

## **DEVELOPMENT RESEARCH OF DIGITAL MANUFACTURING RESOURCE MODELING TECHNOLOGY BASED ON PATENT INFORMATION ANALYSIS**

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### **ABSTRACT**

Based on the analysis of digital manufacturing resource modeling technology research status at home and abroad, it compares and analyzes the related patent for digital manufacturing resource modeling technology by patent data at home and abroad. Our country constantly improve patent applications of the digital manufacturing resource modeling technology, which mainly concentrates in the electronic data processing and control, and is the main body of patent applications in higher learning institutions. The results can provide the data support for the patent strategy of enterprise and research institutes, which study and development information system.

**Keywords:** Digital manufacturing resources, Modeling technology patent analysis patent search.

### **1. INTRODUCTION**

Manufacturing resource sharing makes the product manufacturing resource integration and sharing by the use of networked manufacturing technology and the corresponding tools in the whole process of product including design, manufacture, assembly, sales, and management and so on. It uses modern management science and information technology to establish the modern information network system through the development and building of enterprise manufacturing resource platform, which realizes the integration of material flow, cash flow, information flow and work flow to optimize the enterprise resource allocation, improve the efficiency and level of enterprise management, and improve enterprise economic benefit and core competition ability through rapid circulation of information and service in each link including design, manufacture, assembly, sales, and management and so on. Manufacturing resources has complicated contents and various forms. In the network manufacturing environment, the heterogeneity of manufacturing resource further increased the complexity of manufacturing resources management and sharing [1]. One of the effective management purposes of manufacturing resources is to promote the sharing and application of manufacturing resources efficiently and accurately in the network manufacturing resources. Its key technology is the modeling of digital manufacturing resources.

The modeling of digital manufacturing resource is the abstract expression of all kind of resources in the whole life cycle of digital manufacturing by using the appropriate

modeling methods. Then we are analysis, integration, optimization and simulation of manufacturing resource by studying the structure and features of the model.

Based on the analysis of the research status at home and abroad about the modeling technology of digital manufacturing resource, the paper use patent data as the breakthrough point of information analysis, screens and analyzes the domestic and foreign patent information of the modeling technology of digital manufacturing resource, and research the development trend of the technology to provide the data support for the patent strategy of enterprise and research institutes.

### **2. RESEARCH STATUS OF MANUFACTURING RESOURCE MODELING AT HOME AND ABROAD**

In recent years, the modeling theory and realization method of manufacturing resource modeling are extensively studied at home and abroad. At present, the more influential study of resource modeling at abroad is based on Computer Integrated Manufacturing-Openness System Architecture (CIM-OSA) [2]. It uses the role concept modeling for resources, defines the role of resource in the process of manufacturing, and uses the state chart to describe the state of resource. However, the enterprise modeling method of CIM-OSA are abstract, is more about conceptual study, so it has not been widely used in practice. In China, the research is based on the object-oriented modeling method. The literature [3] is studied the resource modeling and information integration of network manufacturing based on

physical manufacturing unit, and resource model and information integration method based on Extensible Markup Language. The literature [4] about formalize modeling and realization of network manufacturing resource is the comprehensive description of the system from resource classification, logical level and formalized definition. It puts forward the implement of model based on XML and the description method based on semantic description. The literature [5] about the modeling method of manufacturing knowledge is studied the composition and structure of manufacturing knowledge for complex product craft. It uses the systematic method to analyze the manufacture knowledge and propose the systematic modeling method of manufacture knowledge. The literature [6] about the resource discovery of network manufacturing based on the function of semantic extension is studied to define the description model of manufacturing resource and manufacturing tasks, which realize the semantic matching of resource and tasks. But the Web manufacturing resource of Internet as a huge union type of information resource is difficult to find and is not to deal with data, because the lack of unified description lead to different resource description of different enterprise.

### 3. PATENT ANALYSIS OF THE MODELING TECHNOLOGY OF DIGITAL MANUFACTURING RESOURCE

#### 3.1 Patent data

The patent data of this project is mainly based on Derwent Innovations Index (DII), European Patent Office (EPO), and Patent Information Service Platform (CNIPR). The collect data is from 1996 to 2012.5 including invention, utility models. The searching is the combination of subject and international patent classification. The key words are manufacturing resource, digital manufacturing resource, manufacturing resource modeling, and resource description and so on. The international patent classification number is G06F, G05B, etc. Through screening and data processing, the global patent of digital manufacturing resource modeling is a total of 113 pieces. The subsequent data analysis is based on this data.

#### 3.2 The annual patent application trend of manufacturing resource modeling in china

**Table 1.** Distribution of annual patent application of resource modeling in China

Year	1988	2000	2003	2005	2006	2007	2008	2010	2011
Patent application(pieces)	0	0	1	2	3	5	7	8	10

Table 1 reflects the annual trend of patent application of digital manufacturing resource modeling in China. In table 1, we can know that the patent protection of digital manufacturing resource modeling technology is relatively late in China, because the first patent is applied until 2003. But it also get steady development, every year have application of 1 to 2 pieces after 2003. It reflects that the modeling technology of digital manufacturing resource has innovation and development by its polices of enterprise information in China.

#### 3.3 National distribution of patent of digital manufacturing resource modeling

**Table 2.** National distribution of patent of digital manufacturing resource modeling

Number	Nation	Patents	Percentage
1	US	63	59.43%
2	WO	21	19.81%
3	KR	6	11.09%
4	EP	6	3.87%
5	JP	5	4.72%
6	DE	2	1.89%
7	CA	2	1.89%
8	RU	1	0.94%

Table 2 reflects the national distribution of patent of digital manufacturing resource modeling. The table comes from the statistical analysis of processed data of 106 abroad patent families according to the first two representative countries (Regions) code of each patent application number. In the table 2, we can know that the application are mainly distributed in the United States, the world knowledge organization, China, Europe, South Korea, Japan, Germany and other countries or regions. The most application is 63 pieces at the United States. So the United States has the strong ability of innovation and the competitive advantage of patent in the field, and countries such as China and Germany have a certain competitive advantage of patent protection in the field.

**Table 3.** IPC distribution of patent application of manufacturing resource modeling at abroad

Number	IPC	Patents	Percentage
1	G Physical	52	88.14%
2	H Electrical	5	8.47%
3	B Homework, Transport	1	1.69%
4	F Mechanical engineering	1	1.69%

**Table 4.** Small class distribution of IPC of manufacturing resource at abroad

Number	Small class of IPC	Patents	Percentage
1	G06F digital data processing of electricity	38	58.46%
2	G06B general control system	10	15.38%
3	G01R Measuring electrical variables	3	4.62%
4	H04L Transmission of digital information	3	4.62%
5	G06G Analog computer	2	3.08%
6	B60R Other vehicle	1	1.54%
7	G11B Relative motion based on the record carrier	1	1.54%
8	G09B Education or demo equipment	1	1.54%
9	H03K Pulse technology	1	1.54%
10	F03G Engine	1	1.54%
11	H04Q Choose	1	1.54%
12	F03B Hydraulic machinery	1	1.54%
13	G08G Traffic	1	1.54%
14	H01L Semiconductor devices	1	1.54%

### 3.4 IPC distribution of patent application of digital manufacturing resource modeling

Through the statistical analysis of International Patent Classification (IPC) of each patent, we can get IPC distribution of patent application of digital manufacturing resource modeling (knowing table 3), in table 3, we can know that the patent mainly concentrate in G and H. The application of G is 52 pieces, which account for 88.14% of all patent applications.

Table 4 reflects the small class distribution of IPC of manufacturing resource at abroad. In table 4, we can know that the patent mainly concentrate in G06F (digital data processing of electricity) and G05B (general control system). So, we can think that the key of digital resource modeling is data processing and control.

**Table 5.** Small class distribution of IPC of manufacturing resource modeling at China

Number	Small class of IPC	Patents	Percentage
1	G06F digital data processing of electricity	4	40.00%
2	G06B general control system	3	30.00%
3	G01R Measuring electrical variables	2	20.00%
4	H01L Semiconductor devices	1	10.00%

Table 5 reflects the small class distribution of IPC of manufacturing resource modeling at China. In table 5, we can know that the patent application mainly concentrate in G06F (digital data processing of electricity) and G05B (general control system) at China. Although there are certain achievements, we can think that China has not innovation in the field to compare with the developed countries. The patent application of China has not a competitive advantage in the field of G06F and G05B.

### 3.5 Analysis of patent applicant of digital manufacturing resource

**Table 6.** Fillings ranking of patentee of manufacturing resource at abroad

Number	Applicant	Patents	percentage
1	IBM	17	13.93%
2	ABB RESEARCH LTD	4	3.28%
3	MANUGISTICS INC	4	3.28%
4	XILINX INC	4	3.28%
5	IMPRESSE CORP	4	3.28%
6	UT BATTELLELLC	3	2.46%
7	SAP AG	3	2.46%
8	KONINKL PHILIPS ELECTRONICS NV	3	2.46%
9	INNOPATH SOFTWARE INC	3	2.46%
10	SUSTAINABLE MINDSSLLC	3	2.46%
11	BAYOUMI DELA SALAH-ELDIN	2	1.64%
12	PHILIPS CORP	2	1.64%

Table 6 reflects the applicant of the top 20 fillings of manufacturing resource patent. In table 6, we can know that the patent applications of IBM (International Business Machines Corporation) is most, so we can think that IBM has strong competitive advantage of patent in the field of manufacturing resource modeling technology. IBM is International Business Machines Corporation. Its head office is in Armonk, New York. IBM was founded in the United States in 1911, is the world largest corporation of information technology and business solutions, has currently employees about three ten thousand, and has business in more than 160 countries and regions. It's mainly business at begin is the commercial typewriter, then to a word processor, and then to the computer and related services. Today, all kinds of information system of IBM has become the most reliable means of information technology in these field of financial, telecommunication, metallurgy, petrochemical, transportation, commodity circulation, government and education and so on. At the same time, IBM leads the market share in many important field including servers, storage, services, software, etc. IBM has 17 pieces patent of digital manufacturing resource, which account for 13.93% of all applications at abroad.

Table 7 reflects the fillings ranking of patentee of manufacturing resource in China. In Table 7, we can know

that Shanghai Jiaotong University has 2 pieces patent and it has many patents in the field for Zhejiang University of science and technology, Xi'an Jiaotong University and Hangzhou University of electronic science and technology. So we can think that these applicants have the certain innovation and patent activity in manufacturing resource modeling technology in China.

**Table 7.** Fillings ranking of patentee of manufacturing resource in China

Number	Applicant	Patents	Percentage
1	Shanghai Jiaotong University	2	28.57%
2	Citroen automobile company	1	14.29%
3	Zhejiang University of science and technology	1	14.29%
4	Xi'an Jiaotong university	1	14.29%

#### 4. CONCLUSIONS

In recent years, digital manufacturing resource technology has a rapid development. In IPC distribution, the patent application in the field mainly concentrates in G06F (digital data processing of electricity) and G05B (general control system). In regional distribution, the patent in the field mainly concentrates in the United States, China, Europe, South Korea, and Japan, Germany and other countries and regions. The United States in the field has the most patents. IBM has the most patent as a leader in the field.

China starts late in the field, but it are steady development. In China, the patent of manufacturing resource modeling mainly concentrates in G06F (digital data processing of electricity) and G05B (general control system), which is the same as abroad. In the applicant types, the patent of manufacturing resource modeling mainly concentrates several big enterprises and institutions, which the most are

universities to mostly study and development enterprise information system. Relevant enterprises and research institutions should pay more attention to the development of the field especially China, and implement appropriate industry layout strategy and business development strategy.

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