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[1.]Dominika PALAŠČÁKOVÁ

INSIGHT INTO THE PROGRAMMING OF MACHINE TOOLS

[1.] Department of Production Technology, Faculty of Mechanical Engineering TUKE, Košice, SLOVAKIA

Abstract: The article deals with the development of NC machines up to the most modern CNC machines. Automation in the production process provides a number of advantages. Great progress in the production process can deliver both quality products as well as saving time, which is nowadays one of the important aspects of production.
Keywords: geometric axis, synchronous axis, asynchronous axis

INTRODUCTION

During the twentieth century there was a massive substitution of human labor work machines. At the beginning of the fifties were in the United States developed the first NC machine. Since 1966 began gradually all global manufacturers to pass on a third-generation CNC system, figure 1.

The long-term direction of development has become a production process automation across all manufacturing industries therefore also in engineering. Automation brings a number of advantages, in particular, increased productivity, which is associated with the reduction of the cost of production.

Numerically controlled machines are machines with a high degree of automation flexibly adaptable to changes in production. Data necessary to manage the machine are pre-prepared in the form of a control program recorded on carriers or information stored directly on the computer. These machines are now the backbone of flexible automation of machining processes in medium and small batch production. Statistics show the number of hours of downtime when the machine farmed. Most of them compromises the dissipation time in establishing the workpiece, tool setting and inspection of the first piece. Using measuring probes eliminates the need for an ambitious adjustment devices, clamps expensive and time-consuming alignment of the workpiece using a numerical example gauge. Software measurement cycles automatically compensates current length and diameter of tools to calculate the position and rotation angle of the workpiece size and distribution of allowances for machining, dimensional inaccuracies and the like. The result of the use of measuring probes is to reduce lost time and optimum distribution of chips.

Figure 1. The first NC machine from 1951 and the most modern CNC technology

ORIENTATION AXIS IN SPACE ON MACHINE TOOLS

To unify movements CNC was chosen following placement rules coordinate system, figure 2:

- starting from the stationary workpiece,
- always be defined by axis X,
- the x-axis workpiece clamping plane or is parallel to it,
- Z axis is identical or parallel to the axis of the work spindle, which carries the main cutting motion,
- axis is a positive meaning from the workpiece to the tool in the direction of expanding the workpiece,

» if the machine other additional movements in X, Y, Z, are designated U, V, W,
» when the workpiece is moved against the tools are referred to such axis X', Y'and Z'.

In keeping with these basic rules is for the programmer to create a simple program to various types of CNC machines. The position of the machine axes is still the same and made the program can be used on more than machines with minimum modification.

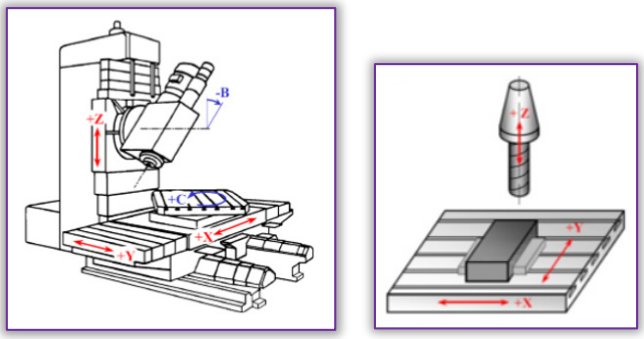

Figure 2. 5-axis vertical machining center and milling machine

Before describing types of movements and interpolation it is necessary to define the concepts of geometric axes, synchronized axes, internal axes and NC axes. From the perspective of a programmer are important mainly geometric and synchronous axes:

» **Geometrical axis** - geometric axis are three and at a given time defining a space - clockwise coordinate system X-Y-Z. Only in these axes, the system performs interpolation in these axes is defined speed. If you have interpolated axes that are not geometry, which can be considered for more complex machines should be switched (eg. From partprogram) as the geometrical axis (see function SetGAx (XNO, Yno, ZnO) in chapter 3). Simple machines have a fixed allocation axes configuration.
» **Synchronous axis** - If programmed together with the geometric axes, this means that basically only that their movement will begin simultaneously with the geometric axes and ends also move together with the geometric axes. If they are programmed separately, traveling speed that enters the system parameter, i.e. not operate the speed programmed address or system parameter F Feed! Unless the system parameter specified speed, traveling at a preset configuration files, type * .ChannelConfig.
» **Asynchronous axis** - generally are fully controlled by the PLC program, mostly various auxiliary axes, often only M-programmed functions. Their use must be in the instructions for a specific machine. Movement is started at the beginning of the block, going "its" speed that is they can end movement earlier or later than possibly simultaneously programmed geometric axis.
» **Internal axis** - used in the preparation part program, is an array of values that can be set and read from part program. Internal axes can be programmed to 9 and AXI0 - AXI8. For normal programming mostly this record is not used. Use is mainly in general programs (macrocycle fixed cycles) which are written, regardless of what axes are actually on the machine. Three of the internal axis are always identified as geometric - either configuration, or switching from part program.
» **NC axis** - the axis with which the module works in real time. They may be connected to internal axes - are derived from this behavior (geometric / synchronous / asynchronous axis). They can be controlled from the PLC.

PROGRAMMING OF NUMERICALLY CONTROLLED MACHINE TOOLS

Automation is a higher form of modern mechanical engineering, in which the number of manufacturing techniques and in the final stage and the race it is automatically controlled according to an established program through monitoring, measuring and control devices. This is a new development path Machinery substitutes not only the physical activity of the worker but also his mental activity. The first steps were machining process automation through a mechanical system to control the timing shaft and Curve drum where all the movements and actions are derived from the control discs. A typical representative of the Line and turret machines. The electrical and hydraulic system is realized duty cycle control successively switching control circuit in accordance with the data control program. The servomotor is controlled by the real position of the tool, which is difficult especially as the tool feed speed and the trajectory along which the tool is moving, depend on the load of the actuator of the components of cutting forces.
On the principle of management by the actual position are comprised all methods of automatic control machine tools, and according to the method of deriving the actual position of the tool is divided into:

a) Control by limit switches, where the dimensions of the workpiece respectively path lengths in different directions, are designed shocks for limit switches for switching servo feed.
b) Copy control, where the locus of tool is template driven.
c) Digital metering track where the tool path relative to the workpiece given electrical signal showing how the digital information about the track, the direction and sense of movement.

Digital metering track where the tool path relative to the workpiece given electrical signal showing how the digital information about the track, the direction and sense of movement:

a) Program management, cross driver. It is essentially a system of two perpendicular to each other Stripping of which is a horizontal sections of the working operations (the steps) and then a vertical machine functions (turn and traverse levels, start and stop, cooling etc.). Inserting a conductive pin to link the respective horizontal and vertical wires which provide gradually switching functionality required in this step. The exclusion of mistakes when setting up the machine at the conductor cross attached card, in which the respective node points of the punched holes. The process was conducted as. the program-controlled lathes and copying program-controlled milling machines with a rectangular cycle, management cues. Currently, this kind of control no longer produced.
b) Analog control enables implementation also significantly more complex machining cycles. On magnetic tapes when making the initial unit records the electrical phase of Synchro, who served as a metering device. Records corresponding to motion phases of the machine and vice versa. The control signal controls the machine tool in a closed control loop and a systematic comparison phase, recorded on a cassette tape with electrical phase of the metering selsyn.
c) Management software used to enter the control program information medium in the shape of the wearer's portable information most often perforated paper tape and innuendo.
d) Numerical control, which is the culmination of a program-controlled machine tools, allows for the fastest entering the control program and machine settings. Its hallmark is the application of digital metering tracks.

Economic program-controlled deployment of these types of machines and better adaptability settings defined area of production for medium size batches and for numerically controlled machines for small-lot and piece production. Since the mass production characteristic inflexible (hard) automation differs mainly by its flexibility and allows settings to automate the area of piece, from medium-sized and small-lot production.

METHODS OF PROGRAMMING OF NUMERICALLY CONTROLLED MACHINES

NC Programming is a challenging and highly skilled work, which is the inclusion in the technical preparation of production. This is a relatively new field of activity, created the deployment of NC machines into production. It requires not only practical knowledge of machining technology especially in the field of the technique, and the sequence of operations in individual operations, but also select the optimum cutting tools, designing cutting parameters etc. The quality control program is influenced knowledgeable programmer functions NC programming and control systems. With increasing levels of technical complexity and technology are increasing demands on adequate skills and knowledge programmer. High intensity and complexity of managing programs for the continuous control systems, where at NC machines must be assumed even more simultaneously controlled axes increasingly requires recollection of programmer's work, with a significant risk of error. Therefore, it focused attention on the possibility of creating control programs, particularly for CNC machine tools in the environment of CAD/CAM, which is characterized by the full possibility of continued creation of CNC programs from basic drawing components.

Then the creation of the program comprises two steps:

a) CAD part, which is defined by the closed contour machined workpiece based on downloaded information from the drawing or CAD system solid modeling,
b) CAM part, which is generally the application of appropriate programs created automatically by the control program for the CNC machine or dialog To create your own CNC program with the possibility of being completed and amended (Tolerances, normalized undercuts etc.).

CNC machines programming is done in two ways:

» system online, directly on the CNC machine shop programming (SAP Shop Floor Programing),
» offline programming, outside the part of the program control system, most often by means of the CAM system, but can be manually.

Reasons for the introduction of offline programming with a focus on CAD / CAM are:

a) NC Programming is a challenging and highly skilled services in TPV,
b) requires a practical knowledge of machining technology, particularly in the technique,
c) with increasing technical complexity and the complexity of the technology increases the demands on the skills and knowledge programmer associated with significant risk of error,
d) focus on the possibility of creating control programs, particularly for CNC machine tools in the environment of CAD / CAM, which is characterized by fully traceable creation of CNC programs from specified parts of the drawing or CAD solid modelers.

This procedure can solve the problems of formation control program in the form of a computer modeling approach for complex shapes and then generate control programs for machine tools, figure 3.

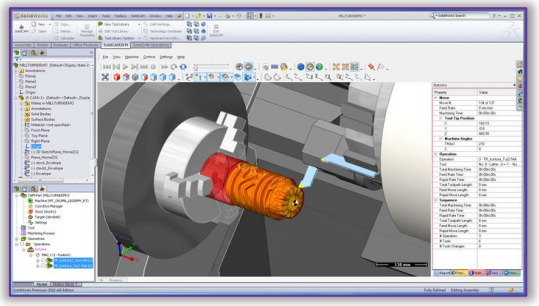

Figure 3. Preview with CAD system

The control panel is used for communication between the operator and the machine control system, fig. 4. With it inserts the operator in the control system commands control program and special machine parameters. The control panel has a display, keyboard, buttons for special functions and knobs. Manual control programmatically controlled machines (NC and CNC machines) is performed using a variety of control surfaces that are different for control systems. The control panel is used for communication between the operator and the machine control system. Manual control of NC and CNC machines is performed by each special buttons on the control panel. Use the buttons can be triggered manually all machine functions. Panel buttons are provided with graphical symbols to indicate control functions numerically controlled machines. Key designations are determined by standards (eg. To DIN 55003) and consist of the basic signs and additional functions. Signs are divided into tags for machine control and construction program. Used symbolic signs facilitate orientation and allow to overcome the problem of the language barrier.

Figure 4. The control panel - Sample dashboards

CONCLUSION

This article shows a rapid development of manufacturing technology over the last few decades. This development obviously affects the whole range of industries, including NC machining. Programs to create 3D applications (CAD) enables very fast and efficient design of components and the whole assembly. Thus created 3D models can then be used in the CAM programs for the creation of control program for CNC machines. Team falls off time-consuming manual programming.

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Reference

[1.] http://www.newtechsolutions.pl/produkty/systemy-cam/solidcam/
[2.] KOCMAN, Karel. Speciální technologie obrábění . Brno: CERM, ISBN 80-214-25628
[3.] NESLUŠAN, M. Experimentálne metódy v trieskovom obrábaní . Žilina : EDIS, 2007.
[4.] http://www.sjf.tuke.sk/vitralab/upload/CNC%20prirucka_CZ.pdf
[5.] Virtual machining on horizontal machining centre with rotary table / Peter Demeč - 2012. In: International Scientific Herald. Vol. 3, no. 2 (2012), ISSN 2218-5348

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