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PROBLEMS OF OPTIMAL CUTTING STRATEGY APPLICATION FOR CNC MILLING TECHNOLOGY

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ABSTRACT
For needs of optimal concept machining implementation at digital controlled manufacturing machines is important accurate to design concept - strategy of tool motion by manufacturing engineer. On the ground of possibility realisation of great number different types surfaces at different manufacturing devices and after exploitation of different from a lot of technological parameters is strenuous to choose of optimal and efficient concept of tool motion. New modern approaches on realisation of these problems constitute application of expert and knowledge systems in collaboration with classical software dedicated for creation of control NC programs. In paper is presented outputs of scientific project realisation on Faculty of Manufacturing Technologies oriented to area of optimal cutting strategy realisation.
Keywords: NC machines, NC programs, CNC milling, optimal cutting strategy

1. INTRODUCTION
The area of the numerical control (Numerical Control - NC) is the most worked part of CAM systems. It is technology, where the programs for controlling of the production machines are used; for example for lathes, milling, drilling, sheet bending, grinding, conventional and unconventional cutting machines (laser, plasma, water-jet), but also for mechanical working and pressing machines by their control systems. There exist two primary types of numerical control, which are different by program storage method. In case of CNC (Computer Numerical Control), the control system of production machine is directly connected to local control computer. The second, more modern method is characterized by flexible distributed controlling of several production machines from common centre - DNC (Distributed Numerical Control). For quality form of program realization for milling NC machine is needed to apply of optimal strategy of cutting tool motion.

2. CREATION OF PROGRAMS FOR CNC MACHINES
The design engineer, for example, must possess enough knowledge of CNC to perfect dimensioning and tolerance techniques for workpieces to be machined on CNC machines. The tool engineer must understand CNC in order to design fixtures and cutting tools for use with CNC machines. Quality control people should understand the CNC machine tools used within their company in order to plan quality control and statistical process control accordingly. Production control personnel should be abreast of their company's CNC technology in order to make realistic production schedules. Managers, foremen, and team leaders should understand CNC well enough to communicate intelligently with fellow workers. And it goes without saying that CNC programmers, setup people, operators, and others working directly with the CNC equipment must have an extremely good understanding of this technology [1].
The first benefit offered by all forms of CNC machine tools is improved automation. The operator intervention related to producing workpieces can be reduced or eliminated. Many CNC machines can run unattended during their entire machining cycle, freeing the operator to do other tasks. This gives the CNC

user several side benefits including reduced operator fatigue, fewer mistakes caused by human error, and consistent and predictable machining time for each workpiece. Since the machine will be running under program control, the skill level required of the CNC operator (related to basic machining practice) is also reduced as compared to a machinist producing workpieces with conventional machine tools.
The second major benefit of CNC technology is consistent and accurate workpieces. Today's CNC machines boast almost unbelievable accuracy and repeatability specifications. This means that once a program is verified, two, ten, or one thousand identical workpieces can be easily produced with precision and consistency.
A third benefit offered by most forms of CNC machine tools is flexibility. Since these machines are run from programs, running a different workpiece is almost as easy as loading a different program. Once a program has been verified and executed for one production run, it can be easily recalled the next time the workpiece is to be run. This leads to yet another benefit, fast change-overs.
Since these machines are very easy to set up and run, and since programs can be easily loaded, they allow very short setup time. This is imperative with today's just-in-time production requirements.
Presented here are three methods of developing CNC programs, manual programming, conversational (shop-floor) programming, and CAM system programming. To this point, we have exclusively stressed manual programming techniques at G-code level in order to ensure your understanding of basic CNC features [7].
In this key concept, however, we will explore the various methods of creating CNC programs. We will give applications for each method to determine which is best for a given company. While we do tend to get a little opinionated in this section, you should at least understand the basic criteria for deciding among the programming alternatives. We will discuss three methods of developing CNC programs, manual programming, conversational (shop-floor) programming, and CAM system programming. Keep in mind that no one of these alternatives is right for all companies. Each has its niche in the manufacturing industry.

3. SOME STRATEGIES FOR OPTIMAL CNC MILLING

In optimized system all the components work until the limit of their maximal capacity, though none of them is being overstretched. In order to prevent the tool damage, turn speed and feed should stay in the boundary of maximal load for existing tool path. This way of setting the turn speed and feed leads to the fact, that in the sections with lower load the tool works slower compared to its maximum.
So we try to keep the tool working up to its limit through the whole trajectory, which means that we attempt to reach constant material withdrawal and steady cutting forces. Unstable cutting force may result to tool damage or slow manufacturing [8].
Optimization of material withdrawal during the roughing is the most important step of CAM programming. Cutting depth and tool pitch recommended in tables for tool and material combination assume that we do the constant pitch roughing through the whole trajectory. If the tool path involves entire tool diameter cutting (grooving), or the driving in corners isn't handled, the tool may withdraw more material than expected. One possibility to keep clear of entire tool diameter irruption into the material in CAM systems is trochoid roughing. (Fig.1)

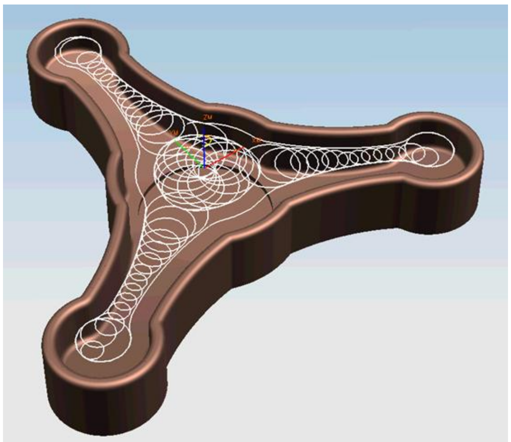
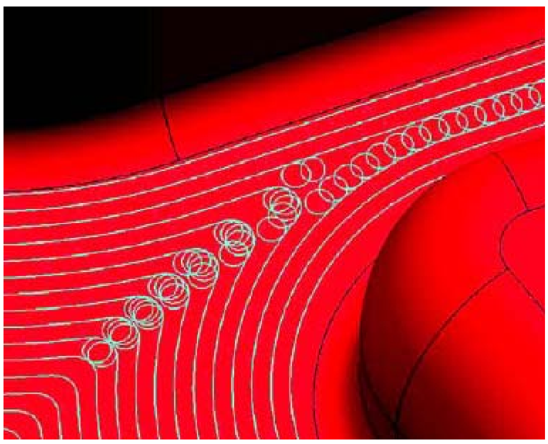

Figure 1 Trochoidal milling in the CAM system

In most cases finishing of 3D surfaces in Z-layers (also known as “water line” or “constant Z finishing”) provides better material breach and more stable withdrawal as finishing with the operations of trajectory projection. In contour strategies with trajectory projection the tool moves up and down according to the geometry, suffering load peaks during axial irruption into the steep surfaces. In order not to cause the tool damage during the load peaks it must work really slow in the sections with lower precipitousness.

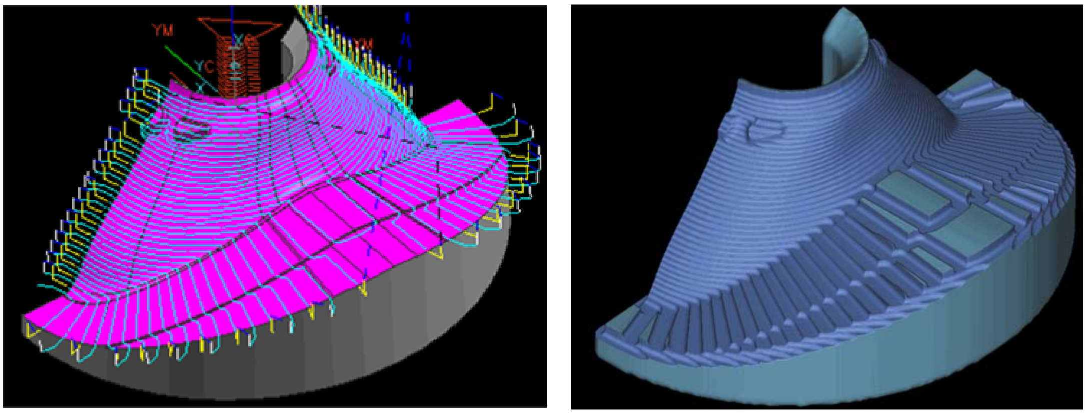

Figure 2 Classical milling with uniform Z-levels

Besides constant Z-layers milling CAM system enables inserting the trajectories in low-pitched areas so that depth of remaining material is constant and next operations have steady material withdrawal (Fig. 3).

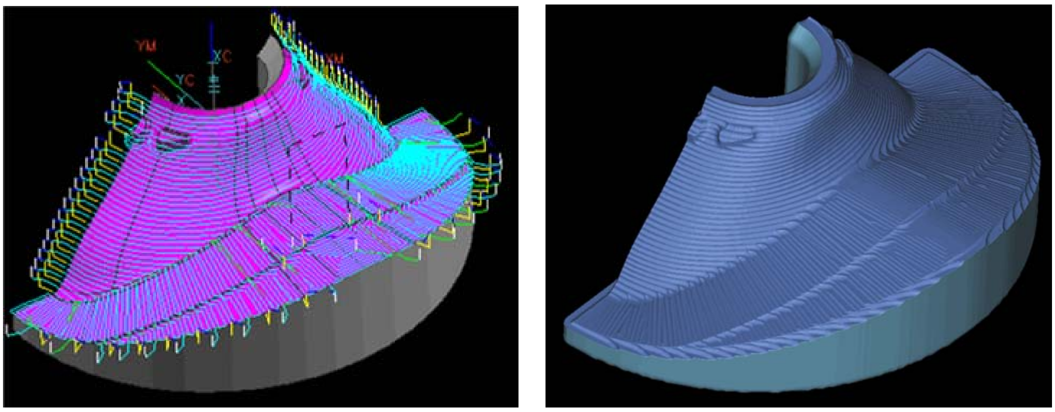

Figure 3 Z-level milling with added levels on non-steep faces in the CAM system

If there is a need of finishing surfaces by 3-axis contouring instead of Z-layers machining, peak load is dramatically increased by axial irruption into the steep surfaces (for example chamfered sides of moulds).

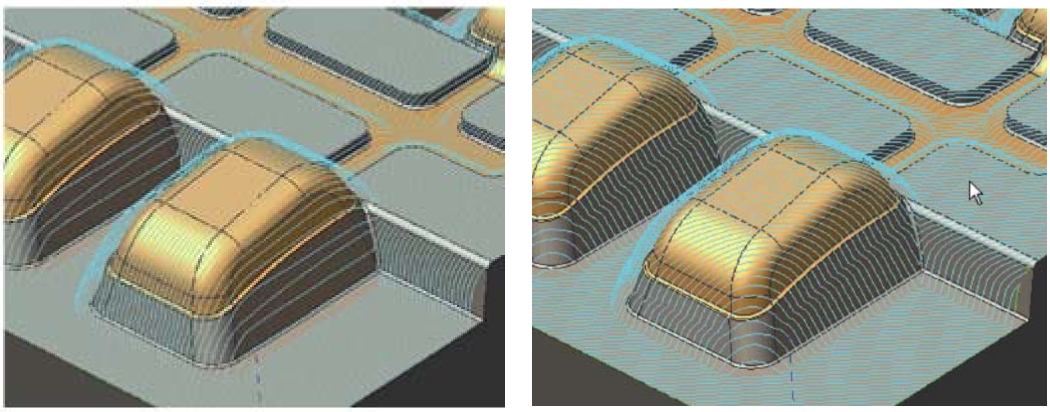

Figure 4 Steep areas engages with 90° and 45° angle

There are two ways of lowering the peak loads while penetrating steep surfaces. One of them is to modify the angle of overriding so that tool goes through the steep sides under 45°. This decreases real precipitousness of trajectory and overloading of tool. Minor effect of this solution is that the tool doesn't longer remain in lengthwise corners. The other method of avoiding the tool overload on steep surfaces is to use first machining using Z-layers operations.

4. CONCLUSION

The demands for keeping and increasing of a level of competitive abilities of a company products force the producers to use CAM technologies in the highest degree and this trend can be also expected in the next future. In order to use the most sophisticated CAM Systems in the manufacturing companies it is necessary to analyse, compare and evaluate the abilities of the above mentioned systems. To appreciate which of the systems offered in a software market are the most advantageous was also a task of the present essay [6].

In CAM Systems field it is possible to expect in future the trends of development as follows:

- Working in of the newest research results from a turning, milling, grinding technology theory into the single modules (a computer support of new technologies, namely high-speed, dry, hard machining, a curve machining – Bezier,, B-spline, NURBS, etc.),
- Further feature of modules for CA support of machining with possibilities of CA support of progressive technologies (water-jet, laser, plasma),
- Modules generation for manufacturing support in other technological fields, e.g. cupping and bending mould, welding, assembly, etc.),
- Working in of expert systems into manufacturing computer support field with aim to use more effectively before solved tasks and problems,
- Creation of finished postprocessors databases with a possibility to use them as a whole, or to use the parts of a postprocessor for another postprocessor creation,
- Transition from CAD/CAM to CAPE (Concurrent Art to Product Environment) Environment allowing, by a control, to solve completely all stages of a new product realization from a virtual design up to practical realization in a manufacturing process,
- Using of STEP (Standard for the Exchange of Product Model Data) Standard for taking over of a model from CAD Systems by specialized CAM Systems.

The present and future CAM technologies must be inevitably able to involve themselves into an integrated chain of computer support technologies, beginning with a model design and its examination in a virtual environment up to a product manufacturing and its dispatching to an user. The most sophisticated CAM Systems will be a part of strong CAD/CAM/CAE Systems, or they will be developed independently but with maximum possibilities to be interconnected with other computer support systems and company information systems.

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