Chapter 1
Intelligent Manufacturing Systems

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Abstract This chapter provides information on intelligent manufacturing systems including an analysis on change and historical progress of manufacturing systems as well as a brief review of traditional manufacturing systems. Fundamental technologies of artificial intelligence are also reviewed in order to establish the baseline for intelligent manufacturing systems. Following that, basic characteristics of intelligent manufacturing and respective architectures are provided. Some examples of the applications of intelligent manufacturing systems are highlighted.

Keywords Artificial intelligence, manufacturing system, fuzzy logic, genetic algorithm, holonic manufacturing system

1.1 Introduction

Automation is one of the major indicators of the change in manufacturing. Machines behaving themselves not only decrease the cost but also produce the products to be more compliant with the needs and specifications of the customers. Although technologies such as flexible manufacturing systems provide various advantages, automation itself is not enough to provide competitive advantage. In most of the modern manufacturing facilities, machines are capable of making decisions and exhibiting intelligent behaviour. That is to say that the manufacturing-related activities starting from the design to product shipment are being carried out through intelligent manufacturing technologies. As traditionally known, manufacturing systems are the integrated combination of various functions such as design, process planning, production planning, quality assurance, storing and shipment etc. In each of these functions several activities are carried out. Intelligent behaviour is exhibited by the machines in all of these functions. This diverted the attention of the researcher to “unmanned factories” and there have been quite interesting studies and implementations along this line. In this chapter, a general overview
of the change in manufacturing and intelligent manufacturing systems with some example applications is provided.

Manufacturing organizations have been facing a very challenging environment with dynamic and increasing complexity of activities. There is still a need for more flexible and dynamically changing systems to cope with the market requirements. Intelligent manufacturing systems are capable of providing this flexibility with increasing performance. They can facilitate highly complex manufacturing systems as well as various degrees of functionality of products. As they can handle design changes as quickly as possible, they can easily adapt themselves to the changes in the market and satisfy customer requirements, which are most of the time too versatile. They can also embed new methodologies and technological progress without any problem. Short manufacturing cycle times, shorter supplier times, adaptation to the changing situations in a short time frame, consistent knowledge flow, etc. provide advantages to global economic competition for which most of the manufacturing organizations need to sustain. Intelligent manufacturing systems are proven to be an effective tool for assuring these advantageous.

Since complexity and functionality of the products are increasing and companies need to sustain advantage in heavy competitive markets, it is not possible to make proper and effective decisions without the help and support of computer-based manufacturing systems. Considering interrelated activities in various manufacturing units, the importance of intelligent systems becomes more obvious than ever before. Since they can foresee problems before they occur and provide respective remedies, intelligent manufacturing systems can be extremely useful in supporting the expected level of competitiveness.

Another aspect of intelligent manufacturing is that, the traditional systems cannot be easily expanded in accordance with the technological achievements. They are now facing very challenging tasks such as the following:

- Automation is possible, but the limited decision-making capabilities of the machines make it nearly impossible to develop learning.
- Re-engineering is not easily achievable.
- Distributed management is hardly possible.
- Decentralized management makes it difficult to sustain overall integration.
- Reusability of systems (especially software components) is not possible.
- Synchronization of material and information flows is always problematic.

Historical progress in manufacturing systems shows several breakthroughs. Among them is the distributed manufacturing system. Due to technological developments in both robotics and information technologies, it is possible to design manufacturing systems in different locations but working in an integrated manner. Intelligent manufacturing systems contribute a great deal of effort to sustain this integrity and make it possible to perform manufacturing functionalities in distributed environments. Sustaining intelligent manufacturing systems can therefore assure both individual decision-making as well as cooperation with other related