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Proposal Model for Programming Numerical Control Lathe Basis on the Concept by Features

N.Ben Yahia[1], Woo-Young Lee[2], and B. Hadj Sassi[1]

[1] CENAFFIF : 6 Rue de France Radès Mongil Tunis, Tunisia
[2] Dept of Mechanical Engineering; Korea Univ. of Technology & Education, Chonan, South Korea

ABSTRACT

The aim of the present work is to propose a model for Computer Aided programming of Numerical Control lathe. This model is based on the concept by features. It has been developed in an Artificial Intelligence environment, that offers a rapidity as well as a precision for NC code elaboration.

In this study a pre-processor has been elaborated to study the geometry of turning workpiece. This pre-processor is a hybrid system which combine a module of design by features and a module of features recognition for a piece provided from an other CAD software.

Then, we have conceived a processor that is the heart of the CAD/CAM software. The main functions are to study the fixture of the workpiece, to choose automatically manufacturing cycles, to choose automatically cutting tools (the most relevant), to simulate tool path of manufacturing and calculate cutting conditions, end to elaborate a typical manufacturing process.

Finally, the system generates the NC program from information delivered by the processor

Keywords: Numerical lathe programming - Artificial intelligence C.A.D - C.A.M - C.A.P.P.

1. Introduction

The machining process of mechanical piece passes by different stages; survey, preparation and manufacture. In a goal of producing, each one of these stages orientates itself toward techniques of the CAD for the survey, the CAM for the preparation of machining and the Numeric Control for manufacturing.

The integration of this system is based on the geometric modelling techniques by features and/or (feature recognition) [7].

Our preoccupation in this domain is to propose a model of programming which help manufacturing for numerical control lathe.

In this research our model is shared in two aspects:

• Geometric Aspect : it concerns the representation of a revolution piece in the graphic screen of the AutoCAD, then a recognition of shapes translated by a standard format DXF. This part constitutes the pre-processor of the system.

•Technological Aspect : being given material to manufacture and the machine tool, the system first proposes the type of installation, then it analyses the volume to remove from the piece while using the data base of cutting tools and while calculating conditions of machining (cutting speed , feed rate, depth of passes, type of lubricant, time of machining, etc.).

Finally the system creates the NC code automatically for the interface with the machine, which can be possibly modified by the user.

2. General preview on the automated process

The conception of the process is the main activity of manufacturing industry, from which is driven all approaches of management of the mechanical manufacture. However, it has been twenty years, with the advent of the computer, that one started works aiming to clear methodologies of process development, to automate this activity.

The first conceived systems had the object to help the human planner to gain time of his work of preparation to manufacture. It's developed more lately than the automation of the production process, from the conception to the manufacture, while limiting to the maximum of the human intervening. Actually in this domain, researches are shared in four approaches: the variant approach, the GT (Group technology) approach, the academic generative approach and the generative approach valuation. [1], [15], [18].

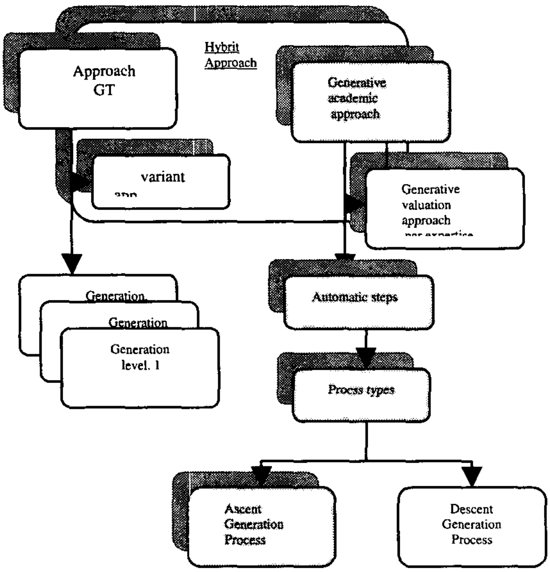


Fig. 1 Generation of process planning concepts

The GT approach is based on the research of analogy between different pieces to regroup them in families. Then, we associate these families to a process plan type or standard process. Currently several systems are worked and using this approach [8],[12],[13].

In the generative approach the basis of hypothesis consists in using knowledge on available resource possibilities and on rules in order to generate a new specific process [16]. By this approach researches are oriented toward methodologies of Artificial Intelligence (AI) that seems to be most promising.

The first systems using this technique only appear to the beginning of 1980 under the Expert System appellation (ES). The first known system is GARI which create by [4], after that PROPEL [17] that has been developed by the INPG of Grenoble (France). Then,

GAGMAT has been developed for GIAT (Industrial Group of the armed Earth). The programming language of AI of these systems is the LISP [6].

Among systems that use the AI for process planning machining mention:

•XPLAN is a system of decision generation tree while combining rules of production.

•KAPLAN is based on the geometric modelling of EUCLID (CAD/CAM software) that permits to solve several types of process for revolution shapes while using the fashion of feature recognition.

Several other systems use this approaches:

APPAS, AUTAP, CPP, TOM, KRONOS, XCUTT, HutCAPP, XPS-E, AMP, POP, MATECH, IPDES,... have been analysed by [9][19].

Otherwise, this generative approach can be adopted in order to develop our following system an Ascending Generation beginning from the profile finished toward the rough

3. Global structure of proposal model

An original model has been developed to contribute to the automatic development of process planning which based on the concept of features. This system has been created for the full or hollow cylindrical piece machining. it has been validated for a lathe equipped by num 760 controller that work with cylindrical rail.

This model includes four modules, from the active representation of the piece until the development of the program for NC code.

The first module is a mixed geometric modelling that permits to represent a revolution piece or to read a drawing coming from another CAD software.

The second module is a survey system of piece fixture for measurements, geometric and dimensional tolerances, as well as of the couple fixture piece/tool rigidity.

The third module concerns the graphic simulation of machining and the calculs of cutting conditions serving to the determination of machining parameters.

The fourth module is the post processor of the system to create the interface program to the NC machine.

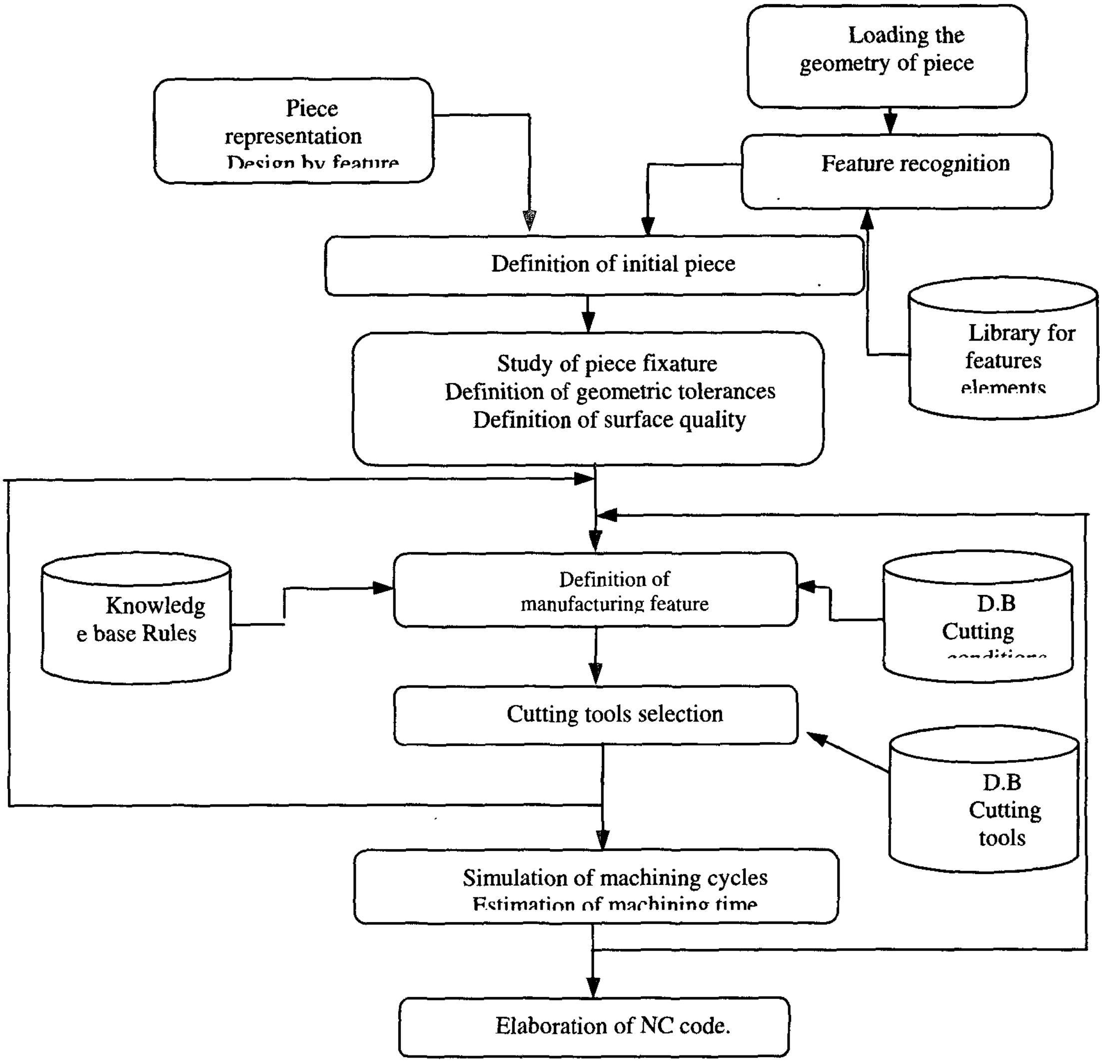


Fig. 2 Model Structure

4. Profile modeling with design by feature

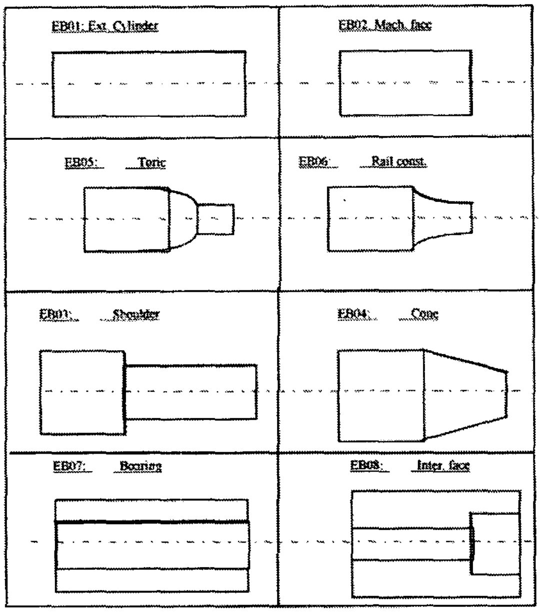
4.1 Simulation

The theme feature and its role in the conception of a product in machining process planning and other activities to generate, represent are very interesting topics of research in last years. Among systems of range generation based on features, we mention [2], [3], [5], [12].

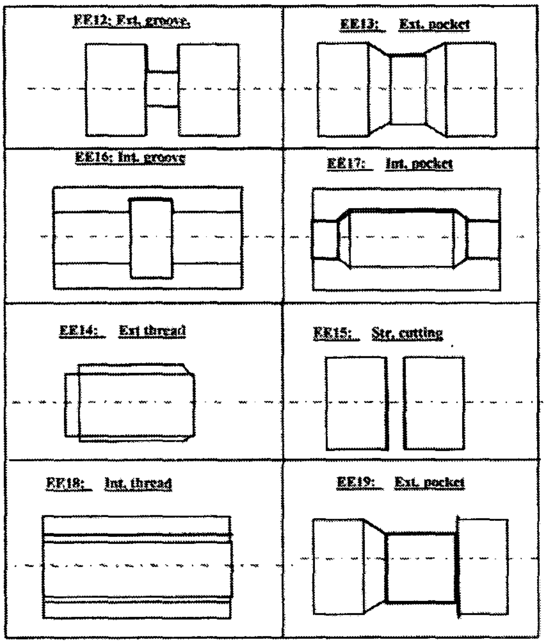
The present system of modelization by features is based on a mixed approach: the first concerns the construction of the piece with design by features, the second is created for the feature recognition of piece shape coming from an other CAD systems

4.2 Design by feature

The database for conception by features is constituted by basis elements; as the segment, the circle and arc with (anti) trigonometric sense (Picture 1) and elements evolved that constitute cycles of thread, boring, etc. (Picture 2).



Picture 1. Basic features for piece



Picture 2. Evolved features for piece

4.3 Feature recognition

The proposed system for feature recognition has its own method for the analysis of the different elements of the piece.

This system possesses a database of 16 geometric elements of entities that serves to extract the shape of machining (Figure 2).

N°	Feature element	Profile geometric description	Rules for feature recognition
1	Pt1 Pt2	Pt1, Pt2, Li	X1<X2, Y1=Y2
2	Pt2 Pt1	Pt1, Pt2, Li	X1 >X2, Y1= Y2
3	Pt2 Pt1	Pt1, Pt2, Li, ai	X1 <X2, Y1< Y2, ai<0
7	Pt2 Pt1	Pt1, Pt2, Li	X1 =X2, Y1 <Y2
8	Pt1 Pt2	Pt1, Pt2, Li	X1 =X2, Y1 >Y2
10	Pt1 Pt2 Pc	Pt1, Pt2, Pc sens (+)	X1 >X2, Y1 >Y2 Xc= X2, Yc = Y1
11	Pt1 Pc Pt2	Pt1, Pt2, Pc sens (+)	X1 <X2, Y1 >Y2 Xc= X2, Yc = Y1
16	Pc Pt1 Pt2	Pt1, Pt2, Pc sens (-)	X1 >X2, Y1 >Y2 Xc= X2, Yc = Y1

Fig. 3 Basic geometric elements

Stages of feature recognition are:

1 - sweep the graphic screen of CAD system from down to the top, then from right to the left.

2 - classification of feature elements according to their morphology (segment, Arc of (+) sense and Arc of (-) sense.

3 - position of the element with regard to material (for same one horizontal elements, the system is capable to distinguish between external or internal machining).

4 - verification of the piece topology before manufacturing. For this part the system is capable to declare the no closing of the contour or the no valid

intersection of elements.

Therefore we propose a generic example for the feature recognition that leans on rules of type: IF, THEN, IFNOT:

Being given : Pi (Xi, Yi); Pi+1 (Xi+1, Yi+1);...

Lj (Pi, Pi+1) Lj (Pi+1, Pi+2);...

IF (Lj, Lj+1, Lj+2) are successive three elements

THEN:

IF Yi=Yi+3 and Yi+2 = Yi+1

IF Xi=Xi+1 and Xi+2=Xi+3

THEN the entity is a groove

IFNOT Xi>=Xi+1 and Xi+3=Xi+2

THEN the entity is a pocket

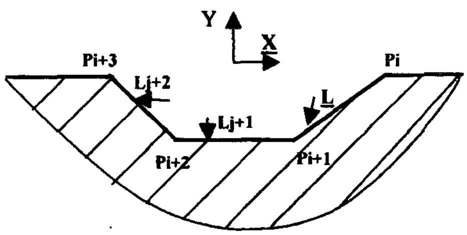
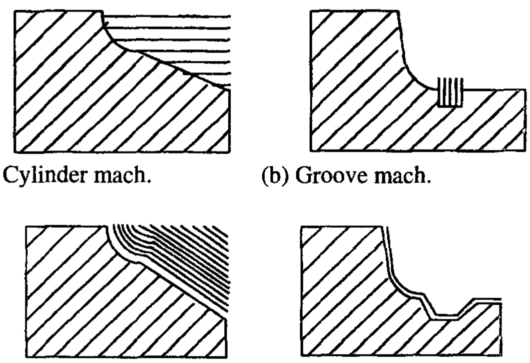


Fig. 4 Pocket geometric element

The result of this recognition of shapes will be the display of the detail of machining feature that facilitates the choice of machining cycles.



(a) Cylinder mach. (b) Groove mach.

(c) Following cycle. (d) Finish cycle.

Fig. 5 Simulation of toolpath

5. Creation of machining cycles from feature

To execute turning operations we must pilot the tool by the straight or circular movements in the median plan that passes by the axis of revolution for the piece. It is merely a work in 2D that pose only few graphic simulation problems.

Being given the profile of the initial piece and the profile finished, the system calculates the number of pass then, it looks for passage points of the tool while integrating clearings for operations of machining.

From the precedent choice of machining cycles, the system identify necessary tools from the data base

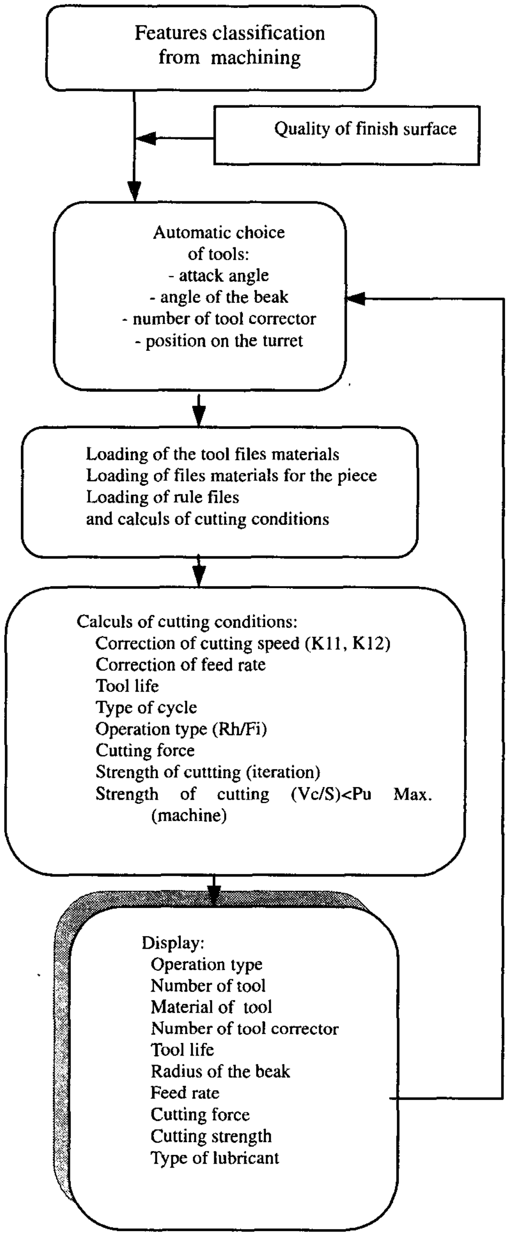


Fig. 6 Model of cutting conditions

6. Choice of cutting tools

The automatic choice of the cutting tool consists in defining the dimensional and technological characteristic of machining cycle that is already defined by the concept of feature.

The choice of tool essentially leans on the:

type of cycle (groove, pocket,...).

existence of a cycle precedes that uses the same tool,

type of operation (rough/finish)

quality of surface

angle limits direction of bone

angle limits complementary direction of bone,

radius maximum of the nose

limit depth of passes

From these parameters the system chooses the applicable tool of the database.

7. Calculs of cutting conditions

The choice of cutting conditions remained a very important problem for operations of machining. In the setting of this survey this problem has been solved while limiting itself to the utilization of values optimised that comes from tool manufacturers as SANDVIK or HERTEL for tools in carbide and the CETIM for tools in ARS [14].

8. Conclusion

The ambition of our work was to propose a model of help to the programming of numerical control lathe based on the concept by features. These features are created in an Artificial Intelligent environment in AutoCAD by its programming language AutoLISP.

In this survey we had fixed a first objective concerning the realisation of a module first permitting to draw the profile of a cylindrical piece, or to recognize features of a piece coming from another CAD/CAM systems.

The second objective is the development of a processor for the present system that established the technological part (database of material to manufacture and database of cutting tools, survy of fixture, of piece, calculus of cutting conditions, etc.).

The third objective is to propose a process planning of machining endowed of a simulation of toolpath in the graphic screen.

The last objective is to create a post processor that writes automatically file for NC code.

These objectives are reached following the real cases of machining of revolution pieces.

For the integration of the present system in manufacturing enterprises, we suggest to improve them by:

· An integration of a practiced system for the automatic generation of machining process and orient the topic toward techniques of CAPP (to Computer Aided Process Planning).

· An enrichment of databases materials and cutting tools by other families that answer to needs of manufacturing enterprises better.

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