

PROGRAMMING AND SIMULATION OF WORKPIECE IN CNC MILLING MACHINE

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ABSTRACT

In this paper are presented programming and simulation of workpiece through CNC Mikron Milling machine, with using of the machine software as such Heidenhain iTNC 530. Piece was making with Mastercam.

In this issue will treating machining process with Milling and applying of Mastercam Software (CAD/CAM Family).

Through Mastercam software, designed and drawn after working pieces will set all the movement trajectories of cutting Tools, such as: point to point interpolation, linear interpolations, circular and spline interpolation. Will be clarified the spline interpolation with third degree polynomial, through software to Heidenhain iTNC 530 Machine.

Keywords: Programming, Simulation, Milling machine, Mastercam, Spline Interpolation, Heidenhain iTNC 530, etc.

1. INTRODUCTION

Using modern system of CAD/CAM (CAD – Computer Aided Design / CAM – Computer Aided Manufacturing) for the manufacturing of workpiece has a large application in a lot of field of Mechanical Industry. Contours, which are described by the CAD system are as Spline, can be transferred directly to the machine software iTNC (Terminal Node Controller) to realize manufacturing.

In this type interpolations of complex curved forms can be present with lower words, as the road through the approximation polygon and linear interpolation.

The machine called Mikron HSM 400 U is very accuracy, extremely dynamics and high speeds working which is combined with other important aspects such as outstanding removal swarf, high flexibility, good ergonomics and with possibility automation.

In this paper will be clarified the Spline Interpolation with third degree polynomial, through software Heidenhain iTNC 530 Machine, supported with postprocessor, which change analog information into digital.

2. SPLINE INTERPOLATIONS WITH THREE DEGREE POLYNOMIAL

Machine software iTNC 530 is very flexible. With this software we can easily programming and manufacturing workpiece, because we drawing anything contour and thought supported postprocessor will covert in languages which know machine. We can program our machine through conventional control milling, drilling, and boring operations.

The machine software iTNC 530 gives us optimal support with smarTNC or plain language – the conversational guidance from HEIDENHAIN – as well as with numerous graphic aids including practice-oriented fixed cycles. For simple work – such as face milling – they don't need to write a program, since it is very easy to operate the machine manually with the iTNC 530. The iTNC 530 can be programmed remotely just as well for example on a CAD/CAM system or at a HEIDENHAIN programming station.

Ethernet interface will guarantees very short transfer times, even the programs will be long. If CAD/CAM system describes as splines contours, we can transfer them directly to the control. The iTNC 530 features a spline interpolator and can process third-degree polynomials, Figure 1.



Figure 1. Three degree Spline Interpolations

Terminal Node Controller (iTNC) introduces a Spline interpolation function with third degree polynomial, where manufacturing can be accomplished with two, three, four or five axes of machine. iTNC - processes has Spline interpolation sentences after third degree polynomial.

Therefore, the general mathematical model is given:

$$\begin{aligned}
 X(t) &= K3X \cdot t^3 + K2X \cdot t^2 + K1X \cdot t + X \\
 Y(t) &= K3Y \cdot t^3 + K2Y \cdot t^2 + K1Y \cdot t + Y \\
 Z(t) &= K3Z \cdot t^3 + K2Z \cdot t^2 + K1Z \cdot t + Z \\
 AY(t) &= K3A \cdot t^3 + K2A \cdot t^2 + K1A \cdot t + A \\
 B(t) &= K3B \cdot t^3 + K2B \cdot t^2 + K1B \cdot t + B
 \end{aligned}
 \tag{1}$$

Each point of the coordinates in last command should be programmed as Spline interpolation parameter - K3 to K1. Range of the rows can be whatever. Then the variable t is from 1 to 0, where t is dependent on Feed F and length of Spline parameter.

Table 1. Types of Spline Interpolation

1 LX+15 Y-05 Z+45 A+10 B-13 FMAX	Start point of SPLINE
2 SPL X+30 Y-25 Z+55 A+20 B-10	End point of Spline Interpolation
K3X+0.07 K2X-0.40 K1X-5.59	Parameter of Spline Interpolation for axis -X
K3Y-0.04 K2Y+0.18 K1Y+2.39	Parameter of Spline Interpolation for axis -Y
K3Z+0.01 K2Z-0.95 K1Z+3.08	Parameter of Spline Interpolation for axis -Z
K3A+0.12 K2A-0.14 K1A-0.57	Parameter of Spline Interpolation for axis -A
K3B+0.01 K2B-0.41 K1B-1.57 E+1 F10000	Parameter of Spline Interpolation for axis -B
3 SPL X+12 Y18 Z-65.....	

3. PROGRAMMING AND SIMULATIONS OF WORKPIECE WITH MILLING MACHINE IN THE CNC MIKRON HSM 400 U

CNC technology is developed rapidly and each year they had advancing progress. Analyze programming and simulations of manufacturing process in Milling Machine with CNC MIKRON are applying through Software Mastercam (CAD/CAM) which enables realizing different kind of couture. CAD/CAM systems have similar efficiency and functions based on common algorithms of reliable theories, they don't have their own unique features for machining speed and efficiency. In other command, Mastercam (family CAD/CAM) system consider only the characteristics of workpiece to be produced, which means that they generate almost the same NC data if the workpiece produced are the same, even though can be used different machines for the realizing workpiece.

To work with CNC must to known five basic elements:

1. Design - prediction and production plane of machine,
2. CAD - introduction with computer design,
3. CAM - introducing of the language machine,
4. Controls - the direction of movement of the machine and
5. Accessories - for realization of desired product according dimension and specification.

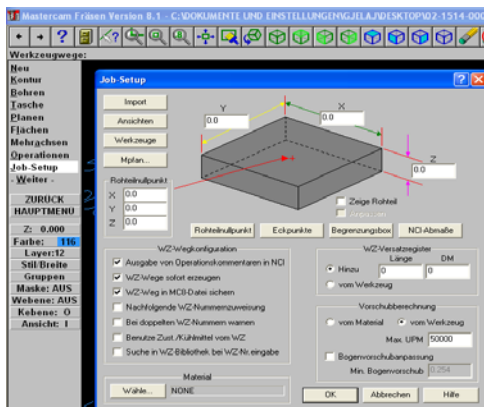


Figure 2. Window Job Setup

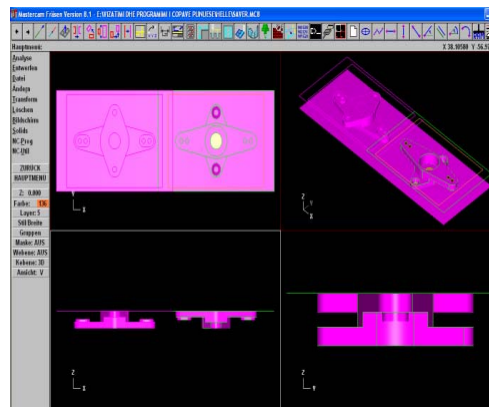


Figure 3. Workpiece in the three projections 3D

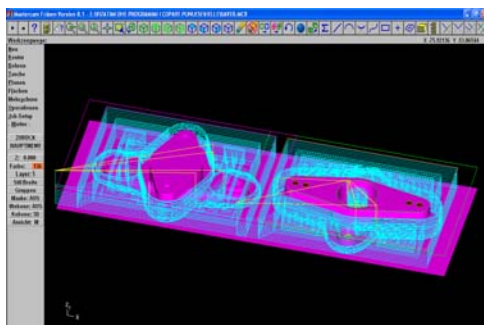


Figure 4. Trajectory of tool cutting

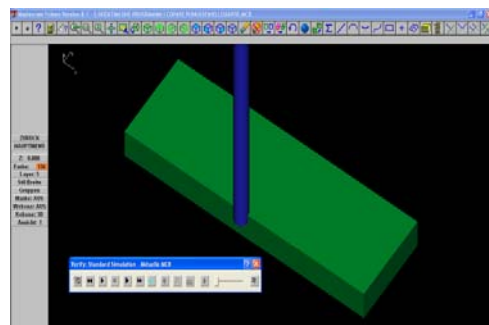


Figure 5. Start point of cutting tools

By using 3D software, engineers drastically can reduce the number of production errors which may be notified in case of settlement of tolerance. With this software we have reducing production costs and save material from errors during manufacturing process.

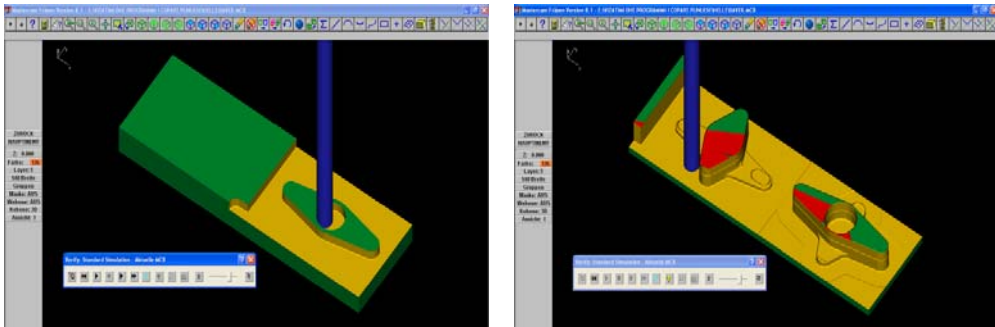


Figure 6. Simulation of cutting process with the Mastercam Software.

In figure 7 is presented programming code for manufacturing workpiece.

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%
O0000
(PROGRAM NAME - SAVER)
(DATE: 03-07-08 TIME 21:02)
N10G21
N12G0G17G40G49G80G90
N14G91G28Z0.
N16G28X0.Y0.
N18G92X0.Y0.Z100.
(TOOL - 9 DIA. OFF. - 0 LEN.
- 0 DIA. - 8.)
N20T9M6
N22G0G90X-41.Y-
22.7A0.S10000M3
N24G43H0Z5.M8
N26Z4.8
N28G1Z-.2F4000.
N30X-32.7F8000.
N32Y22.7
N34X32.7
N36Y-22.7
N8512X-62.865Y17.274R9.973
N8514G1X-59.832Y10.89
N8516G3X-59.71Y10.81R.212
N8518G1X-44.166Y7.632
N8520G2X-38.151Y-0.R7.85
N8522X-44.454Y-7.697R7.85
N8524G1X-59.745Y-10.821
N8526G3X-59.851Y-
10.921R.212
N8528G1X-62.957Y-17.465
N8530G2X-70.001Y-
21.851R7.849
N8532X-75.453Y-
19.649R7.849
N8534G0Z-2.711
N8536Z5.
N8538M5
N8540G91G28Z0.M9
N8542G28X0.Y0.A0.
N8544M30
%
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Figure 7. Numerical Control Code (NC)

4. CONCLUSIONS

Based on theoretical research, experimental and realizing of workpiece and obtained results can be conclude:

- Realization of processing of workpiece with the CAD / CAM systems is more than necessary considering the complicated geometry of the workpieces, which would be difficult to calculate manually,
- With the Heidenhain iTNC machine software, can be read information through the postprocessor of Mastercam or any other applied software, which contain machines with Computerized Numerical Control – CNC and
- With application of the Computerized Numerical Control machine - CNC achieve reducing of the time which plays an important role in the process of manufacturing, increasing of productivity, flexibility, achieve higher automation process and quality of processed surface.

5. REFERENCES

- [1]. Gjelij A.: Programming and Simulate the Processing of Workpiece in Machine of Milling with Computer Numerical Control – CNC with the Software Mastercam Applications, Magister Theme dissertation, University of Prishtina – Faculty of Mechanical Engineering, Prishtina 2008,
- [2]. Yusuf Altintas “Manufacturing Automation ” Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design. University of British Columbia 2000,
- [3]. Hans B. Kief & Helmut A. Roschiwal “NC/CNC Handbuch 2007/2008” CNC, DNC, CAD, CAM, CIM, FFS, SPS, RPD, LAN, NC-MAschinen, NC-Roboter, Antriebe, Simulation, Fach- und Stichwortverzeichnis
- [4]. Dr. Johannes Heidenhain Heidenhain iTNC 530 “Benutzer-Handbuch” Traumreut Deutschland GmbH 7/2004. Factory of Juraform E.K. Rehbergahausen Germany.