PROBLEMS OF KINEMATICS SIMULATIONS OF MACHINING DEVICES IN NX SYSTEM

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Abstract:
This paper describes possibilities of kinematics simulation of machining devices with aim not only to observe simulation of machining process itself, but whole working environment of the machine. This is conditioned by functionally created postprocessor, so the complete NC program could be generated for given device that is to be simulated as a whole.

1. INTRODUCTION

On the base of modernization in the field of computing technology, classical methods and proceedings are substituted by new methods and approaches that have better attributes and provide consequential savings. It can be said, that currently it is important to have an advantage in comparison to competitors together with present attempt for effective collaboration in products development.

Modernization takes part also in area of manufacturing technologies, where high number of software products is used, that optimize and simplify the work of particular production spheres. To the top-class systems belongs also program Unigraphics NX from Siemens company, that concerns CAD/CAM/CAE production spheres. It can be used for very fast and simple modeling of part, creating of assembly, designing of drawings and documentation, generating different analyses and simulations, programming of NC machining and measuring devices and simulating of machining process.

Machining simulation is step in complete part production. Close to this there is related kinematics simulation of machining device. Creation of machine simulation before production of parts with complex surfaces itself becomes more used feature that can verify the tool trajectories and thus prevent possible collisions. Example of kinematics simulation of machining device was realized on machining center Pinnacle VMC-650S. For creation of kinematics simulation of device and for production itself it is first necessary to create functional postprocessor for specific machining device.

2. KINEMATICS SIMULATION OF MACHINING CENTER PINNACLE VMC-650S

Ability to simulate and verify production procedure nowadays can rapidly increase the expectations, that given task will be fulfilled without mistakes and on time. There are some areas in the field of NC machining, where the work of machining device needs to be verify before the running. It is necessary to observe especially right material cutting and respect to the tool trajectories while keeping appropriate cutting parameters. Kinematics simulation of the machine helps us to monitor the machine while machining the part, to prevent unexpected machine breakdowns, decrease the time of part production, increase its quality, decrease production costs and improve total productivity of machine work.

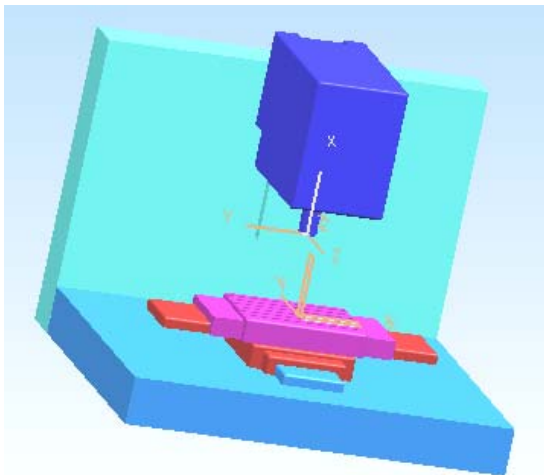Fig. 1   Machining center Pinnacle VMC 650S

Fig. 2   Creation of the motions for assembly
components

Before creating the simulation itself, it is necessary to thoroughly know the machining center. Its work parameters are important.

For creation of simulation the geometry of machining device has to be defined as an assembly of parts in some file. Each part that moves will have assigned kinematics, therefore each part has to be designed separately, with principles of reference to other assembly parts. As result we get the assembly model that is shown on fig. 2.

Creation of simulation is done with use of application Machine Tool Builder. This view on Machine Tool Navigator can be chosen in navigator of NX system. Then after clicking on machines name we can add particular components. First it is necessary to add the main part called also Machine Base. After this step there is function junction used for orientating the machine zero point.

Name	Classification	Axis Name	Initial Value	NC Axis	Junctions
THREEAX_XY-TAB_Z-HD_VER					
⊟ MACHINE_BASE	_MACHINE_BASE				MACHINE_ZERO*

Fig. 3   Machine_zero tree

Step by step we add particular components to the first one and define the part of Z axis that does not move, then we add spindle as another part and define the coordinate system according to which the spindle will move. Movement can be limited in given axis. Our settings presented values from -450 up to 150 mm, step setting was 10mm. After this follows another setting up – place of tool fixation. It is done by selecting appropriate coordinate system. Similarly the motion in Y axis can be defined.

Next step is to define the part itself, define the workpiece that it would be made of and the fixture, for example vice. Therefore in SETUP we create element PART, that will be classified as PART, BLANK, that would be classified as WORKPIECE and FIXTURE classified as SETUP_ELEMENT. Final tree for definition of motions of machining device is on fig. 5.
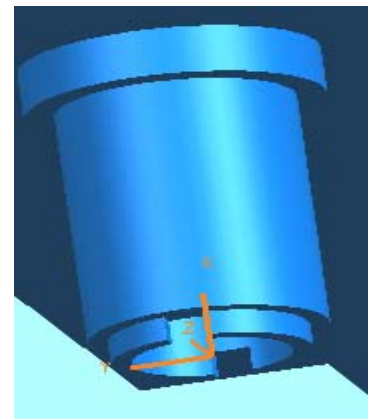

Fig. 4   Coordinate system of
tool fixation

Name	Classification	Axis ...	Initial ...	Junctions
NO_NAME				
⊟ MACHINE_BASE	_MACHINE_BASE			MACHINE_ZERO*
⊟ Z_BASE				
SPINDLE		Z	0	S*
⊟ Y_BASE				
⊟ Y_SLIDE		Y	0	
⊟ X_SLIDE		X	0	
⊟ SETUP	_SETUP_ELEME...			PART_MOUNT_JCT
BLANK	_WORKPIECE, _...			
FIXTURE	_SETUP_ELEME...			
PART	_PART, _SETUP...			

Fig. 5   Final kinematics tree

3. RUNNING OF SIMULATION FOR CREATED MILLING OPERATIONS

For kinematics simulation of machine we use the part called sample. Four machining operations were created. First of them is cavity mill – roughing, second one Z level-profile – machining of part profile with addition of 1mm and use of Cut Between Levels feature, third one Z level-profile with zero

addition and last one Contour Area Non Steep – finishing of part surfaces and corners with removing the residual material.

For simulation running it is necessary in Machine Tool Navigator to define the workpiece (BLANK) and part (PART). After switching to the folds of Operation Navigator and Machine Tool, PTM we select Null Machine and proceed to the window, where Replace Machine and Mill can be chosen. From machines list we choose the kinematics sim_pinacle, while the coordinate system on part needs to be selected, according to which it will be placed on the machine. After pressing the OK button, the machine will be loaded with kinematics.
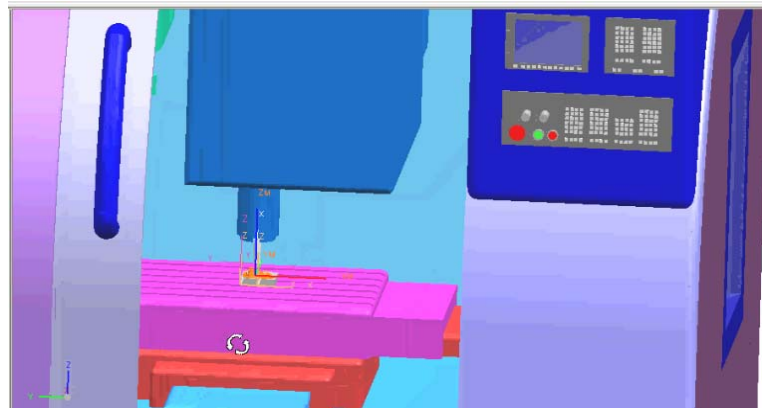

Fig. 6   Final simulation

Machine simulation is a part of programming environment of NX 6. Final simulation is helpful from the view of wide production area for possibility to eliminate the unexpected situations during machining (fig. 6).

4. CONCLUSION

Characteristic of new concept of virtual control:
- It improves the usage of simulation of NC code with significantly simplified configuration,
- It uses configured solution for Sinumerik 840D, Heidenhain TNC and Fanuc,
- Support for external M and G codes,
- Virtual control created with Tcl Language.

Programming and simulation involves to NX:
- verification of full material removal,
- complete tool simulation in machining devices,
- virtual simulation control.

Quick getting of product to the market lies in:
- decreasing the need of testing on machining devices,
- elimination of duplicate data in multiprocessors.

Using the software NX 6 allows us to flexibly react to the production changes, what leads to significant reduction of preparation phase, and thus to decreasing of product cost. Simulation also serves as protective tool that prevents the machines of breakdowns and tests the NC program.

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