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A COMPUTERIZED KNOWLEDGE MANAGEMENT SYSTEM BASED ON MANUFACTURING RESOURCE CAPACITY

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Abstract—
In order to precisely describe manufacturing resource capability and complex relations among manufacturing resources as well as manage them effectively, a knowledge management method based on manufacturing resource capability was proposed. In this method, the manufacturing knowledge management framework based on knowledge transformation model was built, which demonstrated the flow process of manufacturing resource capability knowledge in enterprises. Based on this framework, meta-model was adopted to describe data structure of manufacturing resource capability, and ontology technology was used to build the manufacturing knowledge model in the activities of manufacturing knowledge management.
Furthermore, in order to find manufacturing knowledge quickly and accurately in the manufacturing knowledge management framework, it was represented by combining metadata with ontology technology. Finally an example was carried out to validate the applicability and the effectiveness of the proposed method.

INTRODUCTION
A lot of manufacturing knowledge has been accumulated in the daily production of manufacturing enterprises, which is the basis for the development of manufacturing enterprises.
The higher specialization degree of the knowledge becomes and the more complex the content of the knowledge becomes, the stronger the ability of enterprise innovation becomes.
The definition of manufacturing knowledge is not very explicit and mainly includes product knowledge and manufacturing process knowledge. This paper mainly researched manufacturing resource capability knowledge in manufacturing process, including the capability information of shops, machine tools, tools, processing methods and relationships among them and so on.
Now, more and more manufacturing enterprises begin to realize the importance of knowledge management of manufacturing resources capabilities. The knowledge management of manufacturing

resource capabilities use all sorts of existing manufacturing resource capability knowledge to solve related problems, which includes how to manage manufacturing resource capability knowledge, how to transfer the knowledge in the application of enterprise, how to transform the knowledge into productivity and creativity and so on. Knowledge management is applied in manufacturing resource capacity management, which widens the range of manufacturing resource capacity management, optimizes the goals of manufacturing resource capacity management, describes and manages manufacturing resource capacity management more exactly.

Manufacturing knowledge may be implicitly mastered by a professional alone, and also may explicitly disperse in internal or external enterprises. If the knowledge is not dug, processed and integrated, it will be difficult to use and share for the entire manufacturing enterprises. Many scholars actively research the theory and tools of knowledge management and build business knowledge bases, such as referred in [1] and [2]. However, these knowledge management tools lack truly effective approach of knowledge acquisition, classification, sharing and reuse.

Regarding the application of manufacturing resource capacity in industry, this paper researched how to apply the semantic reasoning of ontology in knowledge management to ensure accurate description of manufacturing resource capabilities, managed all kinds of unstructured, semistructured and structured information, satisfied the requirements of various process decisions, reduced and eliminated the uncertainty impact of the information.

Proposed method

The manufacturing knowledge transformation model based on knowledge spiral solved how to carry out the transformation and transmission of knowledge in manufacturing enterprise, and knowledge sharing and reuse were achieved. The method combined metadata with ontology technology realized to find the required knowledge fast, accurately and comprehensively in the fast growing enterprise knowledge. Thus, manufacturing enterprise knowledge management method based on this model can support knowledge transformation, sharing, reuse and innovation better.

Methodology

II. MANUFACTURING KNOWLEDGEMANAGEMENT FRAMEWORK BASED ONMANUFACTURING RESOURCE CAPACITY

Manufacturing knowledge based on manufacturing resource capacity usually implies in various process files and electronic documents, and also is materialized in manufacturing resources and the minds of experts, and the capability of shops, machine tools, tools, and personnel and so on was included.

Japanese management expert Nonaka defined the SECI spiral model, which initiated the research field of knowledge management. The model defined mutual transforming process of two kinds of knowledge based on the division of implicit and explicit knowledge, namely socialization, externalization, combination and internalization [3]. Combining SECI

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spiral model with the relationship between personal and business in manufacturing knowledge transformation, this paper proposed a manufacturing knowledge transformation model based on knowledge spiral model (Figure 1). In this model, the socialization of manufacturing knowledge means that the knowledge is transferred among individuals by the ways of reports, technical meetings and other means to achieve the exchange and sharing of knowledge. The externalization of manufacturing knowledge is the process which individuals submit knowledge to the enterprise. The combination of manufacturing knowledge is the process which maps and converses enterprise manufacturing knowledge. The internalization of manufacturing knowledge is that enterprises output knowledge to individuals and supports individuals to complete a variety of applications. So on ad infinitum, it supports manufacturing knowledge update and share to form a knowledge spiral. Enterprises need to innovate to develop including manufacturing companies. All stages of knowledge spiral play a leading role in the different processes of innovation.

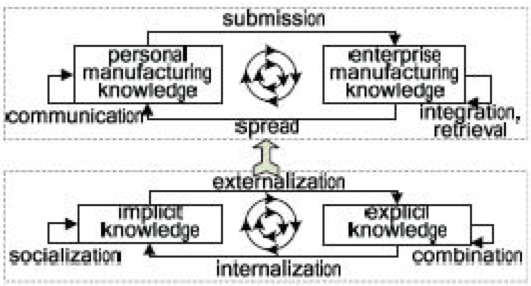

Figure 1. The manufacturing knowledge transformation model based on knowledge spiral model

So, pointed knowledge management behavior can be done to achieve the innovation of knowledge better according to the different features at different stages of innovation process. According to the knowledge transformation model based on knowledge spiral, a knowledge management model based on manufacturing resource capability was proposed to support the manufacturing enterprise knowledge sharing and reuse and to achieve a series of spiral-shaped transformations of manufacturing resource capability knowledge between the individual and enterprise (Figure 2).

The implementation steps of knowledge management based on the framework are as follows:

1) A manufacturing knowledge management tool is built by existing manufacturing resource capacity knowledge of enterprises.

2) Manufacturing knowledge carriers such as databases, documents, manufacturing knowledge workers, managers and so on are ascertained. Exchange of experience between knowledge carriers can generate new manufacturing knowledge. There is feedback of information between anufacturing knowledge carriers and manufacturing knowledge management tool.

3) Weave edit implicit and explicit manufacturing resource capability knowledge provided by manufacturing knowledge carriers, transform and store it into manufacturing knowledge base to enrich enterprise manufacturing resource capability knowledge.

4) Program interfaces are provided to all kinds of applications to realize data transfer and sharing.

5) To solve new problems which appear in manufacturing production and operating process, query the required knowledge by

the knowledge management tool (knowledge innovation is realized), and then turn to 2). In the above five steps, 2)-5) knowledge socialization, externalization, combination and internalization are completed.

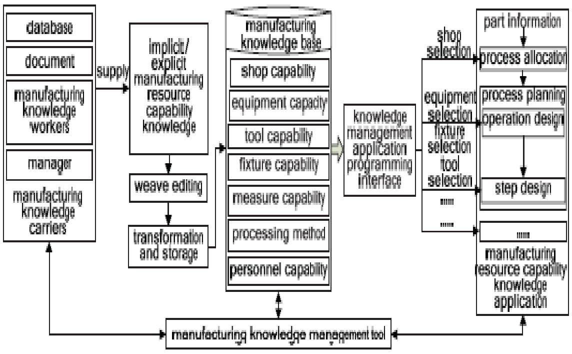

Figure 2. Manufacturing knowledge management framework

III. MANUFACTURING KNOWLEDGE DESCRIPTION BASED ONMANUFACTURING RESOURCE CAPABILITY

The meta-model of manufacturing resource capability knowledge is adopted to describe data structure of manufacturing resource. As shown in Figure 3, manufacturing resource object class is the core class of the meta-model. As the manufacturing resource object can be broken down into subobjects layer by layer, the class itself constitutes a recursive association, which is reflected by adding the submanufacturing resource attributes. This also reflects one kind of meta-data's own structural features, and each metadata can be combined by multiple metadata. Manufacturing resource objects are described by a variety of attributes, which is reflected by the "aggregation" relationship between manufacturing resource types and attribute types in the diagram. Other major attributes of manufacturing resource classes are as follows: Name attribute is used to determine the standardization name of metadata, and ID attribute is the only marker of a metadata in all of the metadata, which facilitates the management and use of metadata. Assisted classes of the model include property, value, status, restriction and relation. Property class is standardized description of the property contents which depends on the manufacturing resource class. The "combined" relationship between property class and value class shows that properties can be described by a variety of property values. Status class reflects the status characteristics of manufacturing resource objects at some time, such as "maintenance", "available" and "closed" and so on, etc. Restriction class refers to the constraint characteristics which manufacturing resource objects face in a specific environment, such as "yes", "no", "equal to" and "less than" and so on. Relation class refers to the relationship characteristics between the manufacturing resource objects, such as "father-son relationship," "membership relation", "contain" and so on. Resource objects which are in possession of above three classes or not depend on the specific the resource object itself.

Manufacturing Resource classes can be generalized as shop class, equipment class, tooling class, methods class and other subclasses. The subclasses inherit all the above-mentioned attributes of manufacturing resources.

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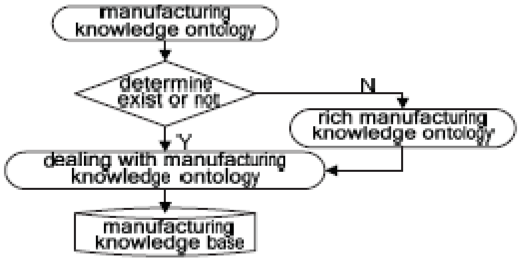
MANUFACTURING KNOWLEDGE ONTOLOGY
MODELING BASED ONMANUFACTURING RESOURCE CAPACITY

Manufacturing knowledge modeling adopted ontology technology according to the foregoing description method. The knowledge generated in the long-term productive manufacturing process is dispersed in various departments, and different needs and different knowledge backgrounds may lead to the different understanding to the same concept, which often impedes knowledge transfer and sharing in manufacturing enterprises. Manufacturing knowledge ontology is a formal specification description to the knowledge of manufacturing domain, which provides a unified understanding to manufacturing employees. A. Manufacturing knowledge ontology building process The manufacturing knowledge ontology supports sharing and reuse. Figure 4 shows the process used to build manufacturing knowledge ontology. When manufacturing knowledge ontology appears, first it should be determined whether it has existed in the ontology base or not. If it has existed, process operations will be done only, otherwise it should be added to the ontology base, and this riches anufacturing knowledge ontology and achieves ontology evolutionary. This process can avoid concept duplication and inconsistency at a certain extent.



Now, there are many tools to the modeling of ontology, such as protégé, Jena, which have been applied successfully [4][5][6].

B. The formalized representation of manufacturing knowledge Competency-based manufacturing resource ontology structure quadruple “On”= (C, A, R, I, S). “C” is a collection of concepts, and it describes the concept entities or classes.

“A” expresses attribute collection, and it is used to describe the concepts and instances in the manufacturing resource ntology. Attribute set A = (Ab, Ac). “Ab” indicates a collection of basic attribute information, and it shows the management information. “Ac” indicates a property collection of the ability information, and it shows processing capacity of manufacturing resources. “R” expresses the relationship collection among the concepts and describes the relationships between different types of concepts. The relationships in the manufacturing resource ontology mainly include: “is _ part _ of”, “match” and “matched”, “process” and “processed” and so on. “I” expresses an instance set which is built on “C”. “S” expresses a status collection of instances, which describes the running status and load rate of manufacturing resources.

MANUFACTURING KNOWLEDGE REPRESENTATION

Manufacturing enterprises possess a lot of manufacturing capacity knowledge. How to discover useful knowledge quickly and

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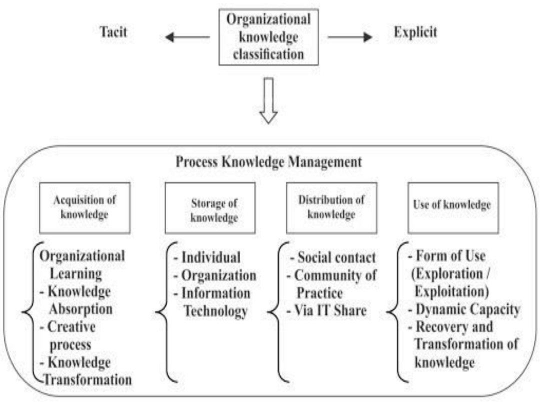
accurately is the key issue. Now most information systems use metadata to describe, organize and manage knowledge, and information retrieval use the method of keyword matching based on metadata framework. But when the metadata base has no the query words matching with the key words, it cannot retrieve knowledge. As the ontology has a good concept hierarchy and supports logical reasoning, it has a good application prospect in the knowledge-based information retrieval. This paper proposed a knowledge representation method which combined metadata with ontology technology for manufacturing knowledge category description. Its implementation steps are as follows:

1) The metadata scheme is made for manufacturing knowledge according to the aforementioned method;

2) When a new manufacturing resource ontology is discovered, the modeling process is carried out by ontology modelling method mentioned above;

3) When new manufacturing knowledge is added, identify its ontology types, and describe it according to metadata scheme;

4) Associate the keyword values of metadata with the ontology, and semantic connection is set up between the ontology and metadata.



CONCLUSIONS

Aiming for managing manufacturing resource capability better, manufacturing knowledge management model based on manufacturing resource capabilities was proposed. The manufacturing knowledge transformation model based on knowledge spiral solved how to carry out the transformation and transmission of knowledge in manufacturing enterprise, and knowledge sharing and reuse were achieved. The method combined metadata with ontology technology realized to find the required knowledge fast, accurately and comprehensively in the fast growing enterprise knowledge. Thus, manufacturing enterprise knowledge management method based on this model can support knowledge transformation, sharing, reuse and innovation better.

Future scope

The main scope of production planning includes the following:

- Identifying and stating the purpose of production, in which this will include the item name, code of the product, quantity, volume, any raw material requirements, and various others.
- Production planning will list any technical specifications for the various manufacturing states as well as for quality control
- Listing operations sequentially, in which this will include cycle time for production completion.
- It will also list equipment, machines, tools, gauges, jobs, fixtures, and anything else required for various stages of production.

- Finally, production planning will also list any specifications to be followed in order to achieve results and reach a higher performance standard pertaining to cycle time, output level, etc.

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