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NONSTANDARD REAMER CAD/CAE/CAM INTEGRATED SYSTEM

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ABSTRACT

The Chinese economy has increased quickly and continuously in recent years. Manufacturing is an important part of Chinese industry. The enhancement of modern manufacturing technology is becoming an important issue. The aim of the present thesis is to develop nonstandard (over-stiff) tools' CAD/CAE/CAPP/CAM integrated system. This will involve integrating modern information technology, manufacturing technology and management technology. The thesis objective is to propose a totally new and integrated design, analysis and manufacturing system. This would provide to manufacturers a capability to carry out the incorporation of CAD/CAE/CAM systems.

Many enterprises and universities have developed standard CAD system tools' in recent years in China. But in regard to nonstandard complex CAD/CAM tools', there is still much to be done. After more than one year investigation and research, a great quantity of information and data has been assembled, thus setting a solid foundation for completing this project successfully.

This thesis considers in detail the problem associated with non-standard over stiff end milling cutters to illustrate the design approach used and its implementation. It uses a feature based model constructing technology and applies the CAD and finite element analysis together with relevant theories and technologies for processing and manufacturing. The thesis completes the development of non-standard complicated tools' CAD \CAE \ CAM integrated system.

The thesis consists of six chapters, dealing with the project's background, system's design and structural design requirements, finite element analysis, CAM, and some concluding remarks based on what was learned during the thesis work. The project's kernel technology is to use finite elements method to analyze the nonstandard complex tools' models using ANSYS large-scaled finite element analysis software.

Key words:

CIMS, Computer Integrated Manufacturing System
CAD, Computer Aided Design
CAM, Computer Aided Manufacture

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INTRODUCTION

The global market competition make the market competition more and more intense. The short product cycle, the quality, the price and the date of delivery have become the enhancement enterprise competitive power. How to use the information technology transformation tradition manufacturing industry, by the most low cost, the best quality, develops the user request fast the product and puts in the market, has become the enterprise to win the competition, to obtain the survival and the development key.

CIMS (Computer Integrated Manufacturing System) one of as informationization primary coverages, is in the present manufacture domain an important research direction. In the CIMS architecture, CAD/CAM is its central content, is also one of its key technologies. The manufacturing industry informationization should face the national economy the main battlefield, develops 3D CAD and the CAD/CAE/CAM integration technology vigorously, sharpens the product innovation design development ability, realizes the design digitization, the production digitization, the management digitization, the equipment digitization and the enterprise digitization, promotes our country manufacturing industry competitive power comprehensively, realizes the industrialization for our country to lay the foundation.

With the rapid evolution of the Chinese economy, the ability to promote the manufacturing sector, depends very much on new technologies such as Computer Integrated Manufacturing System, CIMS which will form the basis of this work.

This thesis is structured as follows: Chapter one deals with background material related to the demand of the CIMS system design, as well as the methods in solving the various problems encountered. Chapter two expounds on the ideas and process of the design of the whole system. Chapter three outlines the design structure of the system, giving users a system's blueprint. Chapter four expounds on the application of the analysis method of finite element in the system design. Chapter five expounds on the ideas and process of CAM design. Finally, chapter six expounds on the foreground and provides some conclusion of this system in an actual application.

The project's kernel technology is the use of finite element method to analyze the nonstandard complex tools' models by adopting ANSYS a large-scaled finite element analysis software.

Of course, our invention and our design procedure also have some disadvantages. Part of the system may be immature and imperfect. Therefore, we do need your valuable suggestions.

CHAPTER 1

THE COMPUTER INTEGRATED MANUFACTURING SYSTEM

1.1 Research Proposal

CIMS (Computer Integrated Manufacturing System) is a highly automated manufacturing system, which integrates modern information, technology and management technologies. It has become an important research direction in the manufacturing field, and has been given more and more attention on the part of the engineering and academic communities throughout the world. It has become important in academic research and engineering practice. In CIMS CAD /CAM is the kernel and one of the key technologies used.[6].

CAD and CAM have been developed independently, so they have different data expressions and data structures[6]. The fundamental difference specifically lies in the explanation and disposal of the parts' shapes. When one system (like CAD) is integrated with another one (like CAM), the product's information process often breaks down so that oftentimes large amount of data have to be inputted and disposed again.

The CAD/CAM integrated system tries to realize the integration of data collection, data exchange, data storage and data disposal among each module of the CAD, CAPP and CAM. During the past several years, the worldwide academic community has done a lot of work on this aspect. They have adopted various advanced technologies in the system's development and put forward many theories and methods. They found that there are two approaches to realizing the integration of the CAD and CAM components: one is to use a special interface or standard format to link up the current CAD, CAPP, and the CAM systems; the other is to develop the feature based on a CAD/CAM integrated system [11]. The first method is often considered a transient measure to realize the integration of the original CAD and CAM.

Feature based module technology replaces the low-level geometric elements. It not only includes the geometric and topological information but also utilizes the information gathered in the design, analysis, techniques, manufacture and testing phases. It reveals the common interest of product designer and manufacturer. It can be comprehended and used by CAM and CAD system. A feature based parts module construction can effectively express such engineering meanings as the parts' geometric and non-geometric meanings. It represents the developing direction of parts' module construction technology.

In European countries, America and Japan as well as in other developed countries, the integrating technology of CAD and CAM have been successfully used in the defense, aviation, automobile, and electronic sectors. Applications range from simple parts to highly complex system. It has led to obvious social and economic benefits. In China, many universities and research institutes have studied the typical parts and standard parts of the CAD and CAM integrating system of the typical parts and standard parts. In the past several years, in China, many enterprises and universities have developed the standard tool CAD system in the tools field. But much remains to be done in the nonstandard CAD/CAM area [12].

As nonstandard tools have a very complex structure, especially those used by the processing center of numerical controlled machine tool, high precision, reliability and duration as well as other aspects are needed. It is very difficult for traditional design or common CAD technology to offer the best design and processing scheme, leading to longer time for the design and production cycle. Using the CAD /CAM integrating technology can improve these shortcomings greatly. It can advance the quality of design and efficiency of the design while reducimg the cost of manufacturing. This project adopts the finite element design method to analyze the intensity and stiffness of the nonstandard complex tools; adopts the feature based module constructing technology; develops the computer based CAD/CAE/CAM integrating system of the nonstandard complex tools. It not only brings obvious economic results to enterprises but also promotes the technological development in tool manufacturing enterprises. Moreover, it has academic values in the study of the integration's principle, implementation framework and practice strategy, etc of CAD/CAM system. More important, it sets an example for Chinese mechanical manufacturing industry especially for the implementation of CAD/CAE/CAM integrating technology in the nonstandard complex tools manufacturing field; accumulates technology and experience; pushes forward the popularization and adoption of CIMS.

1.2 Developing aim, assignment and requirement of the system

Develop a computer based integrated CAD/CAE/CAPP/CAM system of the nonstandard over-stiff tools. The object of the system is to provide a new and convenient integrating environment for design, analysis and manufacturing and to provide enterprises with a prototype to realize CAD/CAE/CAM integration. According to the basic parameter and requirement inputted by the user, the system orderly completes the parameter preparation, structure design (truncated shape design, three-dimensional entity molding and two-dimensional parameter design), the finite element analysis, the processing design and numerical programming of the nonstandard tools design, and the dynamic simulation of processing as well. A requirement is for the system to have a good man-machine interfaces and interactive functions. It will also attempt to provide for safe running, convenient operation as well as timely response and accurate information disposal. Also, the system should have such functions as maintaining and managing the system resources,

CHAPTER 2

SYSTEM DESIGN

2.1 Operation Environment of the System

<u>The system will use the following hardware and software</u>

2.1.1 Hardware environment of the system

586 series computer: PIII1.0G、256MB memory、20G HD

2.1.2 Software environment of the system

Windows98/2000/NToperating system;

Visual C++ 6.0、MDT 3.0;

ANSYS 5.0; MS-Access97/2000; and 3DS MAX 3.0 etc.

(1) This system uses Windows2000 as its software. It assembles several mounting platforms.

(2) The master control system, design preparation module, resource manage module, process design subsystem and the numerical control subsystem and others in the system are all adopted language Visual C++ 6.0 which is an object based program design.

(3) The structure design subsystem takes the three dimensional entity molding

software MDT 3.0 as its supporting platform; uses ARX developing environment, API developing tool and Auto LISP program design language to complete the development of CAD subsystem.

(4) The finite element analysis uses ANSYS 5.0 to analyze the intensity and stiffness of tools' structure.

(5) Processing simulation uses the 3DS MAX 3.0 to complete the dynamic simulation of process design flow.

(6)The system adopts Ms-Access2000 database management software to found related database; uses the ODBC(Open Database Connectivity) of Visual C++ 6.0. and DAO (Data Access Object) to operate and manage the database.

2.2 Architectural Structure of the System

In the development of the system, we use structural design methods to divide the modules so as to accomodate functionality aggregation and divide the system into several functional modules. Each module has a definite goal and assignment. This orderly arrangement not only allows for the ease in the system maintenance and modification, but also improves the system's adaptability and reliability. According to the system's overall functional requirement, the whole system must operate under Windows and utilize VC++6.0 as the development tool. Fig 2.1 shows the system's architectural structure. Its major functional modules are divided as follows:

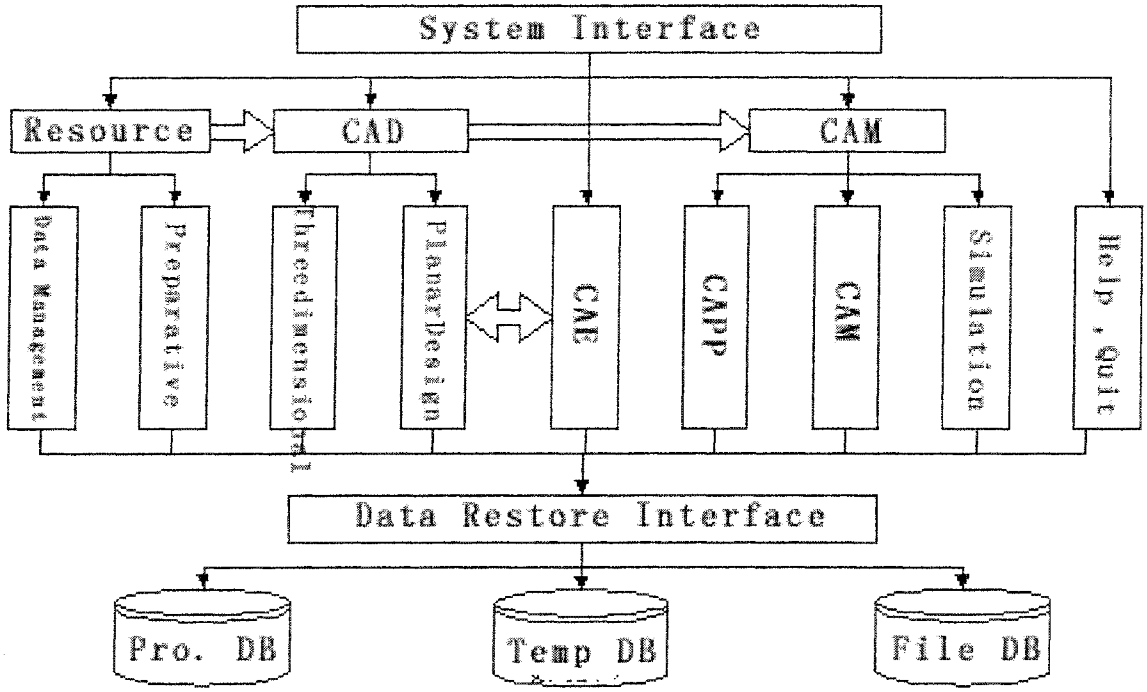


Fig 2.1 Architectural structure of the system

1. The master control program and resource management module.

Its major components are: Preparative, Data management, Planar design and the Three dimensional. Also to coordinate and manage each module, etc. according to a user's specific requirements. All components are developed using Visual C++6.0..

2. Design preparation module

It is a functional module developed on the basis of Visual C++6.0 system. The system searches the corresponding tools database to select the appropriate tools in terms of the design request proposed by the user. At the same time it stores related information produced in the dynamic incident database in the form of a dynamic data exchange file.

3. Structure design (CAD) module

Based on MDT development environment, it is a comparatively independent CAD sub-system developed in terms of ARX API development instrument and Auto LISP language. Its major function is to complete the design of nonstandard end milling cutter's cross-section shape. Based on this, the feature based three-dimensional entity molding design and two dimensional parameter design are completed.

4. Finite element analysis module

Using ANSYS analysis software, it transfers the tool model and data produced by CAD into the system. It then analyze the tools' intensity by means of definite element analysis in order to analyze the valifity of the tools' structures and obtain the optimal cross-section parameter.

5. Assisted manufacturing module

It is a comparatively independent CAM subsystem developed using Visual C++, Access DBMS (database management system) and 3DS MAX, flash software. Its major functions are as follows:

- Complete the processing design of the tools. The system can edit, i.e. add, delete or modify, etc., every procedure content of the processing cards produced.
- Change the procedure content of numerical control processing into corresponding NC macro program automatically.
- Print the reports and transmit NC code, etc.
- Simulate the whole course of tools' manufacturing dynamically by means of a three-dimensional flash presentation, which provides the user with perceptual knowledge of the tools' processing course.

6. Help and exit module

It provides an introduction and a detailed manual of the system. The user can quit the system safely and renew the assignment by means of this module.

In addition, the system is also equipped with the following databases to support the system.

- Product Database: It is used to store various data used by structure design and processing design. It includes: over-stiff carbide cutter material base, model base, feature database, processing knowledge base and resource database.
- Dynamic incident base: save various dynamic data exchange file.
- File base: It is used to store the processing information produced through design and corresponding help files.

2.3 Control Mode of the System's Master control Program and the realization of resource management

2.3.1 Control Mode of the System's Master control Program

To realize the control of each functional module or subsystem, assignment, distribution and resource data management, a master control program for the system must be set up. Therefore, the following demandsare placed on the functions of the system's master control program:

1) Embody each functional module of the system in a simple and clear way.
2) Control and manage the system's functional modules according to different requirements proposed by the users.

3) Manage the system's resources and provide the working route needed by design.

4) Provide correlated information with help and explanation.

We implement the system's master control program, the resource management module and exit module which work in a coordinated manner with the whole system's master control program under the Windows environment. This makes it easier for the user to operate and use.

The Windows environment which uses message queuing, multitasking and multi-window allows the current running program to share all the resources of the computer to implement the associated functional module control.. The data among each subsystem in the integrated system are transferred to a data file.

2.3.2 The Creation and Maintenance of Database

In the development of nonstandard complex tools' CAD/CAE/CAM integrated system, we use the Microsoft Access software to construct the basic database with complete data structure to support the system. These basic databases include: the complete standard end milling cutter's database, shows in Fig 2.3, and a nonstandard end milling cutter's database (Fig 2.4) which is mainly built by autonomous designs. We use Visual C++6.0 to create an interface that can control the operation on the database by means of ODBC. Shows in Fig 2.2 . Through this interface, the users utilize such functions as adding, deleting, filtering, amending and parameter inquiry, etc. on the database's record. In the course of implementation, we combine the MFC's and ODBC packages to allow for SQL language queries. Practice has proven that this approach works well. It is not only fast but also convenient to operate.

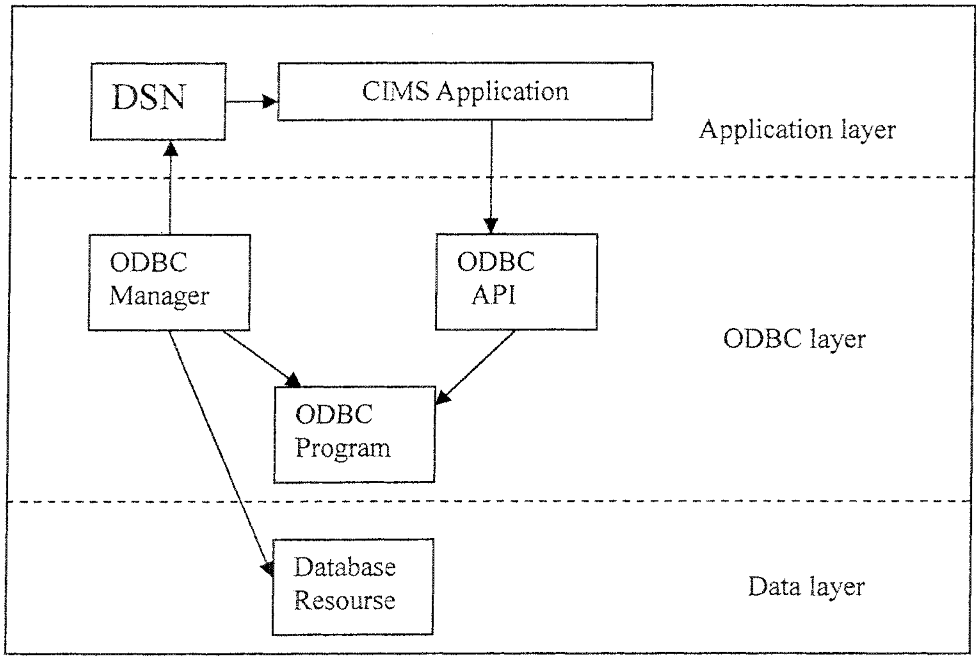


Fig 2.2 The relationship of the application,ODBC and database

参数：表

序号	chishu	XingHao	DA	L1	L	DB	a	b	XH
1	2	SED201DSG	1	2	45	4	30	0	SED2...SG
2	2	SED202DSG	2	4	45	4	30	0	SED2...SG
3	2	SED203DSG	3	6	45	6	30	0	SED2...SG
4	2	SED204DSG	4	0	45	6	30	0	SED2...SG
5	2	SED205DSG	5	10	50	6	30	0	SED2...SG

Fig 2.3 Standard end milling cutter's database

资源库：表

xuhao	XingHao	chish	DA	L1	L	DB	a	b	chaizhi
332	SED2011L	2	11	12	105	55	30	0	硬质合金
（自动编号）									

Fig 2.4 Nonstandard end milling cutter's database (resource database)

2.3.3 Realization of the system's Resource Management

The system's resource management is realized through such functional items or modules as resource maintenance, design preparation, exit and help module. Every design of the system is carried out in a tacitly approved working space (that is the Public Dynamic Space). To avoid the confusion of different assignments, before beginning a new design assignment, the system will refresh the dynamic working space. At the same time, carry out reasonable configuration and management of design resources according to specific working requirements and the necessity of design completion. The file database will save the design information produced by the system according to user's requirements.

When the initiating system enters the master control interface, both the structure design module and the process design module are at failure state. They can be activated only after specific assignments are determined. Resource management module has two assignment options: system's resource maintenance and design preparation.

(1) System's resource maintenance

It refers to the maintenance of the system's database resources. The maintenance rules of different databases differ from each other. As to the standard end milling cutter's database, the standard used by enterprises and its product series cannot be changed at will, so the functions on the database operation offered by the system to the user are collation and parameter inquiry. Only in special cases, such buttons, as the addition, deletion and modification to database can be activated under the resource maintenance operation interface of the system, which should be operated after being specified by the system. As to the resource database, its saved contents are all the user's automatically designed nonstandard end milling cutter's data, therefore the system provides user with the work interface that can carry out all-round operation on this database. (see Fig 2.5).

(2) Design preparation

When a user chooses a design preparation item, one system disposition dialogue frame is sent forth firstly. There are three work patterns that a user can choose according to the information prompt.

a) design preparation

The system sets the tacitly approved workspace empty firstly (that is the public dynamic space), and then it enters the design preparation dialogue frame. The user determines the work assignment according to the design requirements.

b) recovery design

Recover all the files and data lost when last unexpected interruption took place caused by power off or other reasons. The system continues with its last work assignment.

c) save the design data

The system activates the resource database and saves the last design results according to the user's wishes and adds it to the database.

The user determines the work assignment and dispose of the design resources reasonably according to the three methods mentioned above.

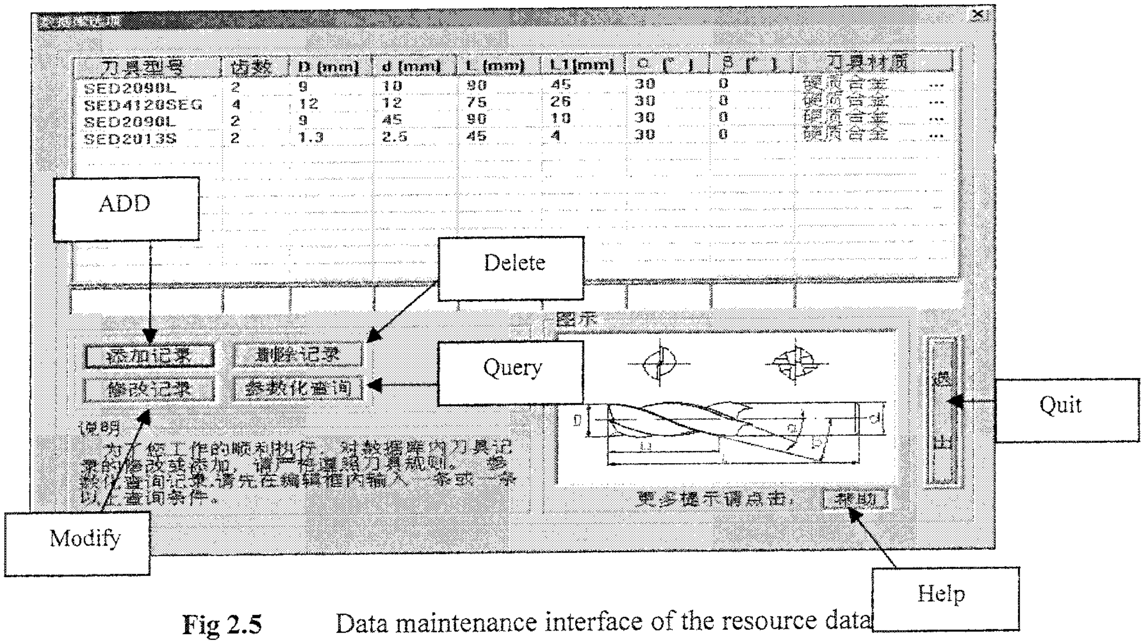


Fig 2.5 Data maintenance interface of the resource data

2.4 Construction of the Design Preparation Module

The main function of the design preparation module allows the system to call the work interface of the design preparation module automatically and to complete the design preparation of the end milling cutter according to the work order sent from the resource management module.

2.4.1 Construction of the database inquiry rule

As the end milling cutter has many different specifications and involves complex models which are difficult to understand. Different processing objects with different processing characteristics and requirements together with different materials, the requests on the end milling cutter's structure, size and property will differ from oneanother and their associated degree may be quite high. Thus, the need to construct an efficient database inquiry rule is fundamental for a good and complete design. Based on the database's structure and the data characteristics constructed and considered from the user's view, we designed four search ways to satisfy the user's requirements. Fig 2.6 illustrates this.

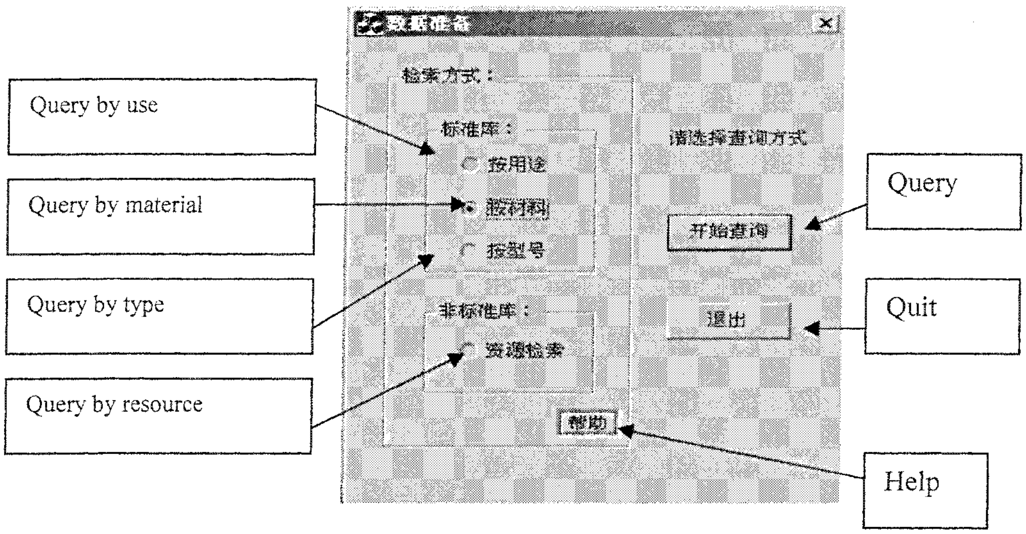


Fig 2.6 Interface of design preparation

In the design for the realization of various inquiry methods, we set up the correlated table of tool model, material, quality and use. Fig 2.7 illustrates this. Corresponding inquiry methods are realized through the construction of the correlation between the correlated table and database. Meanwhile the system provides a user with a "table of the end milling cutter's model and name" in the form of help in order to help the user further comprehend the components of the end milling cutter's model. Fig 2.8 shows it.

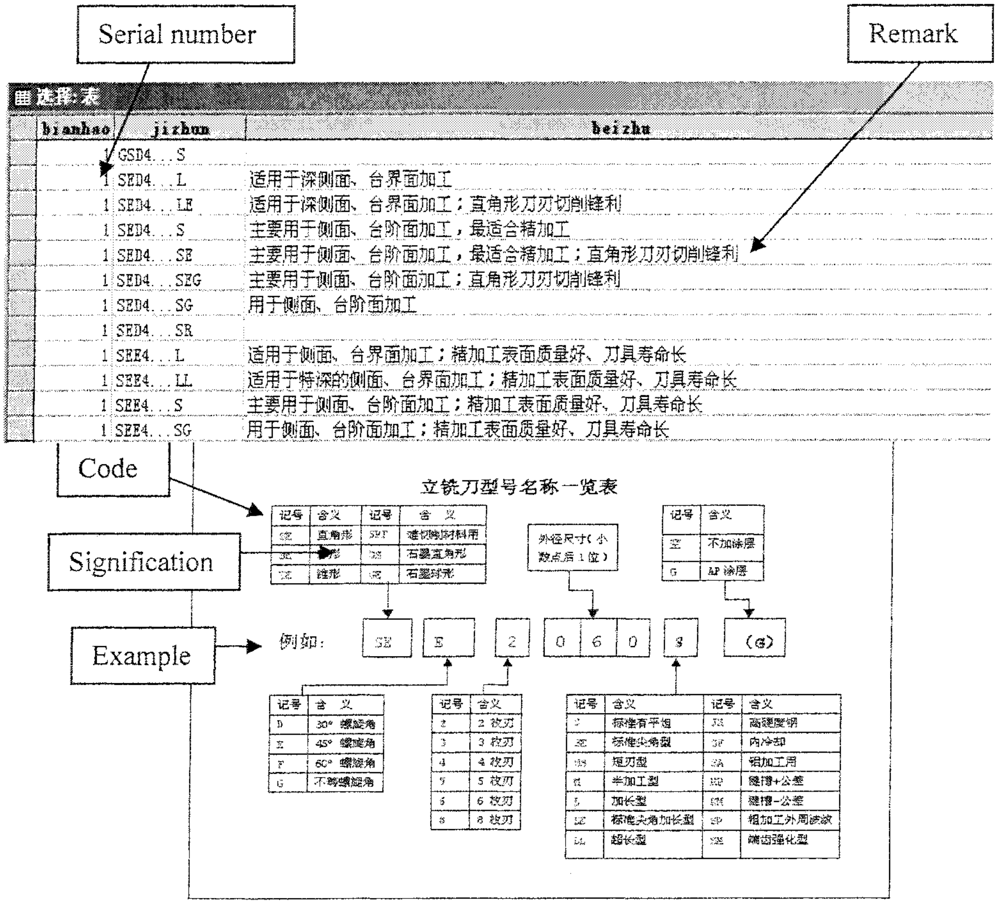


Fig 2.8 Table of the end milling cutter's model and name

2.4.2 Realization of design preparation

Of the four search ways provided by the system, three of them are directed at the standard database. These are: the selector mode by use, the selector mode by material, and the selector mode by model. Another selector mode by model is directed at the database of non-standard end milling cutter. Fig 2.9—Fig 2.12 illustrates.

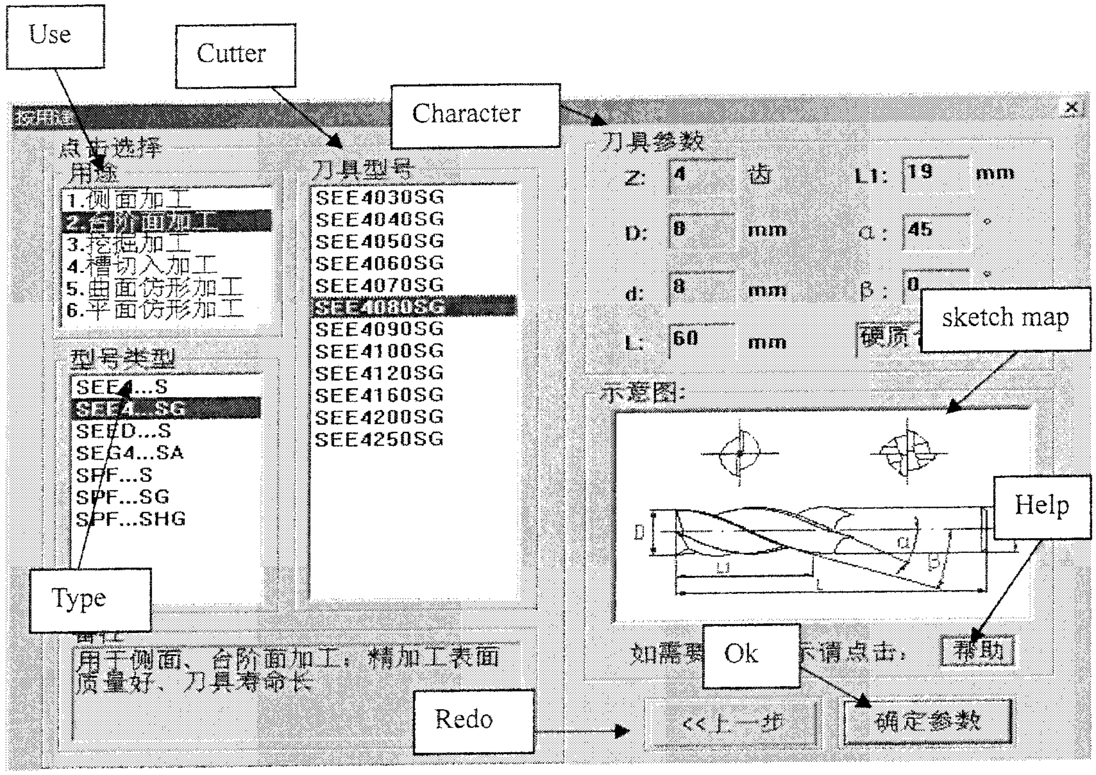


Fig 2.9 The selector mode by use

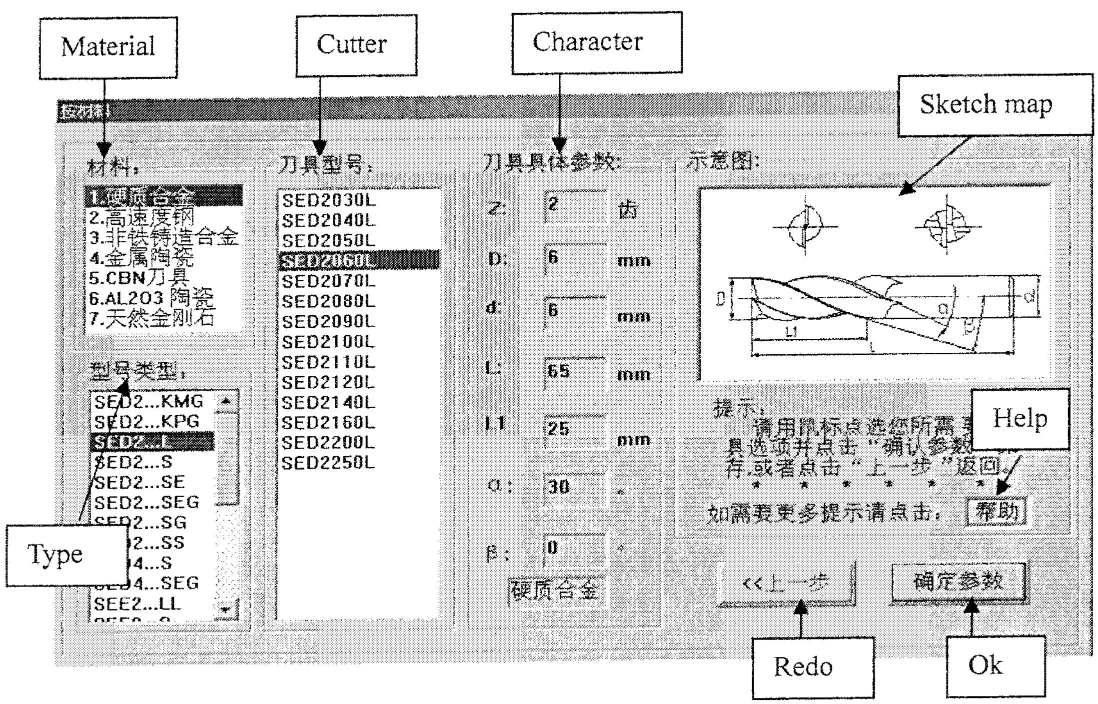


Fig 2.10 The selector mode by material

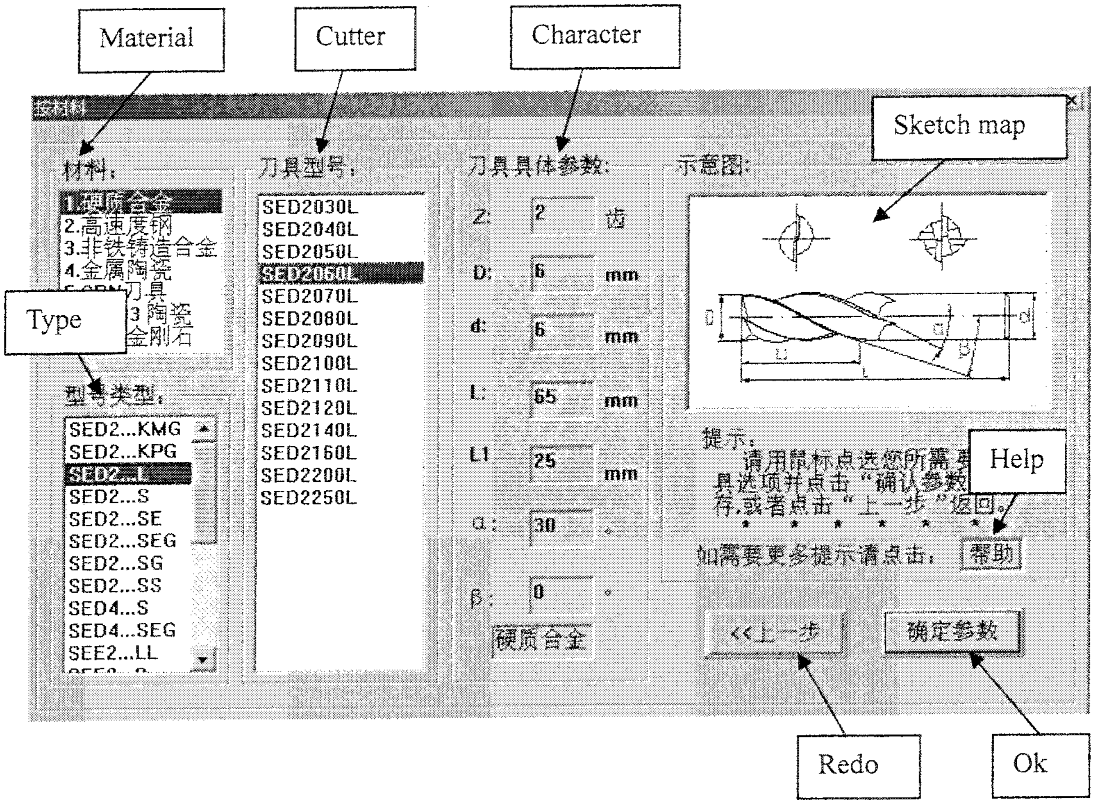


Fig 2.11 The selector mode by model (standard base)

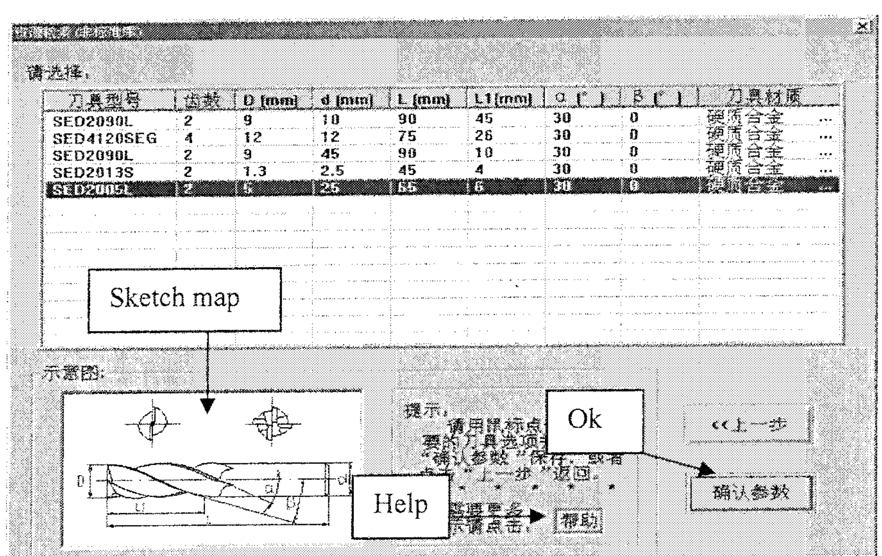


Fig 2.12 The selector mode by model (resource base)

The user can choose different inquiry ways according to different design requirements. Choose the tools' model and parameter to be designed, then push the determinate button, and the system will save the data automatically in the form of dynamic text file.

The user reads the data file during structure design. Another dynamic text file with the same structure and data is created after the design parameters are determined. If the user modifies relative information, the change is embodied in specific data contents of the text file. The system can get the alternative information of the design data only by comparing these two files. Thus, the maintenance of the design information is achieved.

CHAPTER 3

STRUCTURE DESIGN

3.1 Design of the end milling cutter's truncated shape

As for helical blade tools' CAD, in general cases, applying the computer technology, formed instrument's blade shape can be enveloped by processed groove's truncated shape, and check the blade's profile [4]. Whereas, calculated formed instrument's blade profile can also be used to simulate the process on computer. Observe whether the enveloped graph meets the needs on truncated shape parameter of the processed groove or not.

In the design of non-standard over stiff end milling cutter, the tools' truncated shape may vary; the manufacturer can provide the profile of manufacture-used emery wheel obtained from the experience or experiment. Thereby, a new design method of tools' truncated shape is adopted in this system, namely using the emery wheel's profile to simulate the process of non-standard end milling cutter. Seek out the helical groove's port truncated shape reversely.

3.1.1 The Design of emery wheel's profile

In recent years, in regards to the end milling cutter, whose diameter is under the 1 inch (unit), one often uses the linear formed emery wheel to grind helical groove [4]. In the design of standard end milling cutter, the profile of formed emery wheel needs drawing on grounds of the geometric size of end milling cutter's port trough. While in the design of non-standard end milling cutter, the profile of formed emery wheel is often obtained by experiment or experience. Fig 3.1 shows the emery wheel's profile of non-standard four-gear end milling cutter.

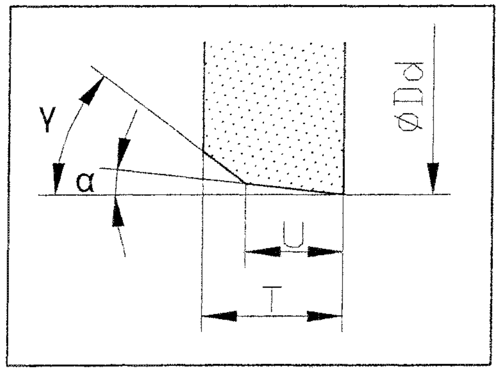


Fig 3.1 The linear emery wheel's profile

3.1.2 Simulation of the process

- set up mathematical model

To simulate the process, a mathematical model using linear emery wheel to grind the end milling cutter should be established. First, we set up a coordinate system and seek out the mathematical model of the process' computer simulation.$O_DX_DY_DZ_D$ refers to the emery wheel's coordinate. $O_GX_GY_GZ_G$ refers to the end milling cutter's coordinate. X_0 (I) and Z_0 (I) refer to coordinate points of the emery wheel's profile.

Translate the local coordinate X_0OZ_0 to the end milling cutter's coordinate $X_GO_GZ_G$ and then use translating exchange.

The formula is:

$$X_G(I) = X_0(I) - X_A + R_G \times SIN\varepsilon$$

$$Z_G(I) = Z_0(I) - Z_A + R_G \times COS\varepsilon \quad (1)$$

In the formula: R_G : radius of the end milling cutter

$\varepsilon_{法}$:I nward deflection angle of the normal profile

$\varepsilon_{法} = SIN\text{-}1(\delta_{法}/R_G)$

$\delta_{法}$: inward biased distance of the normal profile

$\delta_{法} = \delta_{端} \times COS\varepsilon$

$\delta_{端}$: port inward biased distance

$\delta_{端} = R_G \times SIN\varepsilon$

ε : emery wheel vibrating angle

Central moment of the end milling cutter and the emery wheel:

$O_D O_G = R_G \times COS\varepsilon_{法} + R_D - Z_A$

R_D: radius of the emery wheel

To obtain the truncated shape of each profile of the emery wheel, it is necessary to move the coordinate to the emery wheel's coordinate $X_D O_D Z_D$:

$$X_D(I) = X_G(I)$$

$$Z_D(I) = Z_G(I) - O_DO_G \quad (2)$$

Take dissimilar values along the Y_G axis direction from negative to positive, whose range is the intersection part of the end milling cutter and the emery wheel, do a different profile perpendicular to the Y_G axis, thus truncated shape of each profile of the emery wheel can be obtained, then change these truncated shapes from the work piece's profile to the emery wheel's profile, and the port trough enveloped graph of the end milling cutter comes into being. Simulation of the process is realized.

In order to show the enveloped graph, we can transform the coordinates from normal to port in terms of different values of Y, translate to the $O_GX_GY_GZ_G$ coordinate at the same time. If fetch the cross section of Y_N=N, the coordinate of random point B in the emery wheel's profile truncated is :

$$X_G(B) = X_D(B) \ / \ COS\varepsilon + Y_N \times tg\varepsilon$$

$$Y_D(B) = X_D(B) \times tg\varepsilon + Y_N \ / \ COS\varepsilon$$

$$Z_G(B) = - \qquad + \sqrt{R^2(B) - Y_D^2(B)} \quad O_DO_G$$

At this time, the coordinates of each point is:

$$X_G(I) = X_D(I) \ / \ COS\varepsilon + Y_N \times tg\varepsilon$$

$$Z_G(I) = -\sqrt{Z_D^2(I) - Y_D^2(I)} + O_DO_G \quad (3)$$

In the formula: $Y_D(I) = X_D(I) \times tg\varepsilon + Y_N / COS\varepsilon$

The angle of each coordinate points and O_DO_G axis is:

$$\alpha(I) = tg^{-1}[Z_G(I) / X_G(I)]$$

Change the angle to the angle of O_DO_G axis is:

$$\alpha 1(I) = Y_N \times tg\varepsilon / R_G$$

The distance of each coordinate points and the center of OG axis is:

$$R(I) = \sqrt{X_G^2(I) + Z_G^2(I)}$$

Then each point changes to the ODOG axis:

$$X_G(I) = R(I) \times COS[\alpha(I) + \alpha 1(I)]$$

$$Z_G(I) = R(I) \times SIN[\alpha(I) + \alpha 1(I)] \quad (4)$$

At this time, one profile is drawn on grounds of one value of YN, a trough enveloped graph is formed on grounds of different values of Y, and then many grooves can be obtained through rotational variation.

- Steps of the process' computer simulation

Take (d refers to diameter) d=16.0mm, (ε refers to the vibrating angle), ε = 40° as an example:

- Design the linear of emery wheel's profile through experience or experiment, the shape of which is described in Fig 3.2.

In this graph, $U = 7.0mm$, $T = 10.0mm$, $\alpha = 7°$, $\gamma = 40°$。

● Change the coordinates. Translate the coordinate to the end milling cutter's coordinate.

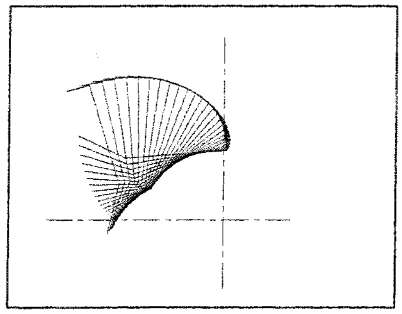


Fig 3.2 A helix groove

● Take one gear to do the process simulation. Divide the length that the emery wheel contacts with the workpiece into 25 shares equally along the O_GY_G axis direction, 25 profiles of the emery wheel are acquired. Each shape of the emery wheel represents one position in the process. Thus the simulation of a helical groove's process is completed.

● Use the method of array. Revolve a trough envelope graph around the center, and we can get four arrays. That is to say, we can obtain the envelope graph of the four-gear end milling cutter described in Fig 3.3.

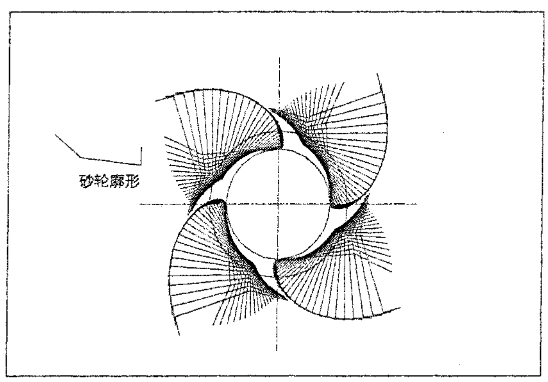


Fig 3.3 Simulation of the four-gear end milling cutter

3.1.3 Obtain the truncated shape of the end milling cutter

Using the spline curve to envelop; make the quadratic post-angle; draw the bottom circle, put in good order and get the graph in the end. Thus we can obtain the port's truncated shape of the four-gear end milling cutter described in Fig 3.4.

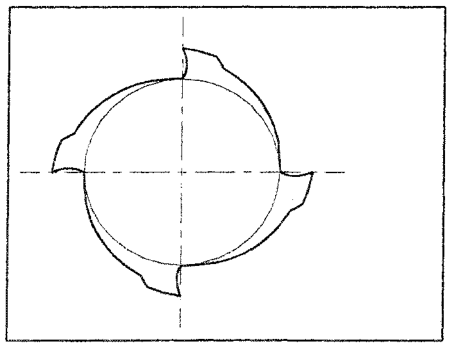


Fig 3.4 Truncated shape graph

We use the method above-mentioned to design the truncated shape of SZE non-standard four-gear end milling cutter. The design parameters are given as follows: Dd = 16mm, $T \geq 7.0$, U1 = 1.6, U2 = 1.6, U3 = 1.6, $\alpha = 20°$, $\gamma = 40°$,$\delta = 30°$. Fig3.5, Fig3.6 and Fig3.7 show its profile, computer simulation of the process and the port's truncated shape. We use the emery wheel's profile to seek out the processed tools' port's truncated shape reversely in the non-standard over stiff tools' CAD. In this way, the tools' design is carried out. The designed results are basically in accordance with such products as the non-standard two-gear and four-gear' etc. produced by Tianjin Tianling Over Stiff Instrument Co.ltd. They meet the needs on processed quality. This truncated shape can be used in the design of after CAD, CAE sub-system.

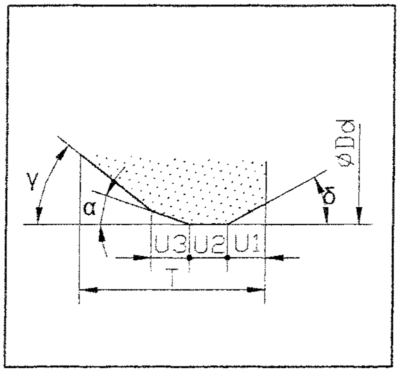


Fig 3.5 Profile of the SZE model emery wheel

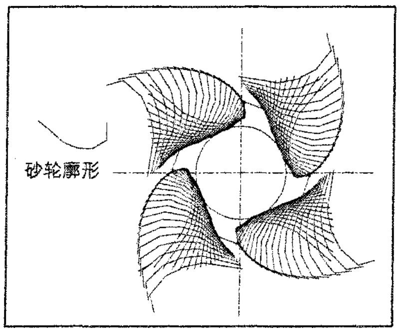


Fig 3.6 Computer simulation of SZE model's process.

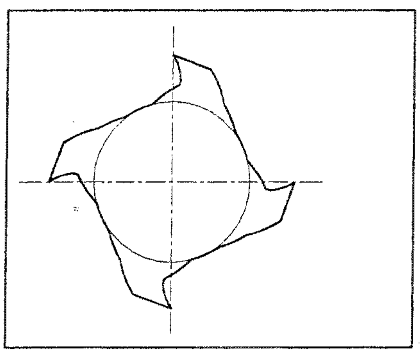


Fig 3.7 Port's truncated shape of SZE model

3.2 Three-dimensional entity molding design

On grounds of the tools' truncated shape, this model builds up the three-dimensional tools' model according to the tool parameters inputted by the user, provides the user with an intuitive tool's design method and gives after finite element analysis an analysis model.

This model is developed by taking three-dimensional entity molding software MDT3.0 as its underlying platform, on grounds of MDT (AutoCAD Mechanical Desktop) 3.0, ARX (AutoCAD Runtimes Xtension) development environment and API (Application Programming Interface) development measure. MDT is a feature based, parameter based general three dimensional mechanical CAD platform, similar to AutoCAD. ARX development environment is a new quadratic development measure of AutoCAD which is the object faced development environment based on C++ and the application program interface as well. In fact ARX is a dynamic connection base that shares the address space with AutoCAD. ARX can call AutoCAD's in-line function directly. Therefore it is faster than AutoLISP and ADS, with stronger function and greater flexibility. Besides, it can fully uses the Microsoft Foundation Class (MFC) offered by Visual C++ in the program through Object ARX. It can enjoy the convenience given by MFC to the greatest extent. API, the mechanical CAD application program development instrument, is composed of a series of interface parameters.

The system sets up the legend of tools' design instrument under MDT environment.. After entering MDT environment, click this legend and enter the function of tool's design. Fig3.8 shows its parameter input interface. At the same time, the system reads the design parameter input by the master control module; the designer inputs other design parameters again. Push the "execute" button; the system will generate the tool's three-dimensional structure module according to the parameter input. Also the system provides an important help function. When the "Help" button is pushed, the system will prompt the design's original conditions and requirements. As for the design itself, the designer can determine other parameters according to the original conditions and requirements. Save the tools' model file in one route after the design is finished. Analyze the tools' intensity and stiffness through finite element analysis software. If the tools' structure is not reasonable, return to MDT and re-input corresponding parameters to construct a new model. Thus, it makes the tools' structure tending to be more reasonable.

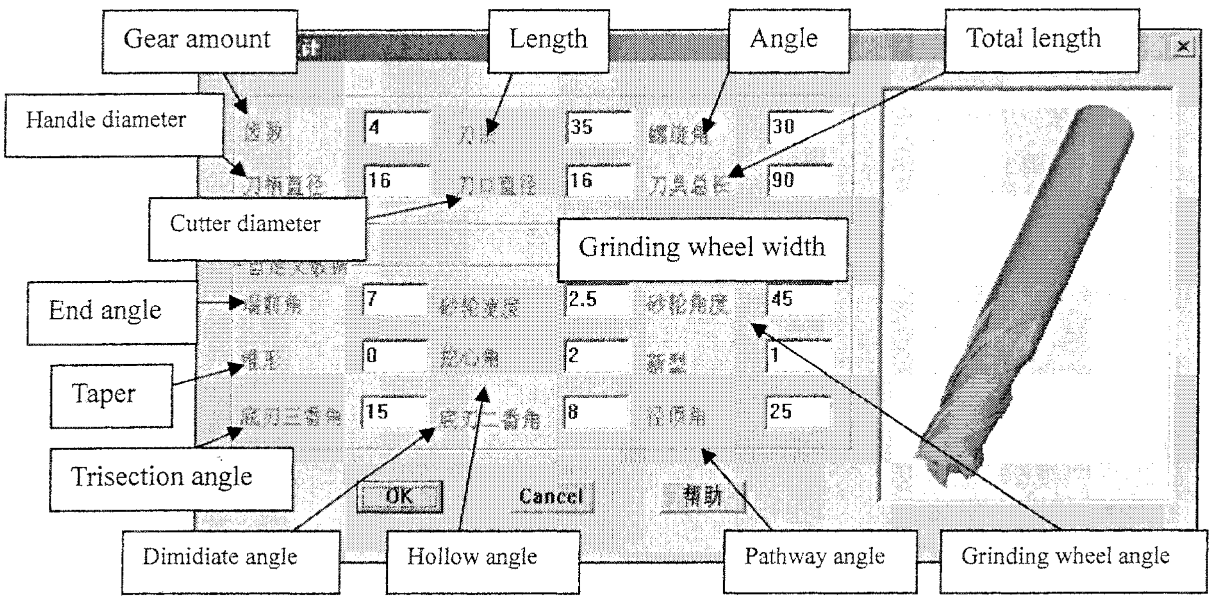


Fig 3.8 The parameter input interface of three-dimensional CAD subsystem

3.3 Two-dimensional parameter design

The module is a relatively independent two-dimensional parameter system, developed to meet the needs of manufactures. The system uses Auto CAD's imbedded program design language, Auto LISP. Because of the design of the tools' truncated shape, the system completes the two-dimensional parameter design of both the standard tools and the user's self-defining tools.

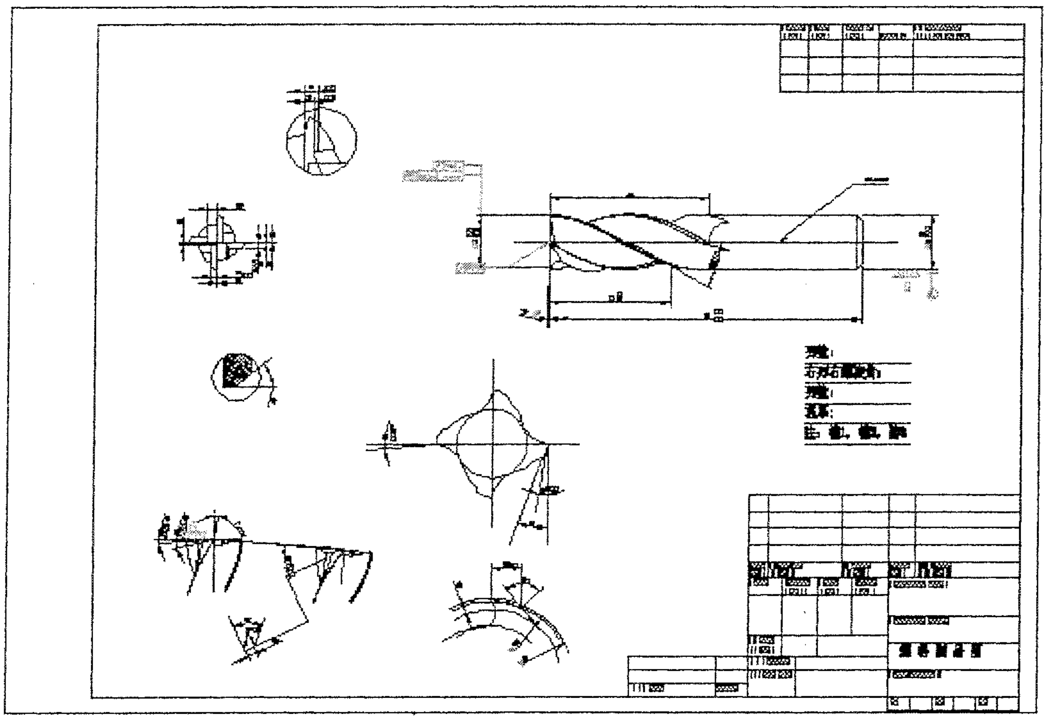


Fig 3.9 The two-dimensional parameter graph of SED4 model tools

CHAPTER 4

FINITE ELEMENT ANALYSIS

Because the nonstandard tools have extremely complex structures, we use the finite element method for analysis and computation. The module uses the large-scale finite element analysis software named ANSYS to analyze the over stiff end milling cutters' intensity and stiffness and, also, to optimize the parameters of end milling cutter's truncated shape. The ANSYS system is a large-scale analysis software. It has powerful functions for finite element analysis and calculation. If we take ANSYS system as a functional model and allow the system to call it will not necessarily produce the best scheme. Therefore, we finish the tools' finite element analysis separately in the ANSYS system. Whereas the function of finite element analysis in the analyzing model is: to input the finite element analysis results of the ANSYS system, which makes it convenient for our comprehensive analysis [2].

4.1 Two-dimensional finite element analysis

Transform the accurate tools' design model obtained from truncated shape design to the ANSYS software environment. Sometimes some model data may be lost. At this time, we will select several key points from the end milling cutter's truncated shape and construct the model in ANSYS once more, then restrain and load the model constructed, and then analyze it [3]. Take the two-gear end milling cutter with the 12mm diameter, 30° helical angle as an example to analyze.

1. Construct the model

Select some points of the half truncated shape from the AUTOCAD's truncated shape and construct the model in ANSYS.

2. Divide the unit

Choose entity units to carry out the automatic division of the lattice. The process is described in Fig 4.2 (a).

3. Simplify and calculate the loadings

Machining force comes from two aspects: one is the resistance produced by the elastic deformation and plastic deformation of the workpiece's machining layer's metal, machined scrapes and the membranous metal as well; the other is the friction resistance among the tools, machined scrapes and the workpiece's surface. The total machining resistance that the tools suffer can be divided into three components of forces perpendicular to one another along the tangential, radial and in-line direction. The total machining resistance that the workpiece suffers can be decomposed into the longitudinal, horizontal, and perpendicular components of force along the supply-giving direction of machine tools operating board.

Fig 4.1 illustrates this.

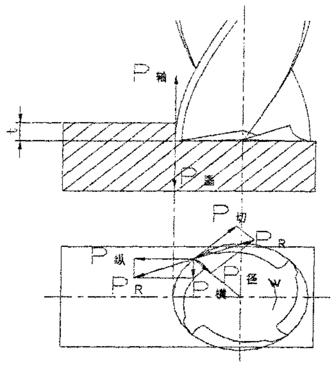


Fig 4.1 Anatomy of cutter

The unit machining force is usually used in calculating machining force, which refers to the tangential machining force used to machine unit area. We use P to express it.

$P = P_t/P_T$ (N/mm^2)

In the formula: P_t :tangential machining force, unit: N,

P_T :sum of the machining area that the tools participate in the machining tool gear, unit: mm^2.

The unit machining force can be obtained by experiment. The machining force's size has a complicated functional relation with such machining elements as machining depth t, supply quantity of each gear Se, machining width B, the number of tools' gears Z, and tools' diameter, etc. So it is very difficult to calculate accurately. In real production, in order to calculate the tangential machining force Pt quickly and conveniently, the approximate calculation can be done according to the following formula:

$P_t = p \cdot F_T = p \cdot (B \cdot t \cdot S_e \cdot Z)/D$

In the formula: $S_e= f/ (n \cdot z)$

Therein: f is the tools' advancing speed, mm/min; n is the rotating speed r·p·m

Reckon other machining forces on grounds of the fraction of each component of machining force. While machining, after the tangential machining force is determined. The relation among the tangential force and its components while machining straignward is:

$P_l = 0.9 \cdot Pt$

$P_v = 0.8 \cdot Pt$

$P_{tr} = 0.5 \cdot Pt$

P_l :longitudinal direction milling component of forces

P_v :vertical direction milling component of forces

P_{tr} :transverse direction milling component of forces

According to the above table, we can educe:

$P_R = (P_l^2 + P_{tr}^2) 1/2 = - P_r$

$P_{径} = (P_r^2 - P_t^2) 1/2$

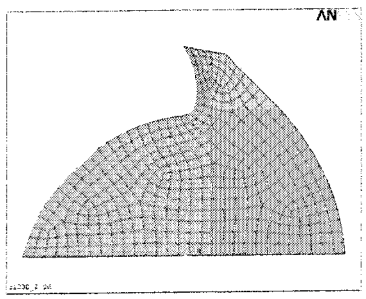
$P_{轴} = - P_v$

On grounds of these three formulas together with the relation among P_t and its components, the radial and in-line component of machining force can be calculated.

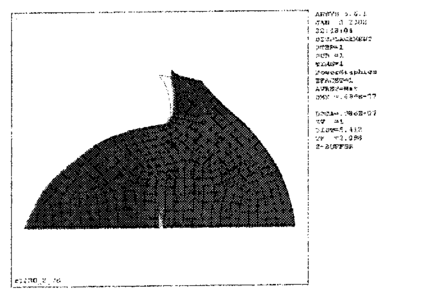
As to the two-dimensional finite element analysis, exert tangential loading and radial loading can be only exerted on the machining blade's outer most port.

4. Restrain

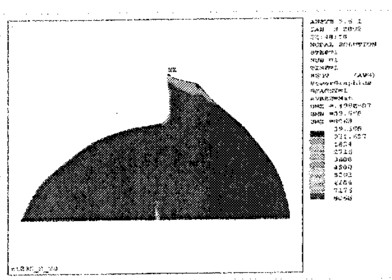
Exerted fixed end restraint on the connection place of machining parts and the shaft. Confine the degree of freedom from its six directions. The two dimensional deformation graph, stress graph and vector diagram of the end milling cutter that is exerted loading can be obtained after the ANSYS calculation and analysis. These graphs are described in Fig 4.2.



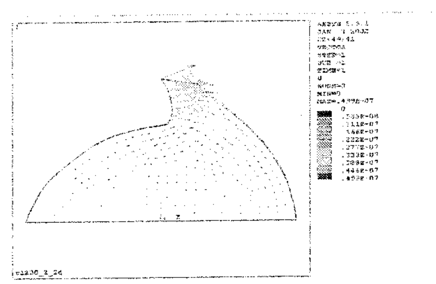
(a) grid chart



(b)deformation graph



(c) stress graph

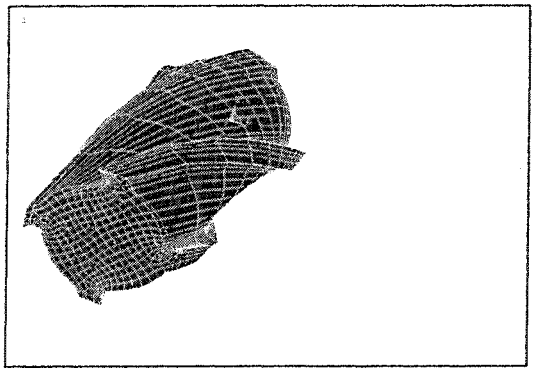


(d)vector diagram

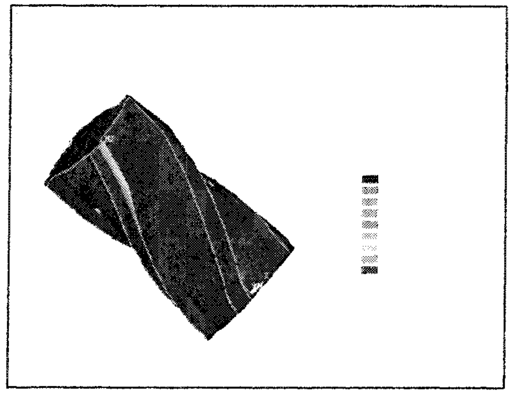
Fig 4.2 Two dimensional finite element analysis

4.2 Three Dimensional Finite Element analysis

It has the same methods and steps as the two dimensional finite element analysis. The difference is that it exerts loadings from three directions on the machining blade's outer most end, tangential loading, radial loading and the in-line loading. The analysis results of the four-gear end milling cutter is described in Fig 4.3.



(a) deformation graph



(b) stress graph

Fig 4.3 Three dimensional finite element analysis

4.3 Calculating results analysis

Select four groups of parameters shown by table 1 to analyze. Elastic modulus: E=2.07E+9N/mm2, u=0.3, when calculating load, HB = 280,Z = 2 , D = 16mm , t = 8mm , B = 16mm , f = 150mm/min , n = 750r.p.m。

Table 1 Four groups of parameters of the end milling cutter

Sequence number	Edges z	diameter Did (mm)	Core d (Mm)	helix angleβ (mm)	Length l (mm)	Length of cutting edge l1 (mm)
1	2	10	6.5	30	70	30
2	2	12	7.8	30	75	35
3	2	14	9.1	30	85	40
4	2	16	10.6	30	90	47.5

From the deformation graph and stress graph, we can determine that the maximum deformation occurs at the master machining blade's outer most end. If other parameters are the same, the bigger milling cutter's diameter is, the bigger the stiffness will be. Take the two-gear end milling cutter with diameter = 16mm as an example, we keep the other parameters constant except for the size of helical angle, and do the calculation and analysis in ANSYS. The change curve of the two-gear end milling cutter is shown in Fig 4.4. From this figure, we see that if the geometric parameters are different, the quantity of deformation and the values of stiffness are also different. The stress reduces with the increase of the helical angle. Using this method, we can optimize the tools' geometric parameters, which could make the deformation smallest and stiffness biggest, thus promote the machining ability.

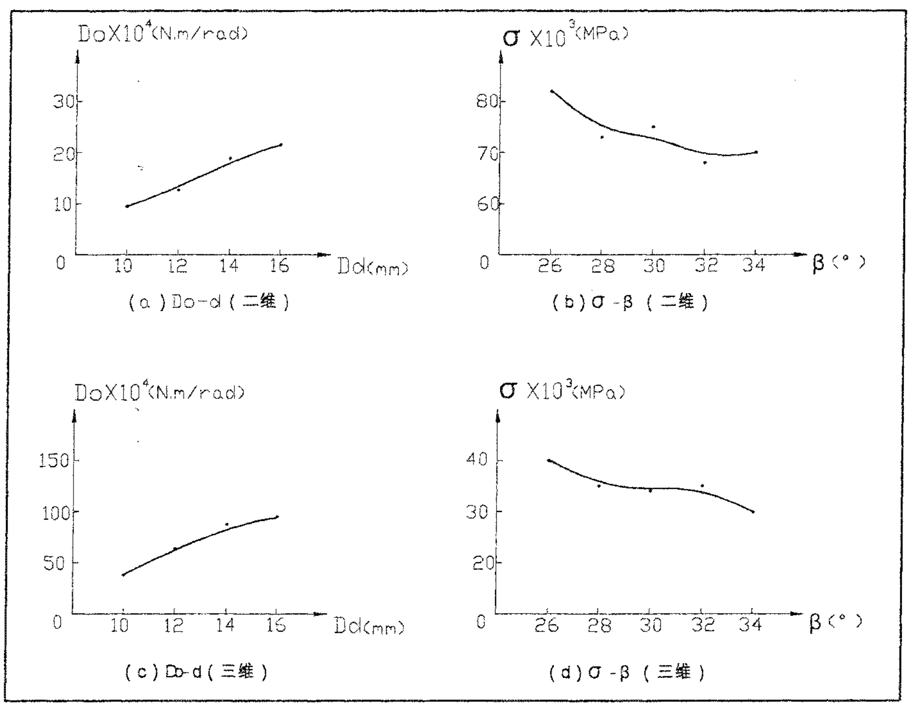


Fig 4.4 The change curve of two-gear end milling cutter

CHAPTER 5

CAM

5.1 Subsystem of the process design

The main function of the process design subsystem is to complete the process design of the accessories, including the choosing and collation of manufacturing methods, alignment of workpieces, calculating the size and procedure margin, choosing the machine tools, the reamer and the frock etc. and finally the process card comes into being in the form of a report. The spares' process information is provided by the characteristic database. Process information can also be inputted by means of a man-machine interaction. This system has a good man-machine interaction interface. It can be used as a sub-model in non-standard tools' integrated system. It can also work independently and complete the process design flow. The system's general structure is shown in Fig 5.1. The system is composed of process design model, process modification model and output model, etc.

Process design model completes the process design. Its process information comes from the characteristic database. By calling relative knowledge and data from process knowledge base and process database, it completes the process design. [6]

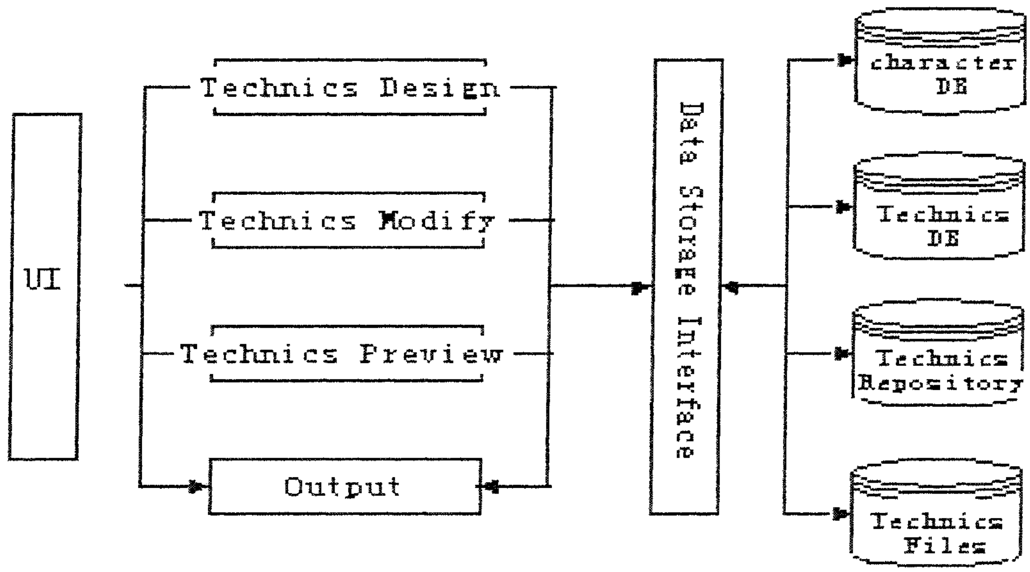


Fig 5.1 The collective structure of technique design subsystem

The design results are saved in the process file base in certain form for user's beforehand skimming and outputting the information. Process modification model can modify the current design. It can take such compiling operations as modifying, adding and deleting, and so on. The modification results are saved in the process file base automatically. Fig 5.2 shows the process flow card manufactured

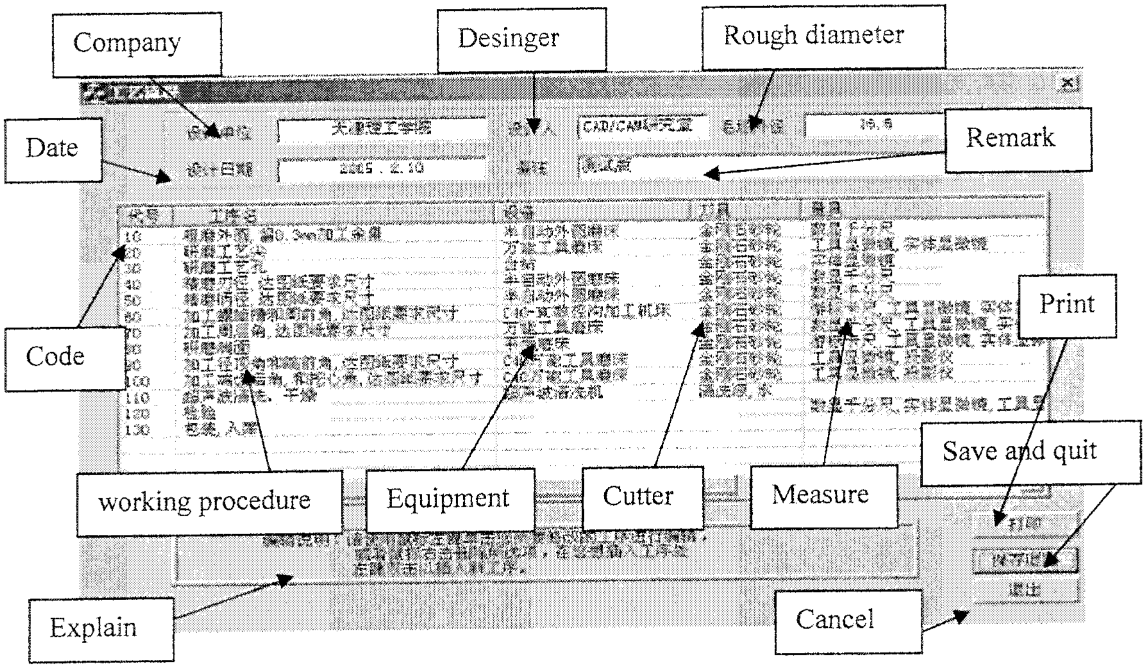


Fig 5.2 The process flow card

5.2 CAM subsystem

In the NC grinding process of ending milling cutter's helical groove, we need to grind furrow 1/2/3 in the ending milling cutter's helical groove. Furrow 1/2/3 take their shapes by the emery wheel's different truncated shapes. Moving tracks of the NC grinder used to grind furrow 1/2/3 are the same. Directed at this feature, our task group use Macro programming to realize the ending milling cutter's helical groove's NC program .

Log the function composed of a series of orders in the memory like a sub-process, then take these functions as one order and make it a representative. We only need to write this representative order to implement its function. The series of orders logged in can be called Custom Macro Body (Custom Macro Program) or Custom Macro for short. This representative order is called Custom Macro Command (Macro Call Command). Custom Macro's functions include condition judgment, shift instruction, reading of the tools' compensating amount, operation instruction, circulation instruction, etc. All these can compress the programming amount and simplify the programming. This model's parameters input interface is shown by Fig 5.3.

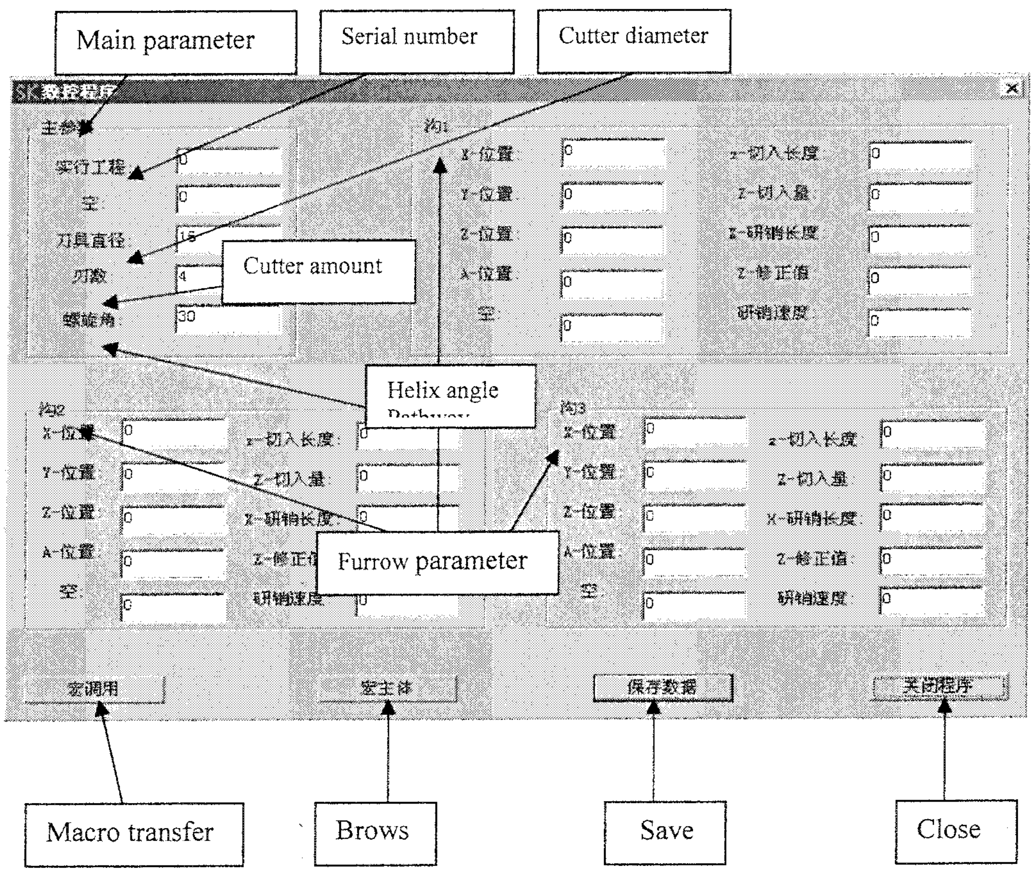


Fig 5.3 The parameters input interface of NC manufacture

The Custom Macro has some characteristics:

◆variables can be used in the Custom Macro Body

◆mathematical calculations can be performed among variables

◆The user can assign variables by using the Custom Macro Command

While using Custom Macro, we can use a variable to replace specific numbers for convenience. Therefore while doing NC programming to the same type of moving tracks, we only need to set the actual values in variables. Thus it is unnecessary to do NC programming to each moving track. The NC program of the end milling cutter's helical groove compiled by Macro Program can realize the NC manufacture of the tools with different helical angles, diameters, blade numbers and blade length.

5.3 Dynamic simulation of the process

Using three-dimensional cartoon to simulate dynamically the process flow of tools' manufacturing, provides the user with an intuitional knowledge while analyzing and formulating the process. This module uses 3D MAX software to complete the cartoon making; integrate the cartoons through PowerPoint according to process design flow and link in the master control program in the end. Thus integration of the whole system is realized.

CHAPTER 6

CONCLUSION REMARKS

This project takes non-standard over stiff end milling cutters as the research objects; uses the feature based model constructing technology and applies the CAD and finite element analysis together with relative theories and technologies on processing and manufacturing. According to design needs, taking consideration of many factors into account, the project completes the development of non-standard complicated tools' CAD \CAE \ CAM integrated system.

Main technological features of this project are as follows:

1. By using the feature-based model constructing technology, we realize the development of non-standard tools' CAD\CAE\CAM integrated system facing the products data, and provides a manufacturer with a scheme to implement CAD \ CAE \ CAM.

2. Construct the frame of CAD—CAE—CAPP—CAM together with the product simulation analysis. Build up the uniform product definition model which sustains the whole process of non-standard complicated tools' design—analysis—manufacturing.

3. Realize the development environment of diverse support platforms, and the software integration of application program and database.

4. In the tools' management, as to the standard tools and UDF tools, the user can implement such operations as addition and emendation of the data as well as modification, etc. Because of user's different demands, methods of various data search are provided.

5. In the design of non-standard end milling cutter's truncated shape, through simulating the process, we can seek out the milling cutter's truncated shape reversely by way of the emery wheel's profile, thus providing an accurate design model for the after CAE subsystem.

6. In the tools' design, we summarize the two-dimensional parameter design technology and feature based three-dimensional model constructing technology, thus complete the design of CAD subsystem and shorten the products' design period and improve the quality of design.

7. Using the finite element analysis to optimize the truncated shape parameters of the milling cutter.

8. Combining the NC machine tools owned by the enterprise at present, the system produces the NC macro program of the helical groove's manufacturing automatically. Thus complete the dynamic simulation of the process.

The accomplishment of this project improves the design method of non-standard tools greatly; shortens the period of tools' design and manufacturing, and responds to the market more rapidly. It can brings obvious social benefits and economic benefits to the enterprise. The correlative technologies of this project can be applied in the design, analysis and manufacturing of over stiff end milling cutters. It has very strong acceptability values and extensive application prospects.

Based on the achievement of the thesis, we proposed that the further research conceives as follows:

1. Complete the CAD subsystem, causes it to satisfy each kind design of non-standard cutting tool.

2. Construction the non-standard integrative system based on product data management (PDM) platform.

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APPENDIX

```
// mydlg2.cpp : implementation file

#include "stdafx.h"

#include "FbdjParSsl.h"

#include "mydlg2.h"

#include "myset.h"

#include "dlghelp.h"


#ifdef _DEBUG

#define new DEBUG_NEW

#undef THIS_FILE

static char THIS_FILE[] = __FILE__;

#endif


// Cmydlg2 dialog

Cmydlg2::Cmydlg2(CWnd* pParent /*=NULL*/)

 : CDialog(Cmydlg2::IDD, pParent)

{

 //{{AFX_DATA_INIT(Cmydlg2)

 m_B = _T("");
```

```
 m_DA = _T("");
 m_DB = _T("");
 m_Q = _T("");
 m_L = _T("");
 m_L1 = _T("");
 m_Z = _T("");
 m_cz = _T("");
 //}}AFX_DATA_INIT
//       m_cdxh=_T("");
}

void Cmydlg2::DoDataExchange(CDataExchange* pDX)
{
 CDialog::DoDataExchange(pDX);
 //{{AFX_DATA_MAP(Cmydlg2)
 DDX_Control(pDX, IDC_LIST1, m_listbox1);
 DDX_Control(pDX, IDC_LIST2, m_listbox2);
 DDX_Control(pDX, IDC_LIST3, m_listbox3);
 DDX_Text(pDX, IDC_B, m_B);
 DDX_Text(pDX, IDC_DA, m_DA);
 DDX_Text(pDX, IDC_DB, m_DB);
 DDX_Text(pDX, IDC_Q, m_Q);
```

```
DDX_Text(pDX, IDC_L, m_L);
DDX_Text(pDX, IDC_L1, m_L1);
DDX_Text(pDX, IDC_Z, m_Z);
DDX_Text(pDX, IDC_cz, m_cz);
//}}AFX_DATA_MAP
}

BEGIN_MESSAGE_MAP(Cmydlg2, CDialog)
//{{AFX_MSG_MAP(Cmydlg2)
ON_LBN_SELCHANGE(IDC_LIST1, OnSelchangeList1Material)
ON_LBN_SELCHANGE(IDC_LIST2, OnSelchangeList2XingHao)
ON_LBN_SELCHANGE(IDC_LIST3, OnSelchangeList3CanShu)
ON_BN_CLICKED(IDOK, OnCanShu)
ON_BN_CLICKED(IDC_BUTTONhelp, OnBUTTONhelp)
//}}AFX_MSG_MAP
END_MESSAGE_MAP()

// Cmydlg2 message handlers
BOOL Cmydlg2::OnInitDialog()
{
CDialog::OnInitDialog();
m_listbox1.ResetContent ();
```

```
m_listbox1;
 m_listbox1.AddString ("7.天然金刚石");
 m_listbox1.AddString ("6.AL2O3 陶瓷");
 m_listbox1.AddString ("5.CBN刀具");
 m_listbox1.AddString ("4.金属陶瓷");
 m_listbox1.AddString ("3.非铁铸造合金");
 m_listbox1.AddString ("2.高速度钢");
 m_listbox1.AddString ("1.硬质合金");

 return TRUE;  // return TRUE unless you set the focus to a control
           // EXCEPTION: OCX Property Pages should return FALSE
}

void Cmydlg2::OnSelchangeList1Material()
{
 UpdateData(TRUE);
 int nIndex=m_listbox1.GetCurSel ();
 CString m_str;
```

```
m_listbox1.GetText (nIndex,m_str);
if(m_str.Compare ("1.硬质合金")==0)
{
m_listbox2.ResetContent ();
m_listbox2.AddString ("SEG4...SA");
m_listbox2.AddString ("SEG4...S");
m_listbox2.AddString ("SEE4...LL");
m_listbox2.AddString ("SEE4...L");
m_listbox2.AddString ("SEE4...S");
m_listbox2.AddString ("SEE4...SG");
m_listbox2.AddString ("SED4...S");
m_listbox2.AddString ("SED4...SEG");
m_listbox2.AddString ("SEG2...SA");
m_listbox2.AddString ("SEG2...S");
m_listbox2.AddString ("SEE2...LL");
m_listbox2.AddString ("SED2...L");
m_listbox2.AddString ("SED2...SS");
m_listbox2.AddString ("SEE2...S");
m_listbox2.AddString ("SEE2...SA");
m_listbox2.AddString ("SEE2...SG");
m_listbox2.AddString ("SED2...SE");
m_listbox2.AddString ("SED2...S");
```

```
m_listbox2.AddString ("SED2...KMG");
m_listbox2.AddString ("SED2...KPG");
m_listbox2.AddString ("SED2...SEG");
m_listbox2.AddString ("SED2...SG");
}
else
{
        m_listbox2.ResetContent ();
        m_listbox3.ResetContent ();
        m_Z.Empty ();
        m_DA.Empty ();
        m_DB.Empty ();
        m_L.Empty ();
        m_L1.Empty ();
        m_Q.Empty ();
        m_B.Empty ();
        m_cz.Empty ();
        UpdateData(FALSE);

        MessageBox("本数据库暂时只有硬质合金材料的刀具.","确定");
}
```

```
}

void Cmydlg2::OnSelchangeList2XingHao()
{
 UpdateData(TRUE);
 {
        m_Z.Empty ();
        m_DA.Empty ();
        m_DB.Empty ();
        m_L.Empty ();
        m_L1.Empty ();
        m_Q.Empty ();
        m_B.Empty ();
        m_cz.Empty ();
        UpdateData(FALSE);
}
CString m_str;
int nIndex=m_listbox2.GetCurSel ();
m_listbox2.GetText (nIndex,m_str);
Cmyset* myset=new Cmyset;
if(myset->IsOpen ())
{
```

```
        myset->Close ();
    }
    myset->Open ();
    myset->MoveFirst ();

    m_listbox3.ResetContent ();
    while(!myset->IsEOF ())
    {
        if(m_str.Compare (myset->m_XH )==0)
        {
            m_listbox3.AddString (myset->m_XingHao );
        }
        myset->MoveNext ();
    }
    if(myset->IsOpen ())
    {
        myset->Close ();
    }
    delete myset;

}
```

```
void Cmydlg2::OnSelchangeList3CanShu()
{
 UpdateData(TRUE);
 CString m_str;
 int nIndex=m_listbox3.GetCurSel ();
 m_listbox3.GetText (nIndex,m_str);
 m_cdxh=m_str;
 Cmyset* myset=new Cmyset;
 if(myset->IsOpen ())
 {
        myset->Close ();
 }
myset->Open ();
myset->MoveFirst ();
while(!myset->IsEOF ())
{
   if(m_str.Compare (myset->m_XingHao  )==0)
      {
            m_Z.Format(myset->m_chishu );
            m_DA.Format(myset->m_DA );
            m_DB.Format(myset->m_DB );
            m_L.Format(myset->m_L );
```

```
                m_L1.Format(myset->m_L1 );
                m_Q.Format(myset->m_a );
                m_B.Format(myset->m_b );
                m_cz.Format("硬质合金");
                UpdateData(FALSE);
             myset->Close ();
                break;

          }
          myset->MoveNext ();
     }
     if(myset->IsOpen ())
     {
          myset->Close ();
     }
     delete myset;
}

void Cmydlg2::OnCanShu()
{

 if(!m_DB.IsEmpty() )
```

```
{
  char* pFileName1 = "D:\\NSEMIS\\workspace\\MDT\\DJDBF.txt";
  TRY
 {
    CFile::Remove( pFileName1 );
 }
  CATCH( CFileException, e )
 {
  #ifdef _DEBUG
     afxDump << "File " << pFileName1 << " cannot be removed\n";
  #endif
 }
  END_CATCH
  char* pFileName2 = "D:\\NSEMIS\\workspace\\MAIN\\DJDBFBACK.txt";
  TRY
 {
    CFile::Remove( pFileName2 );
 }
  CATCH( CFileException, e )
 {
  #ifdef _DEBUG
     afxDump << "File " << pFileName2 << " cannot be removed\n";
```

```
 #endif
}
 END_CATCH          if(m_DA.Left(1)==".")
      {
          m_DA="0"+m_DA;
      }
      if(m_DB.Left(1)==".")
      {
          m_DB="0"+m_DB;
      }
      if(m_L.Left(1)==".")
      {
          m_L="0"+m_L;
      }
      if(m_L1.Left(1)==".")
      {
          m_L1="0"+m_L1;
      }
CString m_str;
CString m_strcz;
 m_strcz=_T("硬质合金");
m_str.Format    ("%s    %s    %s    %s    %s    %s    %s    %s    %s
```

```
",m_cdxh,m_DA,m_L1,m_L,m_DB,m_Q,m_B,m_Z,m_strcz);
	SetCurrentDirectory("D:\\NSEMIS\\workspace\\MDT");
	CFile file;
	file.Open("D:\\NSEMIS\\workspace\\MDT\\DJDBF.txt",	CFile::modeCreate	|
CFile::modeReadWrite);
	file.Write (m_str,m_str.GetLength ());
	file.Close ();
	SetCurrentDirectory("D:\\NSEMIS\\workspace\\MAIN");
	file.Open("D:\\NSEMIS\\workspace\\MAIN\\DJDBFBACK.txt",	CFile::modeCreate
| CFile::modeReadWrite);
	file.Write (m_str,m_str.GetLength ());
	file.Close ();

	CString s1,s2,s3,s4;
	CString n1,n2,n3;
	int n,m;
	n=m_cdxh.GetLength ();
	m=n-7;
	s1=m_cdxh.Left(3);
	s2=s1.Right(1);
	s1=s1.Left(2);
	switch(m)
```

```
{
case 1:
        {
                s3=m_cdxh.Right(1);
                s4="";
        }
        break;
case 2:
        {
                s4=m_cdxh.Right(1);
                if(s4="G")
                {
                        s3=m_cdxh.Right(2);
                        s3=s3.Left(1);
                }
                else
                {
                        s3=m_cdxh.Right(2);
                }
        }
case 3:
        {
```

```
                    s4=m_cdxh.Right(1);
                    if(s4="G")
                    {
                        s3=m_cdxh.Right(3);
                        s4=s3.Right(1);
                        s3=m_cdxh.Left(2);
                    }
                }
            }
            m_str.Format ("%s,%s,%s,%s,%s,%s,",s1,s2,m_Z,m_DB,s3,s4);
            file.Open("D:\\NSEMIS\\workspace\\CAPP\\character.txt",    CFile::modeCreate    |
    CFile::modeReadWrite);      //
            file.Write (m_str,m_str.GetLength ());
            file.Close ();
            /////////////////////////////////////////////////////////
            //给截型三个参数
            /////////////////////////////////////////////////////////
            FILE*str11;
            str11=fopen("D:\\NSEMIS\\workspace\\CAD\\jiexing.txt","w");
            fprintf(str11,"%s %s %s\n",m_DA,m_Q,m_Z);
            fclose(str11);
            str11=fopen("D:\\NSEMIS\\workspace\\CAD\\jiexing.txt","a+");
```

```
fprintf(str11,"%s","999");
fclose(str11);
//////////////////////////////////////////////////////

//////////////////////////////////////////////////////
//给MDT相关的刀具信息
//////////////////////////////////////////////////////
 if(s1=="SE")
{
      s1="直角型,";
}
 else if(s1=="BE")
{
      s1="球形,";
}
 else if(s1=="TE")
{
      s1="锥形,";
}
 else if(s1=="SPF")
```

```
{
      s1="难切削材料用,";
}
 else if(s1=="GS")
{
      s1="石墨直角形,";
}
 else if(s1=="CE")
{
      s1="石墨球形,";
}
      else
      {
            s1="";
      }
////////////////////////////////////////////////////////////
 if(s2=="D")
{
      s2="30度螺旋角,";
}
```

```
 else if(s2=="E")
{
      s2="45度螺旋角,";
}
 else if(s2=="F")
{
      s2="60度螺旋角,";
}
 else if(s2=="G")
{
      s2="不等螺旋角,";
}
 else if(s2=="H")
{
      s2="不规则螺旋角,";
}
      else
      {
            s2="";
      }
```

```
/////////////////////////////////////////////////////
  if(s3=="S")
 {
       s3="标准有平坦,";

 }
  else if(s3=="SE")
 {
       s3="标准尖角型,";

 }
  else if(s3=="SS")
 {
       s3="短刃型,";

 }
  else if(s3=="M")
 {
       s3="半加工型,";

 }
  else if(s3=="L")
 {
       s3="加长型,";
```

```
}
else if(s3=="LE")
{
    s3="标准尖角加长型,";
}
else if(s3=="LL")
{
    s3="超长型,";
}
else if(s3=="SH")
{
    s3="高硬度钢型,";
}
else if(s3=="SF")
{
    s3="内冷却型,";
}
else if(s3=="SA")
{
    s3="铝加工用,";
```

```
}
 else if(s3=="KP")
{
      s3="键槽 + 公查,";

}
 else if(s3=="KM")
{
      s3="键槽 - 公查,";

}
 else if(s3=="SR")
{
      s3="粗加工外周波纹,";

}
 else if(s3=="SM")
{
      s3="端齿强化型,";

}     else
      {
            s3="";
      }
```

```
//////////////////////////////////////////
  if(s4=="G")
 {
        s4="AP涂层.";
 }
  else
 {
        s4="不加涂层.";
 }
//////////////////////////////////////

 m_str.Format
("用户所选的刀具具有以下信息或特征:\n材料为硬质合金,%s%s%s%s\n$",s1,s2,s3,s4)
;
 SetCurrentDirectory("D:\\NSEMIS\\workspace\\MDT");
 file.Open("D:\\NSEMIS\\workspace\\MDT\\help.txt",     CFile::modeCreate     |
CFile::modeReadWrite);     //
 file.Write (m_str,m_str.GetLength ());
 file.Close ();
//////////////////////////////////////////
```

```
//给数控加工写文本
////////////////////////////////////////
FILE*str1;
str1=fopen("D:\\NSEMIS\\File\\capp\\sk\\Release\\nc.txt","w");
fprintf(str1,"%s %s %s\n",m_DB,m_Z,m_Q);
fclose(str1);
////////////////////////////////////////
//      MessageBox("参数已经保存","确定");
CDialog::OnOK();
}
else
{
      MessageBox("请选择刀具型号","提示");
}
}

void Cmydlg2::OnBUTTONhelp()
{
 Cdlghelp dlghelp;
 dlghelp.DoModal();
}
```