Micro Planning And CNC Programming For Cylindrical Part In AMPPS

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Abstract

The decision on sequencing of operations, tool travel and machining time calculations is done in microplanning. After a set of processes has been selected for all the features of part, the sequencing task begins by searching and analysing relationship between features. This is done by rule to detect geometrical interactions and the appropriate precedence relationship in knowledge base. For deciding sequence of operations precedence relationship among the different operations is developed using decision rules.

CNC program is generated based on the process plan of a given component. The generated CNC program is then validated by simulation software before giving it to CNC machine.

Keywords

 Micro planning, Automated modular process planning, Generative process planning, Computer aided design,

1. Introduction

Micro planning deals with decision on sequencing of operations, calculations of tool travel and machining time. As a part may contain many features, a proper sequence for machining these features is vital in achieving efficient and high quality manufacturing of the part. Operation sequencing deals with the problem of determining in what order to perform a set of selected operations such that the resulting sequence satisfies the precedence constraints established by both parts and operation. The objective of process sequencing is to minimise the total time to produce a part.

CNC machine tools require a set of commands in order to carry out desired machining operation. The job of creating this set of commands is known as programming. Programming is the process of coding machining conditions such as machining dimensions with reference points. These dimensions are derived by correctly allocating the X and Z axis. The machine tool may have facility of both manual part programming as well as programming using CNC programming languages such as APT, ADAPT, COMPAPT etc.

2. Micro planning and CNC programming 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.
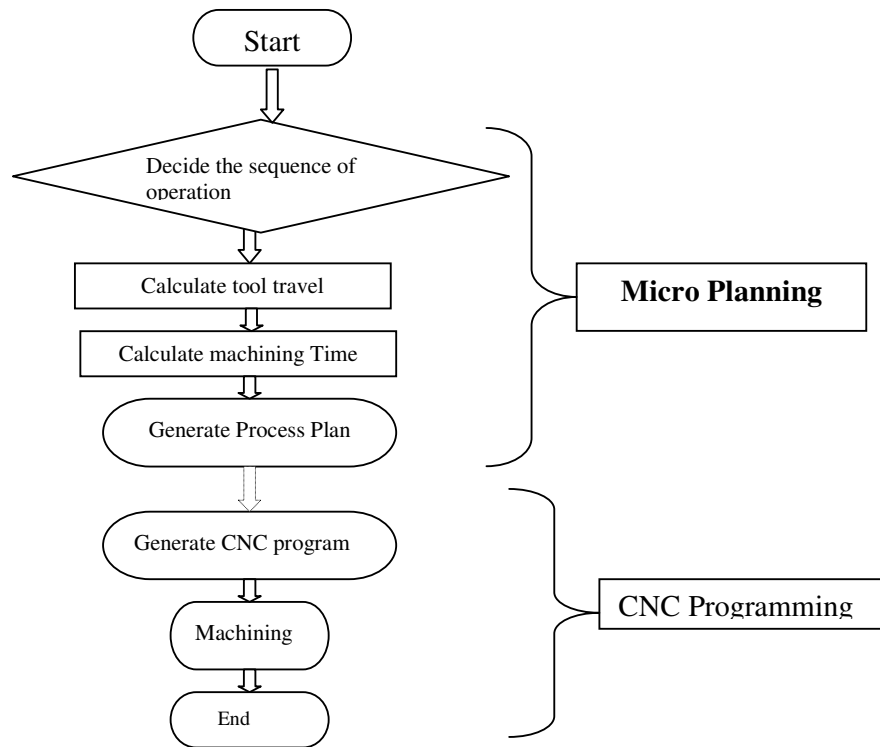

Fig.1 A structure of Micro planning and CNC programming

3. Decision rules for sequencing of operation

1. The operation are selected according to feature having largest diameter first and then descending further in order of size from left to right, till smallest diameter is obtained.
2. Internal operations are considered only after external operations are completed.
3. The stock size is always taken greater than the finished size of workpiece.
4. The first operation in rotational component is always facing of extreme right face because face is considered as a reference for obtaining geometry of other features.
5. As the stock size selected is greater than the finished size of workpiece the second operation is always turning so as to obtain diameter of largest feature of a part on a cylindrical surface.
6. All plain turning (step turning) operations are completed first by converting every feature into a cylindrical surface.
7. All taper turning operation comes after step turning operation (sr.no.6). Taper turning operations are performed from right to left.
8. Finish cut operations of all cylinder, taper, recess and arc features are done before external threading, drilling, and internal threading.
9. External threading operation comes in the sequence after completion of finish turning operation.
10. For internal operations first operation considered is a drilling and then boring.
11. If the hole size does not match with standard drill size, then boring operation is done after drilling.

12. Internal threading operation is performed only when required size of hole equal to major diameter is produced.
13. The last operation is always chamfering.

The built-in rules, as given above, are formulated on the basis of general machining principles and are used to define precedence relations among the features. The approach for operation selection is based on knowledge, the possible operation for each feature is determined heuristically. The program starts with selecting the features as per designed rule and then selecting possible operations for that feature. For example the hole feature can be done by two possibilities i.e. drilling, finish boring or drilling, rough boring, and finish boring. The 9 features and possible operation are described in the fig.2.
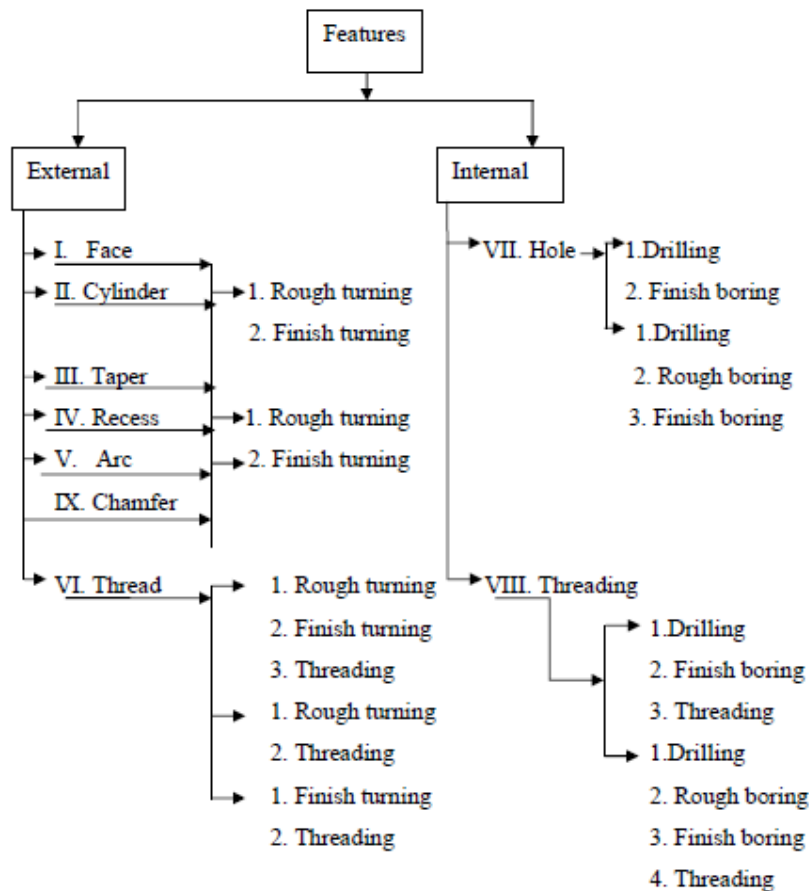

Fig.2 Feature-Operation Hierarchy

4. Generation of CNC Codes

The process plan developed for the given component using as input. The process plan is then used for generation of CNC codes. However, the process plan file is required to be imported again for identification of operation, tool travel and cutting parameters. It may be remembered here that if the operating system used for generation of process plan is different to the one used for part programming, the process plan file can not be imported. Under the circumstances, interfacing is

required to make import process platform independent. Therefore a separate program is developed in VB6 for importing the process plan file.

5. Case Study

The AMPPS is applied to part, called 'Thread Pin' used in dairy equipment. The part drawing is shown in fig.3
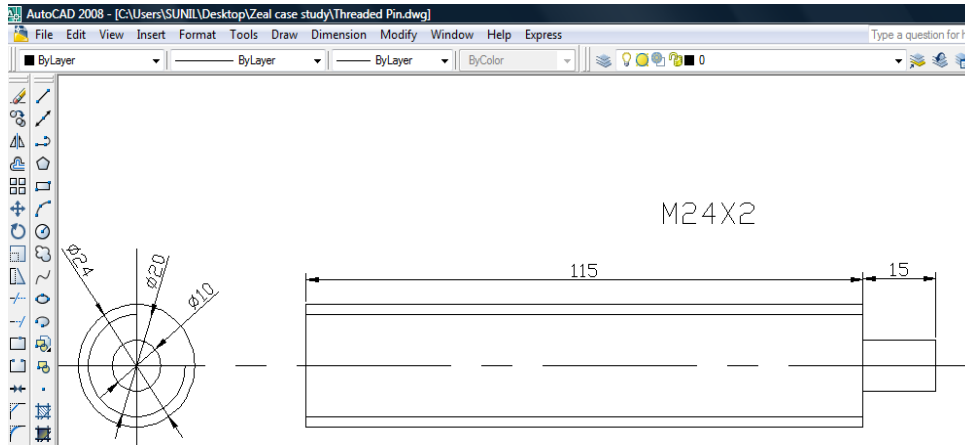

Fig.3 'Thread Pin' drawn in Auto-CAD

Micro Planning

The process plan generated for 'Thread Pin' is as shown in fig.4

Process Sheet

Operation No	Operation	Cutting tool	Tool Material	Length mm	Diameter mm	Feed mm/rev	Depth of Cut mm	Spindle RPM	Machining Time sec
	Work Piece Material		Medium-alloy steels			Stock Size 28.000 Ø x 161.000 (130.000 + 30.000 (mm) + 1.000)			
1	Facing Side A	Facing tool	Carbide	14.000	28.000	0.196	1.000	795.775	0.089
2	PlainTurning Pass 1	Single point	Carbide	130.000	28.000-25.000	0.256	1.500	795.775	38.295
3	TurningStep 1 Pass 1	Single point	Carbide	15.000	25.000-22.000	0.256	1.500	891.268	3.945
4	TurningStep 1 Pass 2	Single point	Carbide	15.000	22.000-19.000	0.256	1.500	1012.804	3.472
5	TurningStep 1 Pass 3	Single point	Carbide	15.000	19.000-16.000	0.256	1.500	1172.721	2.998
6	TurningStep 1 Pass 4	Single point	Carbide	15.000	16.000-13.000	0.256	1.500	1392.606	2.525
7	TurningStep 1 Pass 5	Single point	Carbide	15.000	13.000-11.000	0.196	1.000	1713.976	2.673
8	TurningStep 1 (FinishCut)	Single point	Carbide	15.000	11.000-10.000	0.137	0.500	2025.608	3.245
9	PlainTurning (FinishCut)	Single point	Carbide	130.000	25.000-24.000	0.137	0.500	891.268	63.925
10	External Threading Pass 1	Threading tool	Carbide	115.000	24.000-23.500	2.000	0.500	560.000	6.161
11	External Threading Pass 2	Threading tool	Carbide	115.000	23.500-23.000	2.000	0.500	560.000	6.161
12	External Threading Pass 3	Threading tool	Carbide	115.000	23.000-22.500	2.000	0.500	560.000	6.161
13	External Threading Pass 4	Threading tool	Carbide	115.000	22.500-22.000	2.000	0.500	560.000	6.161
14	External Threading Pass 5	Threading tool	Carbide	115.000	22.000-21.500	2.000	0.500	560.000	6.161
15	External Threading Pass 6	Threading tool	Carbide	115.000	21.500-21.000	2.000	0.500	560.000	6.161
16	External Threading Pass 7	Threading tool	Carbide	115.000	21.000-20.500	2.000	0.500	560.000	6.161
17	External Threading Pass 8	Threading tool	Carbide	115.000	20.500-20.000	2.000	0.500	560.000	6.161

Fig.4 Process plan for "Thread Pin"

CNC Program

The output of AMPPS _CNC programming for thread pin is as given below.
N0010 G01X-3.50F0.26S795.78 EOB
N0020 G01Z-131.00 EOB
N0030 G00X3.50Z131.00 EOB
N0040 G01X-5.00F0.26S891.27 EOB

N0050 G01Z-16.00 EOB
N0060 G00X5.00Z16.00 EOB
N0070 G01X-6.50F0.26S1012.80 EOB
N0080 G01Z-16.00 EOB
N0090 G00X6.50Z16.00 EOB
N0100 G01X-8.00F0.26S1172.72 EOB
N0110 G01Z-16.00 EOB
N0120 G00X8.00Z16.00 EOB
N0130 G01X-9.50F0.26S1392.61 EOB
N0140 G01Z-16.00 EOB
N0150 G00X9.50Z16.00 EOB
N0160 G01X-10.50F0.20S1713.98 EOB
N0170 G01Z-16.00 EOB
N0180 G00X10.50Z16.00 EOB
N0190 G01X-11.00F0.14S2025.61 EOB
N0200 G01Z-16.00 EOB
N0210 G00X11.00Z16.00 EOB
N0220 G01X-2.50F0.14S891.27 EOB
N0230 G01Z-131.00 EOB
N0240 G00X2.50Z131.00 EOB
N0250 G01X-2.50F0.14S891.27 EOB
N0260 G01Z-131.00 EOB
N0270 G00X2.50Z131.00 EOB
N0280 M02EOB

6. Conclusions

In microplanning knowledge based approach is widely used. It is so because it incorporatesall human skills, large amount of qualitative knowledge, and search   procedure required to take various decisions in the form of decisions rules. The consistency in the decision can be maintained due to same decision   rules used irrespective of complications in the part geometry. Moreover database approach is found more appropriate. It uses standard data relevant to specific machine and particular operation.

Manufacturing industries are combining material processing, material handling and part positioning system in to a single integrated manufacturing cell to offer flexibility, better quality and improved productivity. Process planning and part programming time directly affect the economic lot size. Automated process planning system can significantly enhance the throughput of such integrated cells and lower the economic lot size dramatically.

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