9th International Conference on Digital Enterprise Technology- DET2016 – "Intelligent Manufacturing in the Knowledge Economy Era

Intelligent Service Platform of Manufacturing Process and Tool Based on Data Warehouse

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Abstract

Cloud manufacturing takes the advanced information technology as the media to provide life cycle manufacturing resource integration and shares services such as product development and manufacturing. Machine tool as a cloud manufacturing services terminal is an important part of product manufacturing. Machining process and cutting tools as the ways of realizing the manufacturing are indispensable, they are services interface in the cloud manufacturing system. The process data sharing service framework in the cloud manufacturing environment is presented. The basic data of cutting, machining process and tool in data warehouse are the foundation and core of data service in this framework. Data mining technology is taken as data query and processing method. Intelligent matching strategy based on machining feature recognition technique, process parameters and machining tool is established. On the basis of this, the technology of machining equipment inquiry and adaptation method are discussed. Finally, the framework of machining process and tool information service strategy is obtained.

Keywords: Cloud manufacturing; Intelligent process platform; Data warehouse; Cutting tool selection platform

1. Introduction

Cloud manufacturing is a new model of network manufacturing services with cloud manufacturing service platform and network technology, it is used to manage manufacturing resources and provide services to enterprise users. Cloud computing, high performance computing, networking and networked manufacturing are integrated in cloud manufacturing [1]. The various types of manufacturing resources and capabilities are integrated in cloud services, which manage cloud services intelligently, provide safe, high quality and cheap cloud service to enterprise users. The concept of cloud manufacturing is manufacturing as a service, and based upon this all kinds of manufacturing resources and manufacturing capacity are virtualized as a service, forming a sharing service platform of manufacturing resources and manufacturing capacity to achieve a safe, reliable, high-quality and cheap manufacturing life cycle service.

Bohu Li, et al. [1] first proposed the concept of cloud manufacturing and the operation mode, and proposed the five layer system structure of cloud manufacturing (including the application layer, application interface layer, core resource layer, virtual resource layer, physical resources layer). Xu [2] proposed a 4-layer cloud manufacturing system structure that is the application layer, global service layer, the virtual service layer and manufacturing resources layer. Besides, many scholars have proposed other cloud manufacturing systems [3-6]. However, no matter in which system NC machine tool is in the manufacturing cloud physical resources layer. Machine tool is an effective way to achieve high efficiency, automation and flexible manufacturing which plays an irreplaceable role especially in small batch, complex shape, and high precision parts manufacturing. Machining process is the most important resources of machining and the powerful guarantee to promote the quality of the products, improve production efficiency and reduce the manufacturing cost.

The combination of computer technology, process optimization and cutting techniques is achieved firstly through the cutting database. In 1964, the database technology was introduced to the field of metal cutting by United States. The database was researched and developed by AFMDC, which contains more than 3750 workpiece material, 22 types of cutting parameters of processing methods. In 1971, Germany also established a cutting data Intelligence Center (INFOS), it became one of the world's largest cutting databases. After 40 years' development and improvement, more than 30 metal cutting databases are applied to the practical production[7, 8]. Metal cutting database has brought considerable economic outlook for the mechanical processing industry, the International Institute for Production Engineering Research (CIRP) proves the cutting database can make the processing cost of the enterprise to improve reduced by 10% or more through investigation, the research will effectively improve cutting production efficiency [9, 10]. Beijing Institute of Technology has built difficult to machining materials cutting database, coating hard alloy cutting database and coated cemented carbide tool expert system of cutting database since 1986. Shandong University studied the cutting database since 2001, developed some cutting databases aiming at high-speed cutting and difficult-to-machine materials [11].

The optimization algorithm and artificial intelligence can be introduced into the original database system, which becomes main direction of scholars' research. For instance, P.G.Mcropoulos et al. developed an intelligent tool selection system according to the basic principle of metal cutting which could predict new processing conditions based on the existed cutting data. Optimization methods such as the neural network algorithm, particle swarm optimization algorithm, and genetic algorithm are applied to cutting data, obtaining functions of tool wear prediction and cutting parameters optimization. At present, the most mature tool cutting database is manufacturer's tool selection for users. Sandvik Coromant developed a tool management software which can automatically choose the tools from the company's electronic samples and provide information of cutting parameters and tool life.

CAPP has the advantages of improving the efficiency of process design, reducing the cost of process design and shortening the production cycle. Process method and tool performance changed constantly with the development of cutting and tool technology, and the service process won't be able to provide better service unless be timely updated. Therefore, the sharing of processing technology is effective in order to make cutting tools, machining centers and other manufacturing terminals better served for customer. Workpiece materials, machine tools and cutting tools related to processing technology will affect the development of processing technology. Among them, cutting tools have the higher degree of standardization and stronger versatility, thus, this article explores the methods of sharing and service of the processing based on the cutting tools.

2. Basic Framework for Process Cloud Services

NC machine tool as one of the cloud manufacturing terminals is an important part of the product manufacturing, machining process and cutting tools are essential part for CNC machine tool working. Therefore, machining process and tool service are essential link in cloud manufacturing. The size of the processed workpiece and the accuracy of the information are released to the process server through the cloud, process server decomposes the processing characteristics of the parts. The part materials, processing characteristics and requirements of machining are matcher in the server, and the right machine information will be transferred to the process server, combined with the cutting tools matching the processing. Eventually, the information of cutting tools is transmitted to the user or manufacturer, providing solutions, arrangement in the process and choice of cutting tool, as shown in the Fig. 1.
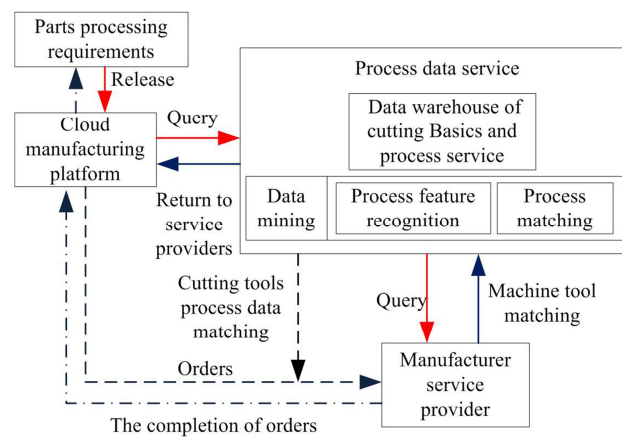

Fig. 1. Process of intelligent cutting tools and process service platform.