Chapter 14
Trends and Prospect of Manufacturing Intelligence

Manufacturing Intelligence (MI) focuses on how to adopt artificial intelligence and computing intelligence methods to solve problems in digital manufacturing, such as intelligent digital scheduling, intelligent digital designing, intelligent digital machining, intelligent digital controlling, intelligent digital process planning, intelligent digital diagnosis and maintenance. In order to meet the needs of a changing market, manufacturing systems have been in a constant process of development and the pursuit of perfection. In this chapter, the various characteristics of the manufacturing industry in the 21st century are analyzed from the perspective of society, market, product, enterprise and manufacturing technology. Then a brief review of MI in previous chapters is presented. The trends and prospects of MI, adapted to the development of manufacturing, are then discussed, followed lastly by a summary of this chapter.

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INTRODUCTION

The manufacturing industry is the mainstay of any modern economy and a reflection of national strength, in which the gross production value generally accounts for 20%-55% of a country’s gross domestic product (GDP). In most countries, manufacturing technology usually plays a 60% role in the structure of enterprise productivity (Li, 1998). The competition among national world economies lies mainly in the competition of advanced manufacturing technology, and this competitive is finally embodied in the market share of products (Kahn, 2001). With the rapid development of economy and technology and the equally rapid changing of customers’ needs and market environment, this competition becomes more intense, and governments attach a great deal of importance to the research of manufacturing intelligence technology. With the advancement of science and technology, and the development of society and economy, ‘manufacture’
Trends and Prospect of Manufacturing Intelligence

has evolved from a simple process finished by an individual worker and an independent machine to a complicated project which has to be finished by a manufacturing system composed of many manufacturing elements. From the perspective of system science and engineering, the manufacturing system which undertakes and completes the modern manufacturing task has developed from a simple system to a complicated one.

From the perspective of the history of manufacturing not only is the scale of the manufacturing body (for instance, the factory) continually enlarging, but its structure is also becoming more and more complicated. In the times of handcrafted industry, the designing, machining, assembling and detecting were finished individually; the scale of the manufacturing system was small, the structure was simple, and it was easy to operate. During the industrial revolution in 18th century, manufacturing systems were still quite small, although manufacturing technology and related equipments had developed considerably. Throughout the mass production times of the late 19th century, operations were specialized through labor division and, with the support of mechanism and electronics, manufacturing systems on a large scale were developed by using an assembly line. Nevertheless, the structure was not complicated, and it was comparatively easy to cope with problems such as analysis design, information process and management control. In the second half of the 20th century, however, particularly over the last 30 years, the diversity of market needs and competition have forced product manufacturing to develop in diverse directions, with different levels of production and short product cycles. As a result, advanced manufacturing modes such as soft manufacturing, computer integrated manufacturing and sensitive manufacturing have been created, and the manufacturing system is not only very large in scale, but also has a complicated system structure, material flow and information flow. Furthermore, the analysis and integration of the system faces many difficulties, as it is much harder to deal with optimization management control problems, which has become a challenging problem around the world (Dimopoulos, 2000).

With the development of computer science in the 1960s, many new control technologies and methods were applied to engineering projects and products, which greatly enhanced the development of industry technology (Paul, 2002). In the late 20th century, the rapid development of burgeoning science technologies and their application in manufacturing, represented by microelectronics, information technology, new material technology, artificial intelligence technology and system science, greatly expanded the depth and range of manufacturing activities. These changes also impacted on design methods, product structure, production mode, production process and production organization of modern manufacturing and lead to profound changes in expressing, storing, transmitting and processing manufacturing information, and saw the emergence of a number of novel manufacturing technologies. Digitalization and networking have acted as indispensable driving forces in the life cycle of the manufacturing product. In this new manufacturing technology environment, digital manufacturing has emerged to become a strong driving force in promoting development of the manufacturing industry in the 21st century. As the information age marches towards the intelligent age, intelligent digital manufacturing systems, integrated automation (Lastra, 2006), networking and intelligence, embodying the most advanced technologies, have promising prospects and will form the intelligent productivity of the new generation.