Macro Planning In an Automated Modular Process Planning System for Rotational Part

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Abstract

Macro-planning involves decisions of selection of stock size, operation selection, cutting tool selection, and cutting parameters selection. The efficiency of the process plan as a whole depends on these decisions.

In this paper AMPPS is a special GPP, which generates process plan directly from an engineering design model (CAD). The major difference between proposed approach and other approaches is the use of automated CAD interface capability. Based on the characteristics of a given part, the program automatically generates the manufacturing operation sequence.

Keywords: Macro planning, Automated modular process planning, Generative process planning, Computer aided design,

1. Introduction

This paper is an attempt to provide a solution for CAD-CAM integration, in the form of automated modular process planning (AMPPS) having no human intervention. The different feature based stages that are being considered in the present work are selection of stock size, selection of operation, selection of cutting tools, determination of machining parameters, sequencing of operations, report generation. The procedure developed for proposed AMPPS for cylindrical components is presented in this paper.

2. Macro planning System

A modular program is developed for each of the function in Visual Basic having connectivity between them. Visual Basic has been selected as a programming language as it has compatibility with Auto-CAD and it is more users friendly. An output of each step is taken as an input for subsequent step. A structure as shown in fig.1 facilitates accurate transfer of data corresponding to each feature from one step to other step. Each of the step is described in subsequent sections.

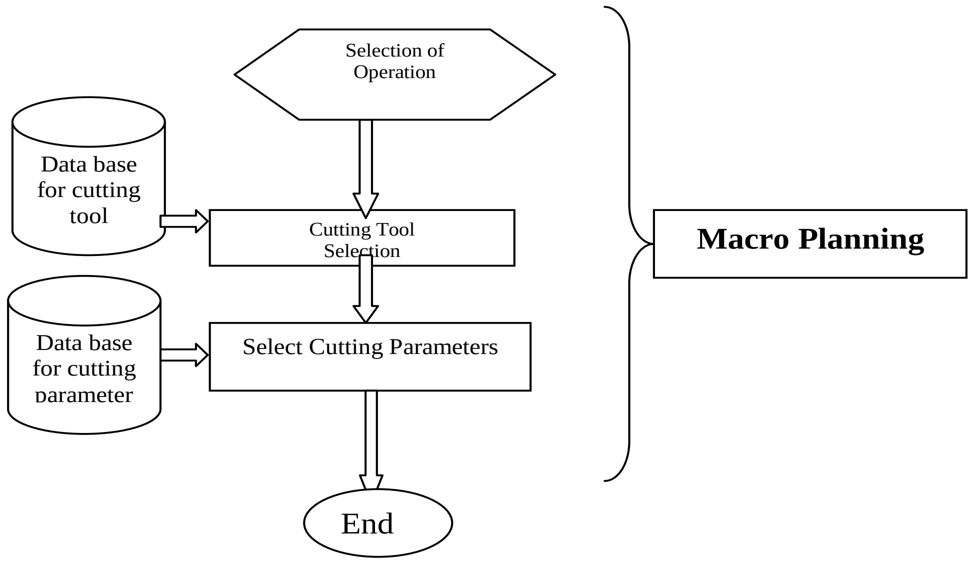


Fig.1 A structure of Macro planning

3. Operation Selection

The decision on selection of operation depends on the type of feature. The decision rules are based on a simple logic used by process planner. The common operations performed on rotational part are facing, turning, threading, drilling, boring, finishing etc. Rotational component, by default, requires facing operation to provide finished surface on a face i.e. right most vertical line of a part drawing. As the stock size is larger than largest diameter of part, removal of excess material (diameter) to obtain appropriate cylindrical surface requires longitudinal turning operation. While machining of rotational part from raw material, first raw material is machined using turning operation so as to get cylindrical shapes corresponding to every feature. It means, all features of every part are first converted into cylindrical features and machined accordingly. Therefore, every feature needs turning operation. For example, in case of taper features, an appropriate step cylinder corresponding to larger diameter needs to be produced before taper turning operation can be performed.

The external threading operation is performed after finish diameter equal to major diameter of thread is available. The chamfering operation is performed only after finishing operations is completed. Internal features are machined only after completion of external features. If hole size is not equal to standard drill size, then drilling operation is followed by boring operation to remove remaining material. The boring operation requires hole to be drilled for appropriate size and hence it is done after drilling. Internal threading operation can be done if the hole having major diameter of thread is obtained by drilling or boring.

In summary, the possible operations corresponding to each feature are listed in the table 3.3.

Sr.No.	**Name of the Feature**	**Possible Operations**
1	Cylinder	Longitudinal turning, step turning
2	Facing	Facing operation
3	Taper	Longitudinal turning, taper turning operation
4	Chamfer	Chamfering operation
5.	Hole	Drilling-boring
6	Thread (internal)	Drilling-boring, Threading
7	Thread (external)	Longitudinal turning, threading
8	Arc	Longitudinal turning, arc turning
9	Recess	Longitudinal turning, recess turning

4. Cutting Tool Selection

The selection of cutting tool refers to the selection of cutting tool material and tool type. Success in metal cutting depends on the selection proper cutting tool both in respect to the tool material and workpiece material. In this work the two types of cutting tool material are considered i.e. carbide and H.S.S. The more emphasis is given on carbide tool because it has very high red hardness (retain cutting edge hardness up to about 1000^0C, high wear resistance, and can be operated at high cutting speeds, when compare to other tool material recommended by SECO tool manufacture. The tool material selected based on work material and cutting speed.

The correct choice of cutting tools is determined by the overall part configuration, rather than by individual contour selection or workpieces. The cutting tool selection depends upon the type of operation required for every individual feature for e.g. the single point cutting tool is selected for operations like turning, facing, recess, taper turning, etc. For operations like arc and chamfering then form tool is selected for performing such operation while for drilling operation a drill from standard data base is selected.

The summary showing the selection of cutting tool based on the operation selected in section 3.3.1 in the table 3.4.

Table 3.4 Operation- Cutting tool

Sr.No.	**Name of the operation**	**Cutting tool**	**Cutting tool material**
1	Turning	Single point turning tool	Carbide (Tip)
2	Facing	Single point turning tool	Carbide (Tip)
3	Taper turning	Single point turning tool	Carbide (Tip)
4	Recess	Form tool	Carbide (Tip)
5	Arc	Single point turning tool	Carbide (Tip)
6	Threading (External)	Threading tool	Carbide (Tip)
7	Chamfering	Form tool	Carbide
8	Drilling	Drill	HSS
9	Boring	Boring tool	Carbide (Tip)
10	Thread (internal)	Threading tool	Carbide (Tip)

5. Cutting Parameters Selection

The cutting parameters in every machining operation include cutting speed, feed, depth of cut and have greatest influence on machining time and surface finish of the workpiece. Large depth of cut increases the cutting force and tool deflection and hence deteriorates the surface finish. So selection of cutting parameters[43] is an important step in metal cutting process. Handbook speed tables and cutting tool manufacturers catalogue can always be considered as general recommendations.

6. CASE STUDY

Part drawing is checked for concentricity of circle, redundant line, overlapping line and point in case of any corrections, the algorithm provides facility for revising the drawing accordingly. As shown in fig. 2 the part name is extracted from the file name of drawing which is given to the drawing in Auto CAD. The part name is displayed on the task bar of window as "Head pin" in the selected case study. The layers used in this case study for dimensions only. The remaining part drawing is displayed on "0" layer which occurs by default in Auto CAD. The part material is extracted from "material layer" and displayed on process sheet.

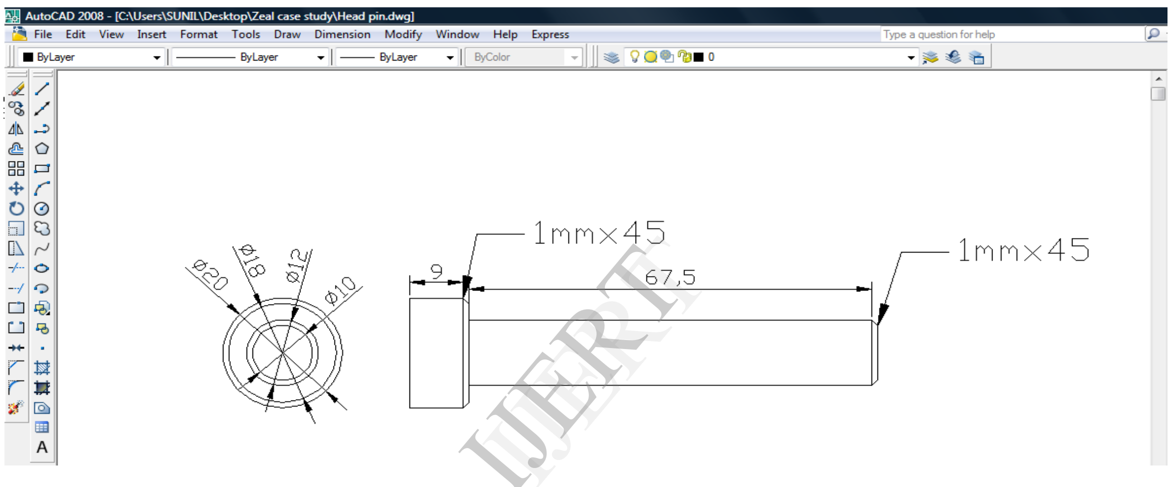
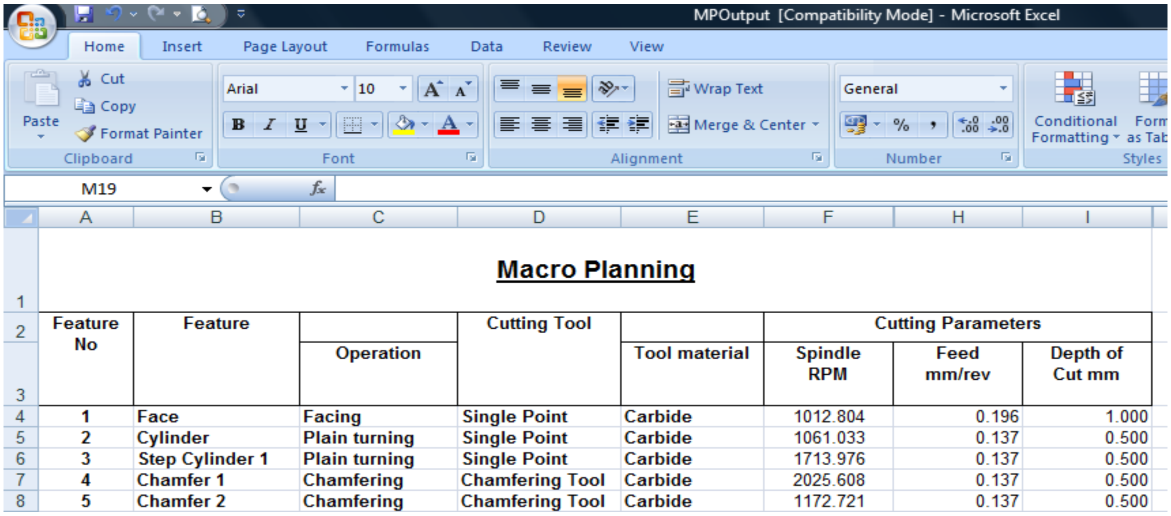


Fig.2 Part drawing

6.1 Macro planning

Further execution of AMPPS is feature based. In the next step the module on macroplanning decides on selection of operation, cutting tool, and cutting parameters. The rule based procedure facilitates selection of operation and cutting tool while speed , feed, and depth of cut are retrieved from the data base. The spindle rpm is then calculated based on cutting speed and the diameter. The output generated by the module for the part " Head pin" is shown in Fig.3



Macro Planning

Feature No	Feature	Operation	Cutting Tool	Tool material	Cutting Parameters		
					Spindle RPM	Feed mm/rev	Depth of Cut mm
1	Face	Facing	Single Point	Carbide	1012.804	0.196	1.000
2	Cylinder	Plain turning	Single Point	Carbide	1061.033	0.137	0.500
3	Step Cylinder 1	Plain turning	Single Point	Carbide	1713.976	0.137	0.500
4	Chamfer 1	Chamfering	Chamfering Tool	Carbide	2025.608	0.137	0.500
5	Chamfer 2	Chamfering	Chamfering Tool	Carbide	1172.721	0.137	0.500

Fig.3 Macro planning

7. Conclusion

The machine selection, cutting tool selection and selection of cutting parameters in macroplanning is done either by using GA (quantitative) or data based (qualitative) approach. Though quantitative approach gives optimum values, data based approach is widely used due its simplicity, flexibility and ability to handle complicated problems requiring large knowledge base.

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