The research of knowledge base for mechanical and electrical product design process

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Abstract—According to the widespread problem of Mechanical and electronic enterprise that the types of knowledge is various, the management and application of knowledge is difficult. Put forward a kind of knowledge management method and tool system supporting for the whole process of mechanical and electrical product design, divided enterprise knowledge into case, method, object three types, extracted all kinds of knowledge's design attributes, built the corresponding expression model, searched knowledge by keyword, parameter and function three methods. The knowledge base can assisted designers to search, group and use the different kinds of knowledge strategically at various stages of the product design process and facing different kinds of design problems.

Keywords-Mechanical and electrical product; Design process; Knowledge management; Knowledge base, Tool system;

I. INTRODUCTION

With the wide application of knowledge management in the enterprise, the importance of the construction and use the enterprise knowledge base is growing. At present the enterprise mainly uses the ERP method to management knowledge and it's application[1-8], pay attention to overall on the product in the whole life cycle of knowledge resources. But it has not been thoroughly studied on the knowledge management and collaboration of the enterprise's specific product design process, which greatly limits the enterprises effective use of knowledge in the product design process[9] .

Therefore, it need to built the knowledge base of product design process to support product design. At present, the research based on this consideration also has some, such as He Wei[10] ,Shen Dan[11], Wang Junmin[12] etc. Although the research for the construction of enterprise knowledge base provides a series of theoretical basis, but it not from the view of the whole process of product design to put forward a specific implementation plan and the application strategy[13-17].

Based on this, combining Electromechanical industry characteristics, in accordance with the whole enterprise process from the project planning, concept design, detailed design, the following design, through the research on the enterprise knowledge classification、attribute extraction、expression、organization、management and application method, a construction method and tool system that support mechanical and electrical products design process knowledge base is proposed and constructed.

II. CLASSIFICATION OF THE ELECTRICAL AND MECHANICAL PRODUCT DESIGN KNOWLEDGE BASE

According to the product design process, the design process knowledge is divided into three categories: project case knowledge, method knowledge and object class knowledge. Project case knowledge refers to the formation of case knowledge corresponding projects after the enterprises' every R&D project are concluded, including product function maps, standardized tasks book, design, performance test report; Object class knowledge includes knowledge (refer to specific parts of design knowledge, such as the size of parts' parameters, strength design criteria, heat treatment, the digital 3D models), components and the whole knowledge(the technology resources of various performance parameters, components and the whole simulation files and related finishing up, in order to facilitate the designer quickly query and selection); Method knowledge refers to the internal dominant summarization method for enterprises, such as assembly method, engineering estimation analysis method, simulation analysis method etc..

III. ATTRIBUTE EXTRACTION AND EXPRESSION OF ELECTROMECHANICAL PRODUCT DESIGN KNOWLEDGE BASE

In order to clearly demonstrate the above each kind of knowledge to the designer, it need to standardized descriptions for every kind of knowledge, it is necessary to extraction reasonable property and expression each kind of knowledge.

A. *Extracting knowledge attribute*

According to the specific content of each kind of knowledge and their products play different roles in different design stage, their attributes are extracted as follows: Project case knowledge attribute is extracted as customer demand, product protocol, functional items, design task book, team organization, design, digital product model, performance test report and product specifications; Method knowledge attribute is extracted as the method name, functional properties, technical difficulty, inspiration, experience, reference; The parts knowledge attribute in object knowledge is extracted as the part name, attributes, size parameter, digital model, heat treatment, strength analysis of processing technology and quality standards, design,assembly, machine knowledg e attributes are name, function, performance parameters, technical resources, digital model, assembly method.

B. *The expression of knowledge*

Three kinds of knowledge are presented in this paper are related to the design knowledge of the product itself, belonging to a specific domain knowledge, so use the frame representation method to express, and use semi structured way to gradually appear. As shown in Figure 1 for the expression of one project frame case knowledge.

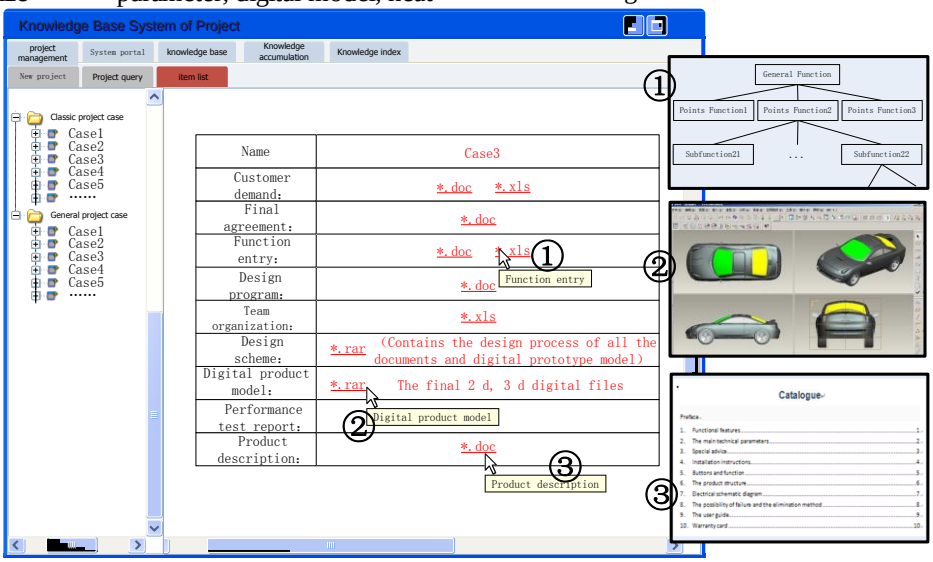

Figure 1. the expression of project frame case knowledge

IV. THE ORGANIZATION OF ELECTRICAL AND MECHANICAL PRODUCT DESIGN KNOWLEDGE

The above each kind of knowledge of one property are composed of one or several underlying data, these data include

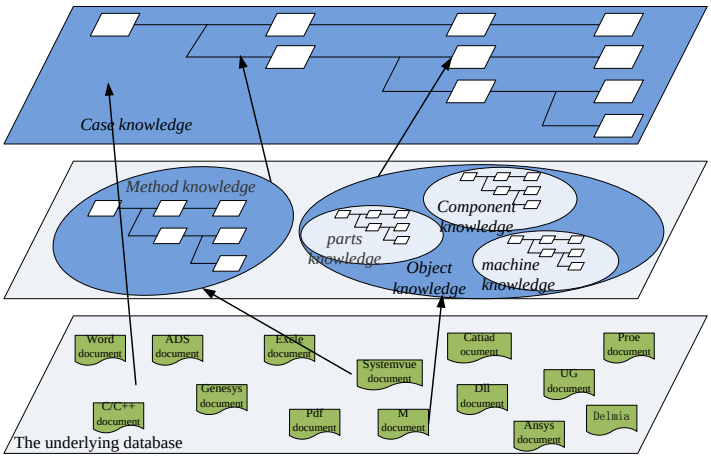

Figure 2. The hierarchy of the knowledge base

document basic data: such as word documents, excel documents and PDF documents; electrical digital files such as ADS files, Genesys files, System vue files, C/C++ files, M files, DLL Dynamic Link Library etc. structure、process and the digital documents of simulation such as: Catia file, UG file, Proe file, Ansys file and Delmia file etc. these massive basic data of are summed up to each knowledge item level by attribute extraction knowledge , and managed by the underlying database, the organizational form and the the hierarchical structure of all kinds of knowledge such as shown in figure 2.

V. THE RETRIEVAL OF ELECTRICAL AND MECHANICAL PRODUCT DESIGN KNOWLEDGE

On the basis of the above knowledge attribute extraction and expression of the model, three kinds of retrieval mode were designed: keyword search, parameters search and function search. Designers can using different retrieval methods according to the specific problems, as shown in figure 3.

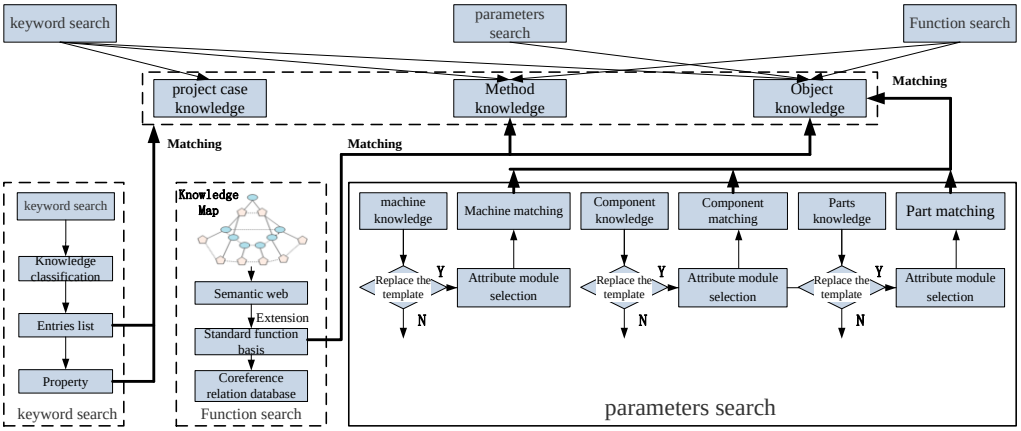

Figure 3. The model of knowledge retrieval system

Among them, keyword search is the first knowledge according to classified, then, according to the classification of knowledge, a list of entries, attribute matching of hierarchical retrieval; parametric retrieval is the designer premises more clearly express the design object general framework, Through the parameter retrieval module could search the similar existing object and its design knowledge quickly; function retrieval based on the semantic network knowledge to match the entries by "functional group" [18,19].

VI. THE OVERALL DESIGN FRAMEWORK OF KNOWLEDGE BASE IN MECHANICAL PRODUCTS DESIGN

Considering the practicability and necessity of the knowledge base system, the overall is designed to five modules: project management, portal system, knowledge base, knowledge accumulation, knowledge index. The overall framework is shown in Figure 4.

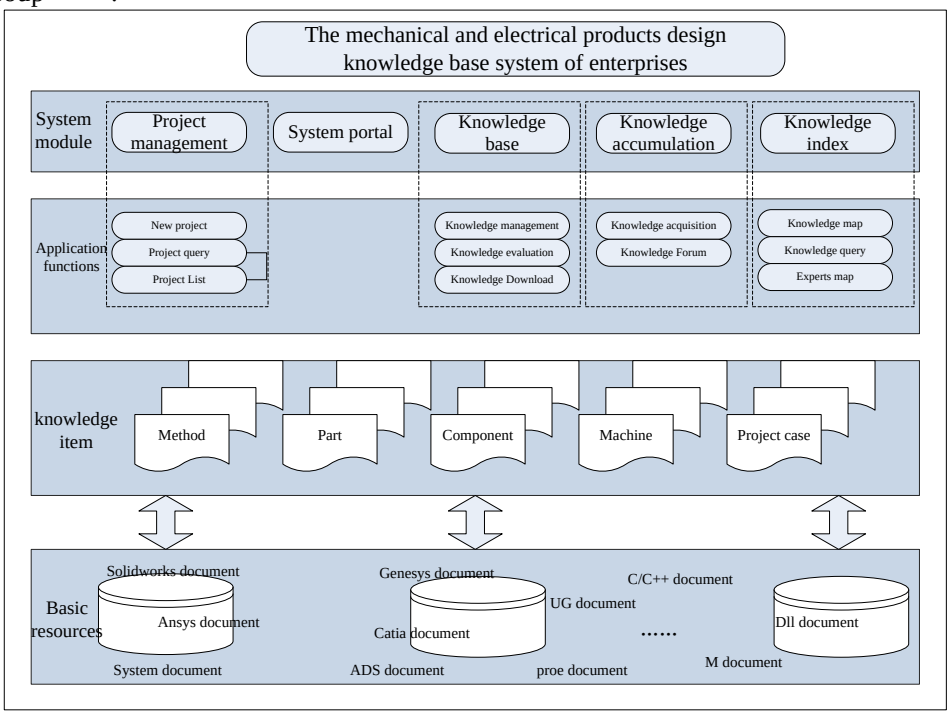

Figure 4. The overall structure of the knowledge base system diagram

The project management module mainly consists of three functional :new project, project, project list query; system gateway module provides quick access to enter each tab; knowledge base module contains three applications: the knowledge management, knowledge, knowledge evaluation download; the accumulation of knowledge module is based on explicit and tacit knowledge effectively extraction and finishing, in order to the accumulation of enterprise's knowledge resources; knowledge index module includes three application functional: knowledge map, knowledge query, expert map.

VII. APPLICATION OF PATTERN KNOWLEDGE IN MECHANICAL PRODUCTS DESIGN

According to the figure 5, expounds the application mode of knowledge base system.

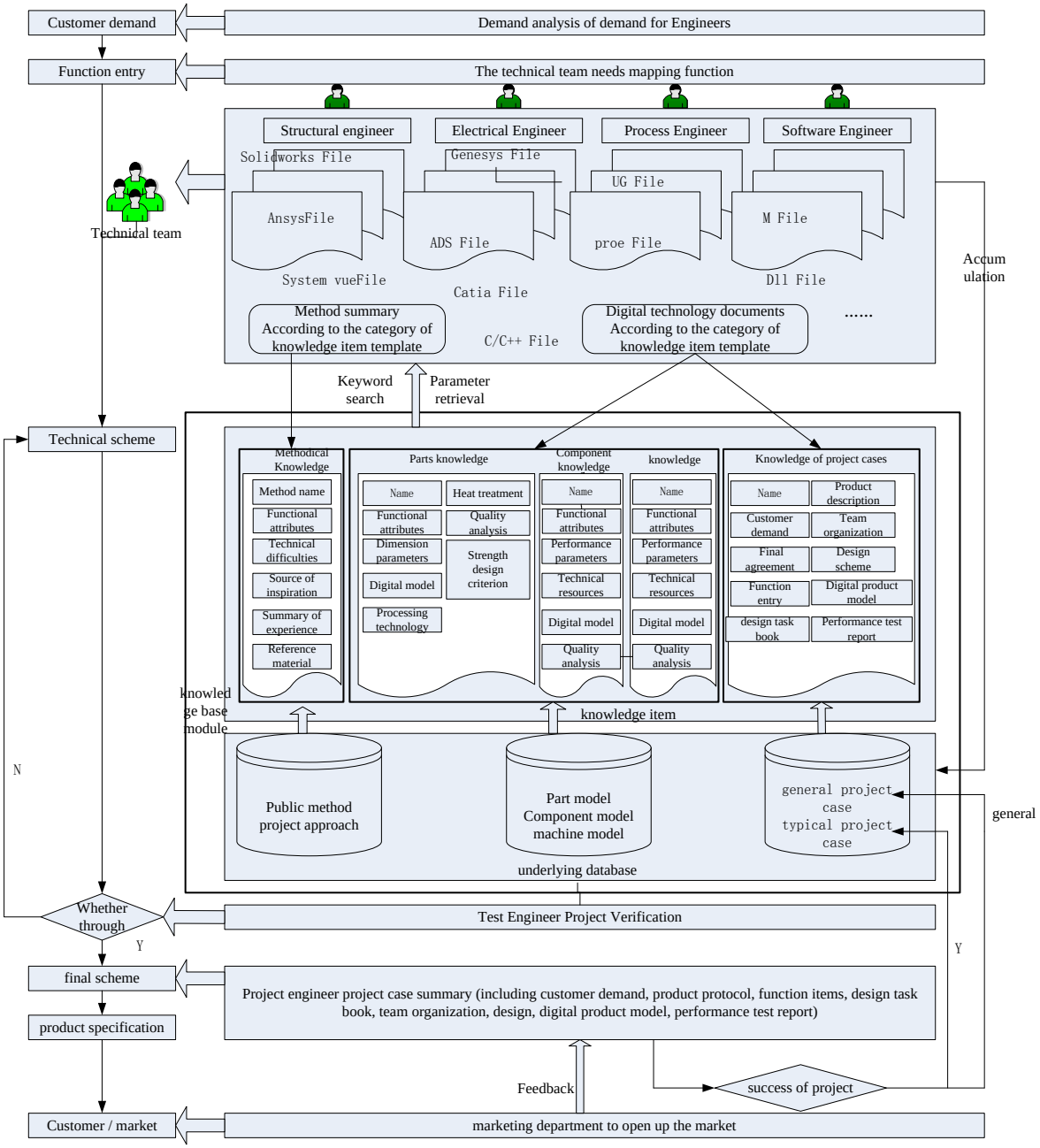

Figure 5. Application of pattern knowledge base system

The first stage: project manager through the system of new project module to form a new project. If the current R & D projects similar with the previous project, you can find ten attributes of case knowledge for reference, R & D team members are determined by the project manager. If it's a new project, the project manager can also through creat a new project module to control global, at first, division the demand, The requirements engineer complete the user requirement analysis through user questionnaire, interview, engineerson-site investigation and research of competitors' products.

The second stage: Project manager organize the technical team to concise and clearly descrip the fuzzy and general user demand, that is user demand mapping function.

The third stage: the designer (structural, electrical technology, software, etc.) to determine the design task and technical index of their fields through the function spectrum of products, make out the design.

The fourth stage, the test engineer determine the optimal solution and guide the production after repeated testing.

VIII. CONCLUSION

Based on knowledge engineering as the guide, combined with product design process of electromechanical field, through the classification of knowledge, the attribute extraction, expression, organization and management and

application method, Put forward a kind of knowledge management method and tool system supporting for the whole process of mechanical and electrical product design. The system can help the enterprise to realize the tacit knowledge to externalization, explicit knowledge structured, individual knowledge sharing, the overall knowledge process, help the enterprise to improve design professionals' collaborative skills knowledge in the product design process.

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