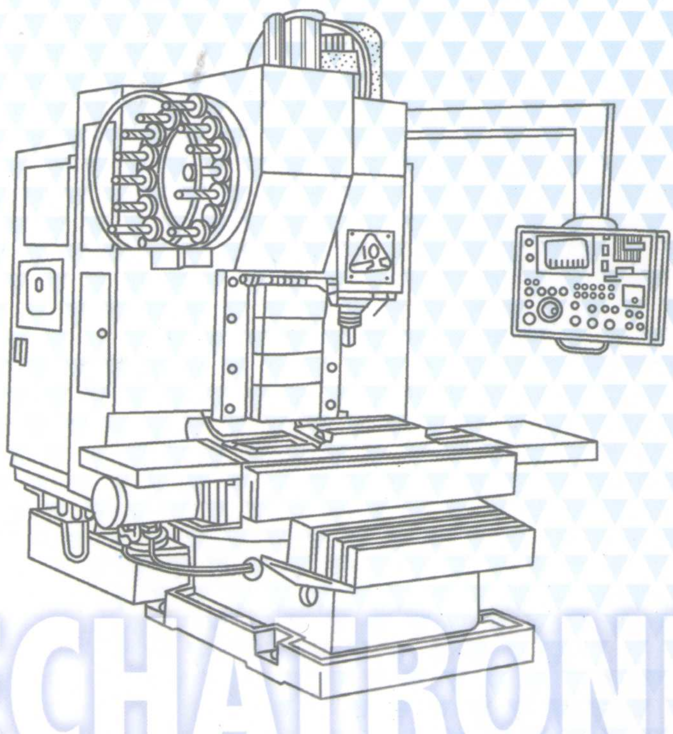
普通高等教育机电类规划教材

机电一体化专业英语

宋主民　主编



MECHATRONICS

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普通高等教育机电类规划教材

机电一体化专业英语

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本书系统地阐述了机电一体化，包括机电一体化产品和机电一体化的生产方式两个方面。第1章用方块图和时序图简要描述机电一体化产品及其生产方式的发展历程；第2章至第7章介绍机电一体化产品的几个基本环节；第8章到第11章是机电一体化生产方式，也就是制造自动化的几个历史发展阶段。本书着重系统地、定性地阐述各部分的关键内容，覆盖面大，英语方面可读性强，专业词汇量大，使读者在学习专业英语的同时能系统地学到机电一体化的基本知识。本书可作为高等学校机械类专业本科生和研究生的专业英语课程教材，也可作为本科生的机电一体化课程的双语教材和机械工程技术人员的参考读物。

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Preface

编者在多年担任重庆大学机械制造工艺、设备及自动化专业硕士生的专业英语课程教学中，深感缺少适用的教材或参考资料。虽然采用过收集的产品说明书、商务合同书和使用说明书以及一些国外刊物上的科技论文，但这些内容不是偏浅就是过于专深而不适用。所以就只好自己编写一些英文讲义，选定的内容就是机电一体化。

在20世纪80年代，机电一体化的内容包括机电一体化产品和机电一体化的生产方式，当时还有“机电控制及自动化”一词，也是指机电一体化的产品及生产方式。以后则相继出现了“先进制造技术”和近期的“现代制造工程”等。编者认为仍可将其归诸于机电一体化的生产方式在信息时代结合现代管理技术的拓展。因此，本书还是围绕着机电一体化产品和机电一体化的生产方式这两个方面来编写。

使用本书初稿的工学和工程硕士生反映这些内容覆盖面宽，词汇量大，可读性好，有助于提高专业英语读写能力，而且在学习专业英语的同时还能系统地学习机电一体化的知识。为此，编者争取出版此书，以为更多的读者服务。

全书共分11章，第1章是机电一体化简介，第2章至第7章是机电一体化产品的各组成部分，第8章至第11章是机电一体化的生产模式，也就是制造自动化的几个历史发展阶段。本书除第2至5章和第7章内容基本摘译自所列的中文参考书目外，其他各章均有部分或大部内容是编者根据教学和科研中的认知来撰写的，对于本书的“后记”中所列的一些浅见，欢迎读者提出宝贵意见。

编者认为，学习外语贵在坚持和积累，关键是要善于模仿和记忆，所以各章都列出了一些 Referable expressions（可供参考的表达）和供参考的语法分析。此外，还专门就正文课文制作了CD录音光盘（约240分钟），希望有助于提高学生的听读能力。

为了帮助读者理解和掌握本书的专业内容，本书提供课文译文供读者参考，需要者请通过书后反馈表与编辑联系。由于中、英文的结构是完全不同的，所以课文译文主要采用意译而非逐字直译。

本书可作为机械类专业本科生和研究生的专业英语教材，教师可根据情况选择一部分内容进行教学。同时，也适合作为本科生的机电一体化课程的双语教材框架，教师可适当增加一些专业内容。编者还希望它能成为机械工程技术人员的专业英语读物。

本书的第5、6、7三章由宋捷编写，其余各章由宋主民编写并统稿。由重庆大学何玉林教授担任主审。

本书引用和摘译了所列参考书目中的内容和插图，编者对此深表感谢。各章作业中英译汉和汉译英部分的第二小题均取材自互联网，在此一并感谢。对于全书中存在的缺点和不当之处，敬请读者批评指正。

编者　于重庆大学

CONTENTS

Chapter 1 Brief Description of Mechatronics

1.1 Introduction

Mechatronics is the abbreviated form of the words of mechanical and electronics. It was created by Japanese but you cannot find it in dictionary. Mechatronics is also the combination of the science of mechanical engineering and electronics. Mechatronics was defined by EEC (the European Economic Community) as "the optimum cooperative combination of precise mechanical engineering, electronic control and system technique considered in designing products and manufacturing system".

Mechatronics system consists of mechatronics product and mechatronics productive system (mode). Mechatronics product is generally recognized as "A system consisting mechanical components, electronic units and softwares, in which electronic techniques are introduced in the aspects of principle function, driving function, information and control function". On the other hand, the current developed mechatronics manufacturing system is aimed at realizing flexible automation of manufacturing, upgrading the efficiency of designing products and product's quality to adapt the rapid changeable market requirement and improving the ability in market competition.

This book will provide you with fundamental knowledge of mechatronics products and brief description on current mechatronics manufacturing system. The author aims to meet the need for teaching the course of "English for special purpose" for those students in the speciality of mechanical engineering. You will find as learning technical English you have learnt concurrently much of field knowledge in mechatronics products and contemporary manufacturing technology.

1.2 Mechatronics products

A typical mechatronics product such as numerical controlled (NC) machine tool or industrial robot is composed of machinery and microprocessor-based electronic circuit including signal sampling, data acquisition and processing, and computer control. Compared to traditional mechanical product, mechatronics product has the advantages of higher precision, higher productivity, higher reliability and lower consumption of energy, material and labour.

1.2.1 Constitution of mechatronics products

Fig. 1.1 is the block diagram showing the constitution of a mechatronics product. Functions of the blocks are described as follows:

1. Mechanical system Mechanical system includes machinery and working process which

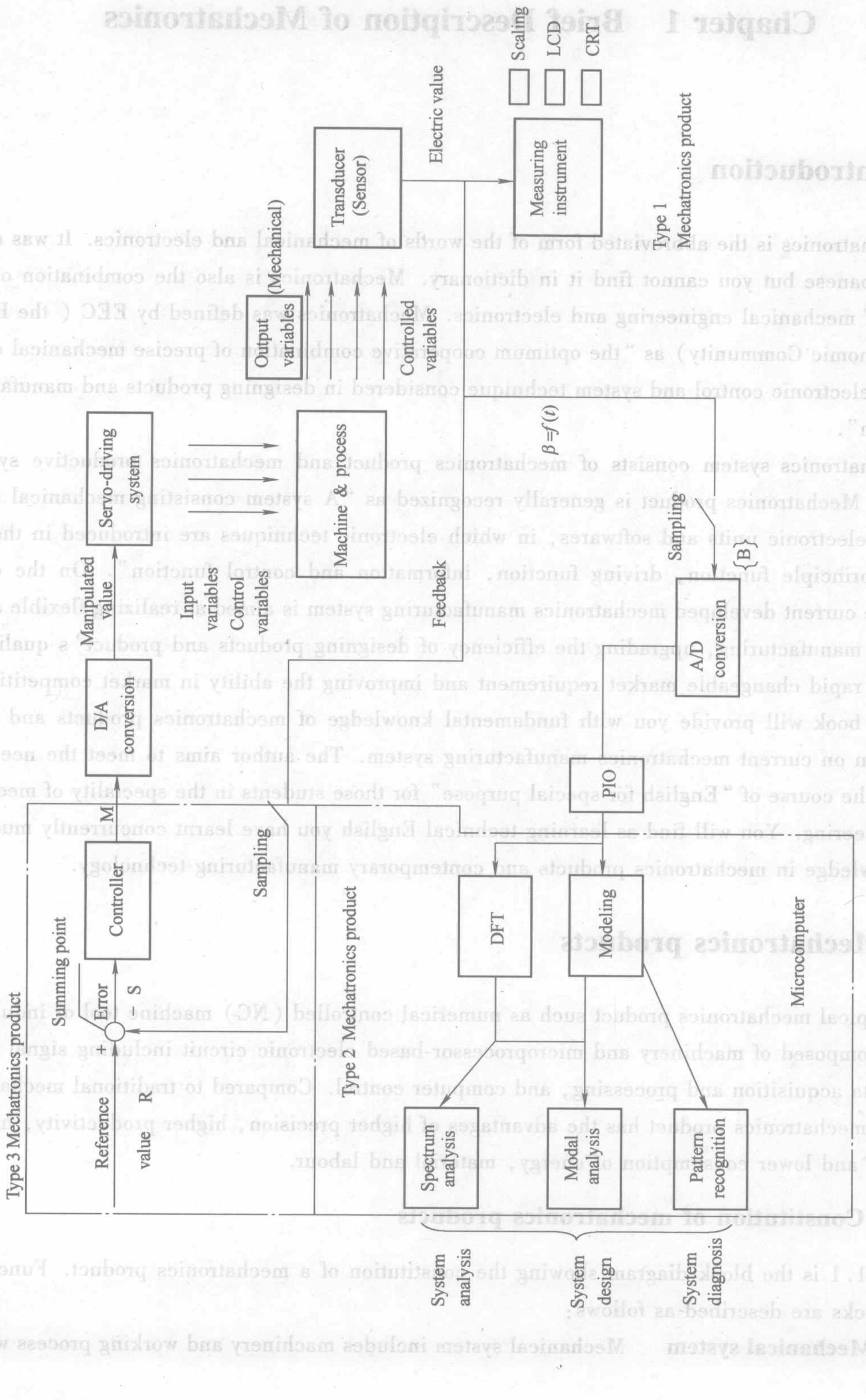

Fig. 1.1 Constitution of mechatronic products

has various input and output variables. The input variables are also called control variables while controlled variables for output variables. For example, turning process performed on a lathe shown in Fig. 1.2 has input variables including speed of spindle, feedrate and depth of cut, and output variables such as roughness, cutting force, vibration level, machining precision, temperature, noise, metal removal rate and energy consumption etc. Some of them are measurable on line, but some have to be measured off line.

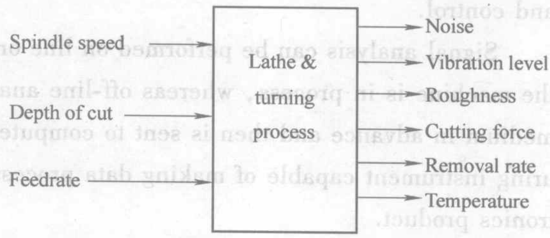

Fig. 1.2 Input and output variables of turning process

2. Transducer (sensor) Transducer is an instrument used to measure output variables and convert it from mechanical signal into electric value. For example, pyrometer is used to convert temperature into voltage, strain guage converts strain into the variation of resistance and accelerator converts acceleration into electric charge etc.

3. Measuring instrument Transducer is usually called primary instrument. The electric signal it generates is transmitted into measuring instrument called the secondary instrument in which the signal is treated by signal processing circuit to be suitable for displaying on scaling meter, LCD (liquid crystal display) or CRT (cathode ray tube). The measuring instrument records quantitatively the measured output signal of machine and process. In a sense it is a kind of mechatronics product used to monitor the status of machinery or process and herein classified as the type 1 mechatronics product.

4. Data acquisition Apart from being transmitted into measuring instrument for displaying, the electric signal is also transmitted into microcomputer for further processing via data acquisition system which consists of modem, filtering, sampling, A/D (analog to digital) conversion and PIO (peripheral input and output) interface circuit. Modem simply to say is a circuit used to transmit very weak and slowly varying non-periodic signal by modulating and demodulating. Filter is used to eliminate or weaken the disturbance and noise mixed in signal; it is also a device allowing or blocking the signal of specific frequency band to pass through. Sampling is a circuit used to cut off the continuous output signals to be discrete pulses in terms of certain time interval. A/D conversion is an electronic circuit denoted by ADC used to convert discrete analog value into digital data so that it can be transmitted into and accepted by computer. Finally PIO interface is a circuit providing the channels for inputting signals into computer.

5. Signal analysis Signal analysis in computer is also called data processing. Signal analysis contains a variety of work to do from obtaining the simplest statistic value like mean value, variance or distributed square root (DSR) to complicated analysis like correlative analysis and spectrum analysis etc. There are two ways to make signal analysis: one is to do that by directly using input data, the other is to build with the data the mathematic model of the system at first, then make further post-modeling analysis based on obtained parameters of the model, which includes correlative analysis, systematic stability analysis, modal analysis, spectrum analysis and pattern recognition etc. All these signal analyses are applicable for systematic design, analysis, diagnosis and control.

Signal analysis can be performed on line or off line. On-line analysis means it is performed as the machine is in process, whereas off-line analysis refers to that the signal has been recorded in medium in advance and then is sent to computer for analyzing. The machine equipped with measuring instrument capable of making data processing on line can be classified as the type 2 mechatronics product.

6. Computer control A typical mechatronics product is a machine in combination with a computer control system, as shown in Fig. 1. 1. The electric value output from transducer is fed back to computer via sampling, which is then compared with the reference value of certain controlled variable, R, at the summing point to generate error, E, which is then sent to controller, a computer algorithm, to generate a manipulated value, M, for rectifying the error. The digital value M is converted by D/A converter (DAC) into analog value and transmitted into servo-driving system as the input variable to control the machine or process.

As shown in Fig. 1. 3, the servo-driving system consists of servo-driving circuit, servo-driving motor (or valve for hydraulic driving system) and mechanical actuator including gear chain, lead-screw-nut pair and carriage-slide pair. The transducer used here is a displacement transducer which depends on whether the control system is open-loop, semi-closed-loop or closed-loop. Machine equipped with computer control system is represented typically by NC machine tool, which is classified as the type 3 mechatronics product.

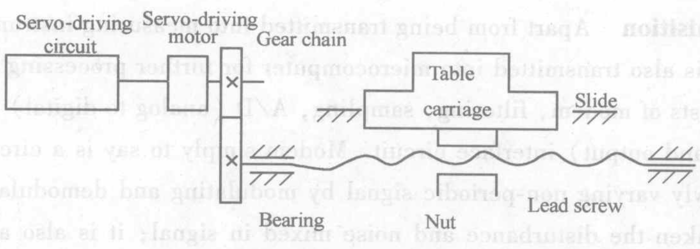

Fig. 1. 3 Servo-driving system

1. 2. 2 Common and critical technologies in developing mechatronics product

In developing a new mechatronics product, no matter what, a robot, a NC machine tool or any others, the following six common and critical technologies must be developed.

1. Transducer and measuring techniques.

2. Data acquisition including modem, filtering, sampling, DAC/ADC and PIO interface.

3. Signal analysis/data processing including mathematic modeling and post-modeling analysis, and designing controller algorithm as well.

4. Servo-driving system to drive mechanical actuator according to the manipulated value provided by controller.

5. Precise mechanical technique to design, manufacture and assemble a precise machine.

6. Systematic technique From the viewpoint of the discipline of "system engineering" to arrange and combine the functions of software and hardware, mechanical components and electronic circuits reasonably in order to obtain the maximum ratio of performance/cost of the system.

1.3 Mechatronics production system (manufacturing mode)

In reviewing the history of developing automatic manufacturing system (In fact it is mechatronics manufacturing system) in the past century, scholars divide it into five stages as shown in Fig. 1.4. They are:

1.3.1 Industrialized production stage

In the 30's of the 20th century it was represented by Ford productive mode which adopted the productive manners of interchangeability, flow process and using specific automatic machine to realize rigid automation in large scale production.

1.3.2 Facilities automation stage

It was represented by NC, CNC, DNC and industrial robot in 1940's to 1960's. Since soft program medium of the workpiece machined is used in NC machine tool, there is no longer the contradiction between the universality and automaticity of machine tools. This leads to realizing automatic manufacturing in small batch even one type-one piece production, which motivates renewing products and makes our life colourful.

1.3.3 Flexible automation stage

It was represented by FMC (flexible manufacturing cell) and FMS (flexible manufacturing system) in 1970's. FMS aims at making manufacturing system optimum by means of the following activities:

(1) FMS is composed of a group of NC machine tools, since a workpiece usually needs more than one operation to machine it, but the working time for each operation is different. It is appropriate to put several kinds of workpiece into manufacturing system simultaneously so that the expensive NC machine tools used can be uniformly loaded and work efficiently with the aid of computer allocating.

(2) A material handling system (MHS) is implemented in FMS to greatly decrease the idle time in manufacturing including parts/tools presetting, transport and mounting etc. MHS consists of part/tooling preparing station, cubic inventory, vehicle/curt guiding system (VGS), orbital way or inductive-guided orbital way, as well as automatic pallet changer (APC) and automatic tool changer (ATC) etc.

(3) FMS is featured by its flexibility, which enables the system to adapt any change of the manufacturing system; for instance, if one of the machine tools is out of order, the system can

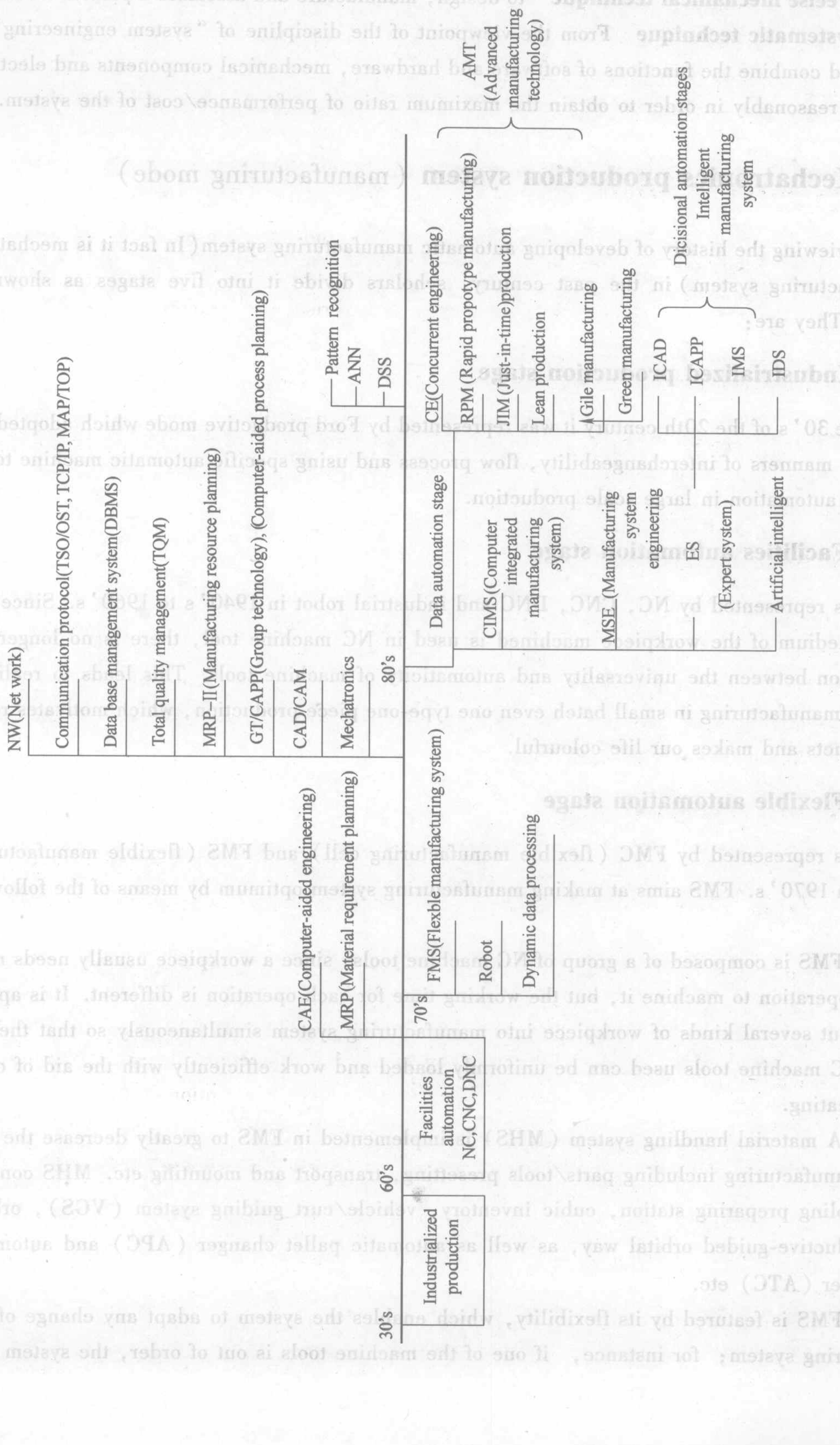

Fig.1.4 History of developing automatic manufacturing system

transmit the workpiece prearranged on this machine tool to another one by means of computer allocation.

1.3.4 Data automation stage

In 1980's to 1990's it was represented by CIMS (computer integrated manufacturing system). CIMS is aimed at building a data integrated system supported by computer network and database techniques, in which each division of the enterprise including production planning, product design, manufacturing, management, quality control, sells and purchase etc. can share the data with any other, so that the correct data of each division can be transmitted to correct place/man at correct time. This is greatly helpful for the decider of enterprise to make correct decision.

It is shown in Fig. 1.4 that all the technical items up horizontal line are the fundamentals of developing CIMS. They will be introduced hereinafter.

1.3.5 Decision automation stage: Intelligent manufacturing (IM) and advanced manufacturing technology (AMT)

From 1990's, manufacturing entered decision automation stage which is the combination of manufacturing and computer science in expert system and artificial intelligence. In decision automation system, knowledge of various field experts including chief engineer, engineer of design, manufacturing and management is stored in a knowledge base. When user inputs a question or requirement, the expert system replies it via man-machine interactive interface by searching for the knowledge base and making reasoning step by step; once the satisfactory result is given, it is then stored in the form of an event or a rule as a new knowledge in the knowledge base.

In decision automation stage, with the aid of expert system various techniques become intelligent including intelligent CAD (ICAD), intelligent CAPP (ICAPP), intelligent management (IMS) and intelligent decision system (IDS) etc., which compose an intelligent manufacturing system.

On the other hand, in this stage as developing of various advanced techniques like integrated CAD/CAM, advanced management system like MRP-Ⅱ system, computer network and data base system, computer communication protocol, total quality management (TQM) etc., advanced manufacturing modes are being developed including concurrent engineering (CE), rapid prototype manufacturing (RPM), just in time (JIT) production, lean production, agile manufacturing, virtual manufaturing and green manufacturing etc., on which a brief description will be given hereinbelow.

Terminology

mechatronics 机械电子学，机电一体化
electronics 电子学
European Economic Community 欧洲经济共同体