SOFTWARE SUPPORT FOR SELECTION OF SUITABLE MILLING STRATEGY

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Abstract: The goal of this paper is to describe solutions concerning computer aid of selection of suitable manufacturing strategy with use of software application. It features two variants of solution realization – use of existing software (Excel application) and creating of new one. It also analyses assumptions for creation of such application.

Keywords: computer aid, milling strategies, software application.

1. INTRODUCTION

There is always need of improving the production’s efficiency, production time shortening, simplification of production and saving of energies and materials in the field of production engineering. These goals can be achieved by better exploitation of production devices and lesser tools consumption. Request of productivity improving concerns all the participants from the field of tool, automobile and aero-industry, producers of moulds and different parts of variable shapes in various usage areas.

One possibility of production’s efficiency improvement is innovation attitude in milling. It is technology of miscellaneous exploitation for machining of planar, 3D shaped and rotary surfaces, slots, threads and gearing. One of attributes related to better use of milling is milling strategy, which means the way of tool motion down the machined surface. Wrong strategy selection can negatively affect production time and costs in roughing as well as in finishing strategies. Question of suitable strategy choice is therefore still actual even in new vintage CAM systems.

Optimization of manufacturing strategy selection is important matter mainly for new and inexperienced users of CNC technics, as acquirement of knowledge in this area could present barrier from economical and time aspect. Such optimization can be achieved also with use of existing software application that is known worldwide, but its options would be limited. Another way is to create an independent software application that would be more specialized to the mention problem. Paper concerns briefing of computer aid of manufacturing strategies with use of MS Excel as well as creation method of software used for milling strategy selection.

2. COMPUTER SUPPORT IN THE FIELD OF MANUFACTURING STRATEGIES

Currently there is a lot of products offering computer aid in different production spheres including manufacturing strategies area. These systems are intended to simplify the work of NC programmer and to ensure the correctness of his decisions or even to substitute his own decision by software process and by that to secure best possible milling efficiency.
To most common CAD/CAM systems solving the problems of manufacturing strategies currently belong (lat versions of software are listed in brackets): EdgeCAM (version 12), ProENGINEER (Wildfire 5), ProTOOLMAKER, CADDs (version 5), CAM-TOOL (V3), Catia (V5R18), FeatureCAM (2008), SurfCAM (Velocity), Unigraphics (NX6), MasterCAM (X2), PowerMILL (version 8), ESPRIT (SolidMILL), VX CAD/CAM (version 13).

CAM systems offers machining up to 5 axis. They contains sections for roughing, which is machining with goal of cutting the most material volume possible considering additional material for further operations and finishing, which means the process of removing residual material left on workpiece after some previous technology.

To main roughing strategies supported in CAD/CAM systems belongs:
- raster milling – tool path is parallel with coordinate system axis, tool is moving upright with minimal steps
- contour milling – tool path copies the contour of machined element
- profiling – tool path copies the contour of machined element while keeps moving with defined steps
- raster and profiling – combination of two previous strategies

Finishing strategies often offered in CAD/CAM systems are:
- projection milling – means projection of 2D predefined motion to the model
- constant Z-height milling – mill moves in certain hight while copying model’s contours
- corner milling – for removing the residual material after previous tool or in between two intersected surfaces
- nib milling – mill moves down the model continuously like a pen
- rotary milling – tool moves linear, workpiece rotates around its axis

In most software concerning manufacturing strategies NC programmer has an option to choose suitable strategy, which would allow surface machining in shortest possible time while preserving requested quality. However only few programs select optimal strategy without choice process of its user.

3. TWO DIFFERENT ATTITUDES TO SOFTWARE STRATEGY SELECTION

When determining the suitability of strategy for certain shape, element or surface, it is necessary to come out with concrete criteria, based on which the decision will be made. These criteria should be usable for various elements, usable and available in different CAM software and utilizable either for man and computer. To most considered criteria for optimal milling
strategy selection belongs machining time, achieved surface quality, level of residual stresses and tool wear level.

- **Using of MS Excel for optimal strategy selection**

  Microsoft Excel (full name Microsoft Office Excel) is a proprietary spreadsheet application written and distributed by Microsoft for Microsoft Windows and Mac OS X. It features calculation, graphing tools, pivot tables and a macro programming language called VBA (Visual Basic for Applications). It is overwhelmingly the dominant spreadsheet application available for these platforms and is bundled as part of Microsoft Office package.

  From the view of creation of software solving the selection of suitable milling strategy Excel offers very limited options for successful realization of some complex application. On the other hand, possible output in the form of simple application would have one great advantage – worldwide availability and realization possibilities thanks to wide-spread using of MS Office products. Without use of Visual Basic, the application options will be rather reduced, but it can still be useful. Utilization justification of such simple and slack software need to be verified by NC programmers and users from praxis.

  The solution for quick and simple selection of basic milling strategies has been created using only typical modest Excel operations and calculation of data entries between the cells. This preliminary version contemplates two basic strategies RASTER and BOX applied in square and round mode. This comes out as four ways of moving the tool over the machined surface, what is graphically viewed in figure 2.

  ![Fig.2 Calculation of tool paths using the Excel sheet](image)

  ![Fig.3 Milling strategies realized in new software application](image)
Computations in first version of program will use mathematical operations summarizing length of tool trajectory. When entering input data into the editable labels, it assigns them to relevant variables. Numerical dimensions of machined surface and tool diameter serves as limit borders decisive about stopping of tool motion. After pressing the COMPUTATION button program starts the procedures that calculate the length of tool path for each strategy according to input data received from user. Optimal solution presents the variant with lowest value of machining time criteria.

As programming environment, Delphi software was chosen. From programmer point of view, application will use events control of particular visual components – panels, edit fields, labeled edit fields, buttons, images. From the aspect of computation, main part of program code will consist of cycles, that ensure computing determination in case of reaching the borders of machined surface. Final border contouring of machined element needs to be added to result in order to make the final faces and edges smooth.

Fig.4 Sample of source code from prepared application – cycle determining computation of trajectory accumulating lengths of strings inside the diameter of machined surface

4. CONCLUSION

Computer support for optimal manufacturing strategy selection and proposition has important role in improvement process of production efficiency and productivity. This fact is confirmed by experiences of many companies operating in different industrial spheres. Therefore it is mission of software creators to provide users with better and more accessible possibilities of usage of computer aided selection process related to manufacturing strategies.

CAD/CAM systems that are currently used dispose with great tools in the field of suitable strategy selection and proposition. Many users though would appreciate simple program that would not be fixed to any other software able to pre-select optimal manufacturing strategy.

This contribution analyzes the possibility of using MS excel for determining the most suitable strategy, what concerns only the calculation of length of toolpath. Along with this, it describes the way of such program’s creation, briefly describes programmer environment and methods used for determining of suitable strategy. In future the program should be enriched of computations concerning third dimension, what would make it applicable for non-planar surfaces. It should also provide the option for joining the elementary geometrical shapes in order to analyze surfaces that are more complex.

5. REFERENCES