Study of CAPP Decision-making System based on Experience

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***Abstract*—The CAPP decision-making system based on experience is put forward on the basis of analyzing the current application and development prospect of CAPP. The theory basis, reasoning structure and function modules of decision-making system also are discussed and analyzed in detail in this paper. Meanwhile, the CAPP decision-making system based on experience is divided into ten main function modules according to the thought of hierarchical planning. By the planning, using enterprise experience as the foundation, the paper has analyzed five modules of them in detail such as the decision-making of process route, processing methods selection, machine tool selection, tools and measuring implement selection and cutting dosages selection. The enterprise experience is fully reflected in design through considering the influence of various factors on process decision-making and establishing corresponding process decision-making model and system based on experience.**

Keywords—CAPP; Decision-making System; Experience; Hierarchical Planning

I. INTRODUCTION

CAPP(Computer Aided Process Planning) refers to formulating machining process with the aid of computer hardware and software technology and supporting environment, and by using computer numerical calculation, logic and reasoning etc functionality. Process design data is the data source of the production and information system. Along with the development of modern manufacturing technology, especially the requirement of information sharing during whole life cycle of products, The function of information integrated and functional coordinating allotted by CAPP has more and more important during the entire product life cycle. CAPP system can be classified into five types: interactive, derived type, gen into type, comprehensive type and CAPP expert system according to a principle of work. Although the types and design methods of CAPP are various, CAPP based on derived type is more common from domestic common situation. And for a long time, the CAPP researchers and developers often ignored the universal basic techniques, methods and depth research and exploration of data involved by the process design problem. And the use of all kinds of new concepts, new methods and new technology both lacks application base and lacks systematic basis[1]. Based on this, the paper puts forward the CAPP decision-making system based on experience, and this decision system make the process knowledge, product process database as the core, interactive design as the basis, enterprise experience as the guide, the management of technology knowledge base and technology editor as application support tools. Also the decision system faces the computerized and informationization of product process design and management, and has changed research concept of pursuing completely automated blindly, highlighted the important role of "flexibility, tools, integration, experiential" in CAPP system requirements,and make this system have practical applicability, versatility and extensibility.

II. CAPP DECISION THEORY BASED ON EXPERIENCE

A. CAPP decision theory basis

Process design is the interface of product design and manufacture, and an important technology of optimization process resource and reasonable arranging process. Its main task includes identifying processing methods, choosing machine tools and cutting tool, choosing cutting parameters, fixture selection, manufacturing hours and cost calculation, etc. Process decision is a typical semi-structured decision problem based on human-computer interaction process. Because the process design is a typical solution of multiple complex system, and the process decision itself is the multitarget problem whose subjective and objective factors are various. Therefore, process decision-making model is the most complex model of all ones[2].

Due to the complexity, empirical and personality outstanding of the process decision making problems, it is usually divided into each subtasks according to the hierarchical planning, and the decision-making submodel will be established according to each subtasks in order to achieve "aided process design". Therefore, this decision system divides a complex problem into a set of sub-problems according to the basic idea of hierarchical planning. If subproblems still are too complex to being found out its solution easily, the subproblems can be further divided into some subproblems subproblems, and the solution of whole issue is constituted by combining solutions of all subproblems[3].

B. The structure of CAPP decision-making reasoning

After dividing the problem of complex process decision-making into several subtasks which can be solved directly, it is necessary to analyze and finish these subtasks, to establish and solve the strategies, methods, task rules and data of these

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subtasks.The basic idea is analyzing and classifing the nature of each subtask, determining their solution sequence, structuring the solving methods of component tasks,

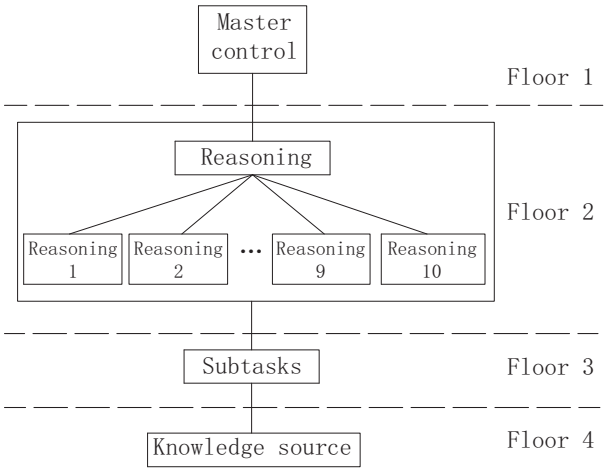

Fig.1 The structure of CAPP decision-making reasoning

determining the decision-making rules and data to solve subtasks. Based on hierarchical planning, the structure of CAPP decision-making reasoning is shown in Fig.1.

C. *Function structure of CAPP decision-making system*

According to the hierarchical planning,the process decision making system can be divided into ten main function modules. In each function modules, the corresponding aided process decision model based on experience are constructed and the

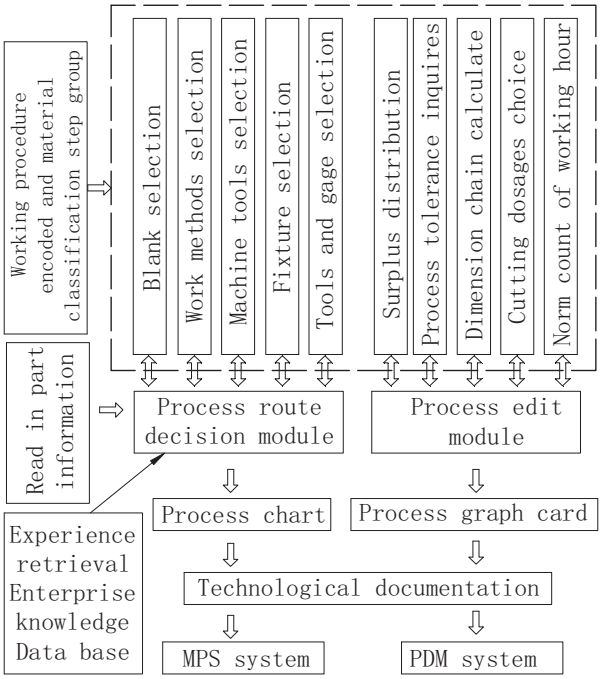

Fig.2 Function structure of CAPP decision system

structure of decision system is shown in Fig.2. It is not hard to see that working procedure encoded and material classification step group are the conditions of CAPP decision-making. Because the technological procedure of parts is composed of working procedure, installation, work step, so the standardization and coding of work processes, work step is the primary work for constructing CAPP system. As parts material is determined by design, and directly affects the choice of processing method, the selection of tools and cutting dosages, so the coding of parts material is also very important. Besides, CAPP decision-making model based on experience also includes ten subsystem models such as process route decision-making model, processing methods selection model, machine tools selection model, tools and gages selection model, cutting dosages selection model, etc. Five subsystems of them are introduced in detail in the paper as follow.

III. PROCESS ROUTING AND PROCESSING METHODS DECISION SYSTEM

A. *Process routing decision system*

The process route decision-making system is showed in Fig.3. This module uses mixed form of retrieval and the interactive model. In the retrieval part, it sorts out the process based on enterprise experience according to certain way and used for retrieval. After finding similar process it will enter

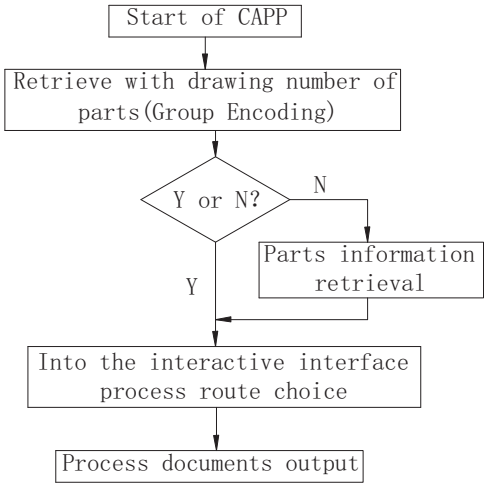

Fig.3 Decision-making process of technological route

man-machine process editing interface. In this interface, designers can make use of the processing methods selection module, machine tool selection module, tools and gage selection module and cutting dosages selction module, etc to require the necessary information and finish the preparation of process documents finally.

This module should also support the capture, sharing and reuse of process design information. System obtain and optimize process design data (including product data, process data and management data) and knowledge (including process design principle, etc), and finally manages those design information through relational database. This may explain design decision, and predict the influence of design change. And it is helpful for the sharing and reuse of knowledge to undertake all levels of self-learning and self-adaption.

B. *Processing methods decision system*

Traditional selection of processing methods is made by process personnel one by one. The way, quality and compilation time of selection are mainly decided by the experience and proficiency of process personnel. This way extremely limits the efficiency of decision making, consequently, adding to the cost of the enterprise[4]. Therefore, make use of the characteristic of big information store capacity, quick speed calculation, convenient operation on computer to manage the compiling, storage, query of process data documentations, and to realize the automation of processing methods selection, which will greatly improve the efficiency of enterprise and provide the liable guarantee to the rapid and exact inquires of processing methods.

The achievement of computer aided inquires system on processing methods will make many of processing personnel out of onerous and repeated work and provide a realistic and feasible method. The use of computer inquires system not only improve the speed and quality of inquire but also allows the operating personnel with low level. Compared with traditional selection methods, making use of computer inquires system will not only improve the speed of query but also overcome the inconsistency and quality instabilityof processing methods selection.

IV. SELECTION SYSTEM OF MACHINE, TOOLS AND MEASURING IMPLEMENT

A. *The structure of machine selection module*

Machine tool selection is a process problem faced with after formulation processing operations. The proper selection of machine tool has a direct effect on the quality of parts

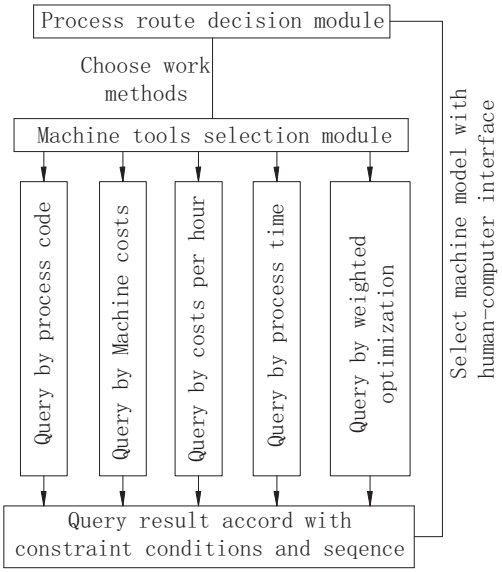

Fig.4 Structure of machine tool selection

processing, equipment utilization, load balance, production cycle, labor intensity, etc. By adopting different types and models of machine processing methods, using the tree layered structure as a general framework, this paper has described their knowledge of the underlying units with production rules, and proposed several strategies for selecting the machine tool[5]. Machine tool selection system divides machine tool into lathe, milling, boring, drilling, planer, grinder, pulling seven categories which corresponding to the "process name " of process route decision system in the way of processing. In the preparation process, the designer select the processing method firstly, and then enter the machine selection module for the inquire and selection of machine tools. This way can greatly narrow down the range of inquire and improve the efficiency of system.

B. *Decision-making system of tools and measuring implement*

The selection of tool affects the selection of the processing parameter, the fixtures and the equipment, but also affects the productivity, production costs, then affects the machining accuracy. The selection of the traditional tools is done by experienced workers and engineers manually. This way needs artificial processing data. Due to various and dispersed data, so

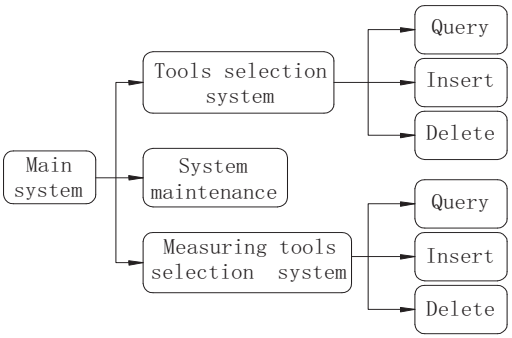

Fig.5 Structure of tools selection

the speed of data retrieval is very slow, and the accuracy is also very poor[6]. Therefore, to use computer aided tools can improve the query efficiency and accelerate information circulation, and there are the stable quality of inquires and the high standardization degree. The requirements of experience and proficiency of technologist are not high. We just need input work step, processes, parts size parameters and can inquires out the selection of tools automatically. It should be integrated conveniently in CAPP system and CAM system, and is convenient to tool for scientific management[7]. According to the function requirements of system , decision-making system of tools and measuring implement is divided into three main modules: tools selection system, measuring tool select system, system maintenance. The system structure is shown in Fig.5.

V. SELECTION SYSTEM OF CUTTING DOSAGES

Parts processing is finished mainly by the relative movement between the cutting tool and workpiece. The relative movement mainly include main movement and feed movement, and define the speed of the main movement as cutting speed v, the size of the feeding movement as feeding f , the size of penetration of a cutting tool as the cutting depth ap. Cutting speed, feeding and cutting depth are three important processing parameters of parts processing. The correct choice of cutting dosages plays an important role on improving the efficiency of cutting dosages, ensuring cutting machining quality and reducing the processing cost[8-9].

A. Selection of cutting depth a_p

The selection of cutting depth ap is relatively easy when working allowance is ascertained in the process. The range of cutting depth corresponded by accuracy level can be ascertained according to dimension precision grades and cutting depth relationship. After being compared with existing working allowance, makes cutting depth equaling machining allowance if the working allowance in the corresponding scope, or remove material by two steps[8]. Cutting processing are generally classified into rough machining, half finishing and finishing. During rough machining, remove all the working allowance as much as possible in one-pass. In the medium power machine, cutting depth may reaches 8~10mm. During half finishing, define the cutting depth as 0.5~2mm, but 0.1~0.4 mm during finishing.

B. Automatic selection of feeding f

The automatic selection of feeding f is key to identify cutting dosages automatically. Because it has no demand for surface quality and the cutting force is often large during rough machining, we must mainly consider the process system stiffness, cutting force size and tool size, etc, as selecting the feeds. Meanwhile, the feed must ensure that the machines and tools should not be damaged because of large cutting force, and the workpiece deflection caused by cutting force should not exceed the numerical value allowed by workpiece precision, and the value of surface roughness should not be too big. In half finishing and finishing, according to the roughness requirements, we should determine the feeding on the basis of workpiece material, arc radius of tool nose, cutting speed, etc[8].

C. Selection of cutting speed v

Cutting speed v is mainly affected by the tool durability. When cutting depth a_p and feeding f is ascertained, the relationship of cutting speed v and tool durability T is shown as follow[8]:

$$V = \frac{C_v}{T^m f^{yv} a_p^{xv}}$$

In formula, the coefficient C_v and index m, yv, xv, etc, can be found in the forms, and these forms is kept in the parameters database of CAPP decision-making system. The data can be easily found by using general query method of library files, therefore, it is very easy to determine the cutting speed in automatic computer design.

VI. CONCLUSION

This paper analyzes the advantages and disadvantages of the above two categories based on the CAPP system, combining with enterprise applications, and considering the thought of experience. Based on this, the paper puts forward the decision-making model and system based on the experience of computer aided process. This system aims at the enterprise experience information. It can not only applicable to enterprise's specific application, also can provide various auxiliary tool to computer-aided the designers processing design. That can avoid problems of hard to architecture general process decision model, and balance the integration of systems. Finally the practical CAPP system which apply to all kinds enterprise is developed.

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