WORKSHOP PROGRAMMING AS A PART OF TECHNOLOGICAL PREPARATION OF PRODUCTION

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ABSTRACT

The article deals with the application of workshop programing system - Sinumerik Operate 840D SL in technological preparation of production. Application of the system in real situation pointed out on several problems and disadvantages of the system. The article contains a comparison of the effectiveness between workshop programming, ISO programming, and CAM system programming. Sinumerik Operate was used as a control system at a milling machine EMCO Concept Mill 105.

Keywords: Sinumerik Operate 840D SL, workshop programing, EMCO machine tool.

INTRODUCTION

At present, three types of programming methods are used to develop NC programs, ISO programming, workshop programming and CAM programming. All these types impose requirements for operators at a machine or programmers in the CAM system. Writing a program manually requires a good knowledge of the ISO code. For complicated shapes CAM system can be used, but the programmer must know how to work with a chosen system. Workshop programing allows to create NC programs for complex but simple components. Workshop programing is also called "conversational programming" [1–4].

After a purchase of Sinumerik Operate 840D SL control system applying this system for machine tool EMCO Concept Mill 105 was necessary. This machine tool is used for teaching in Laboratory of Machine Tools Programming Department of Automation and Production Systems (DAPS). The article deals with the application of workshop programming in manufacturing process. The solution includes verification of the control system Sinumerik Operate 840D SL for the production of components through experimental components. Part of verification is also a comparison of the effectiveness of the use of this method for creation of NC programs [5–8].

DESCRIPTION OF EQUIQMENT MACHINE TOOL

Machine EMCO Concept MILL 105 (Fig. 1A) is a training machine designed to teach programming and operation of CNC machines. The tool change is done by a tool turret equipped with 10 stations. The work area allows to use a work piece with dimensions in X-axis 200 mm, in Y-axis 150 mm, effective height of Z axis is 150 mm. The machine tool can be controlled by several control systems, e.g. Sinumerik 810D/840D, Heidenhain TNC 426/430, Sinumerik Operate 840D SL and others. WinNC serves like host for emulation control systems and allows to install up to nine control system. All systems are controlled with interchangeable control panels (Fig. 1B) and control keyboards [8–11].

INTERCHANGEABLE CONTROL PANEL

Interchangeable control panel (Fig. 1B) allows user to change the control keyboards accord-

Fig. 1. EMCO Concept Mill 105 and interchangeable control panel

ing to the selected control system. Change can be made quickly and it takes only a few seconds. Interchangeable panel can be connected to any Concept machine or PC. In Figure 2 all control keyboard owned by Department of Automation and Production Systems are shown, A – Heidenhain TNC 426/430, B – Sinumerik 840D, C – Sinumerik Operate 840D SL. Each keyboard has specific layout and keys with specific functions.

WORKSHOP PROGRAMMING

Workshop programming allows users to easily program complex components, even without knowledge of ISO codes. This type of programming is encountered mainly for lathes and milling machines. It is most suitable for a wide range of components with simple shapes in pieces or small series production.

Basic features and characteristics workshop programming can be separate into several groups:

- Efficiency and intuitiveness – dialogue between operator and system,
- User friendly interface – inputs fields including animated elements,
- Simulation of the machining process – simulation of the machining process, toolpath and collision between tool and work piece.
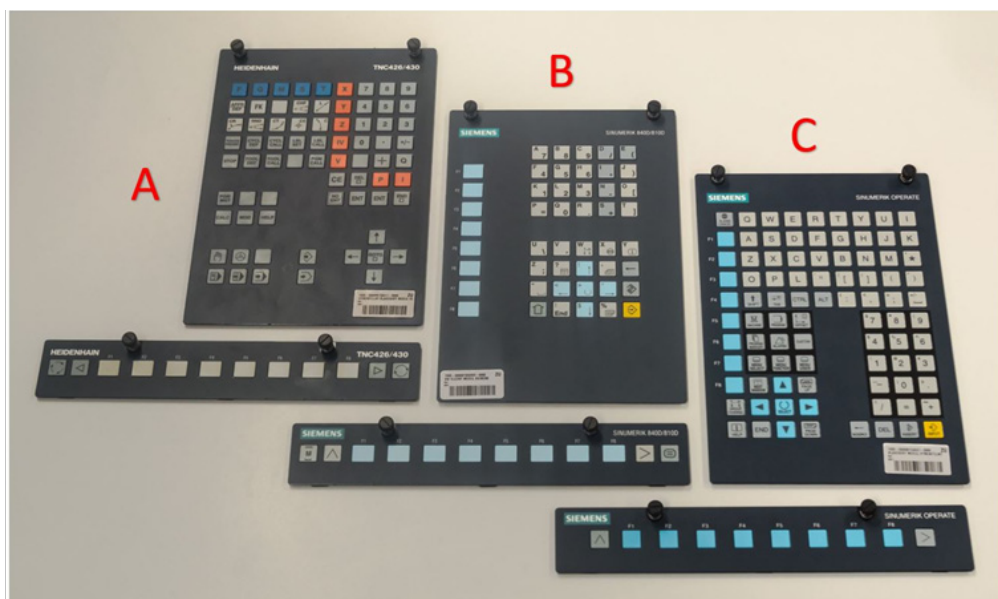

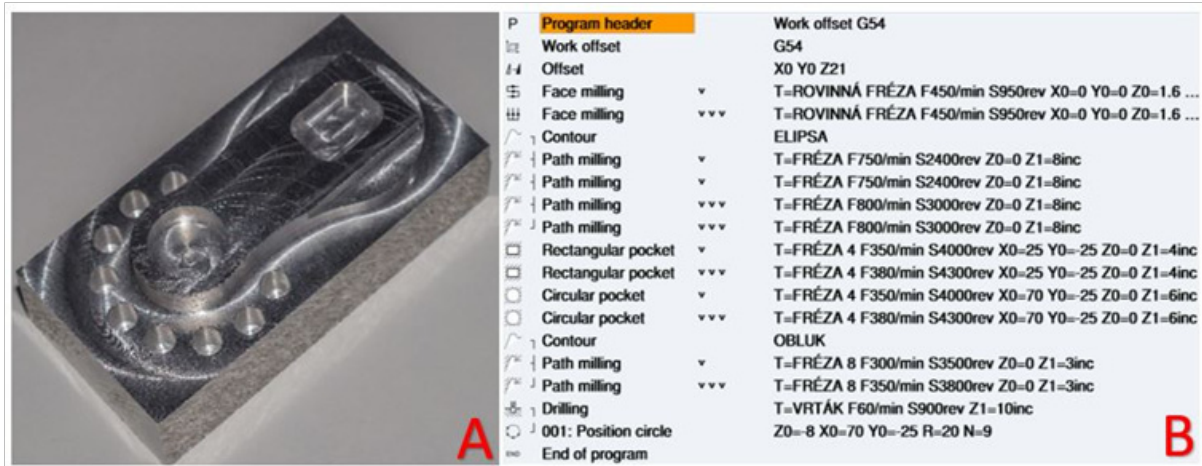**Fig. 2.** Control keyboards for interchangeable control panel

Fig. 3. First component and NC program in Sinumerik Operate 840D

APPLICATION AND VERIFICATION OF WORKSHOP PROGRAMMING AT EXPERIMENTAL MILLED PART PRODUCTION

For verification of Sinumerik Operate 840D SL was used a group of components with similar shapes. From this group were selected three components for further experimentation - component no. 1, 2, 3. The experimental components were designed to verify the accuracy and effectiveness of using different cycles in their production. The main purpose of verification was to verify functionality of the available cycles.

The first component (Fig. 3A) represents a group of components which use more machining cycles, e.g. the cycles for machining spigots, pockets and drilling holes. Geometric properties of pockets are entered inside of the cycles. There is no need to define a contour of pockets. In Fig-

ure 3B is shown the NC program with all cycles. The second type of component (Fig. 4A) includes machining cycle for pocket and drilling. Manufacturing process was created in order to verify the functionality of both cycles. In Figure 4B is shown machining cycles for pockets with defining dimensions of pocket. The third type of component (Fig. 5A) contains different cycle for machining pocket. This cycle requires the definition of contour and it was verified in the production of circular spigots. In Figure 5A is shown in NC program with defined contour for milling of spigots.

All experimental components contain cycles for drilling holes. Patterns of holes are different e.g. on first component a circular pattern was used, On second and third components square and rectangular patterns were used. The experimental components were created by using workshop programming Sinumerik Operate 840D SL. They were further used to compare the efficiency
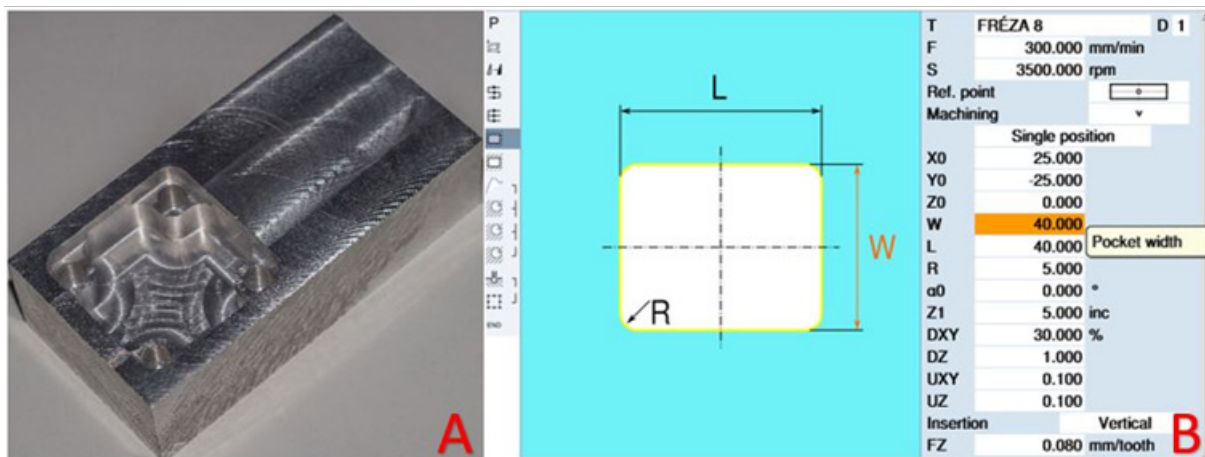

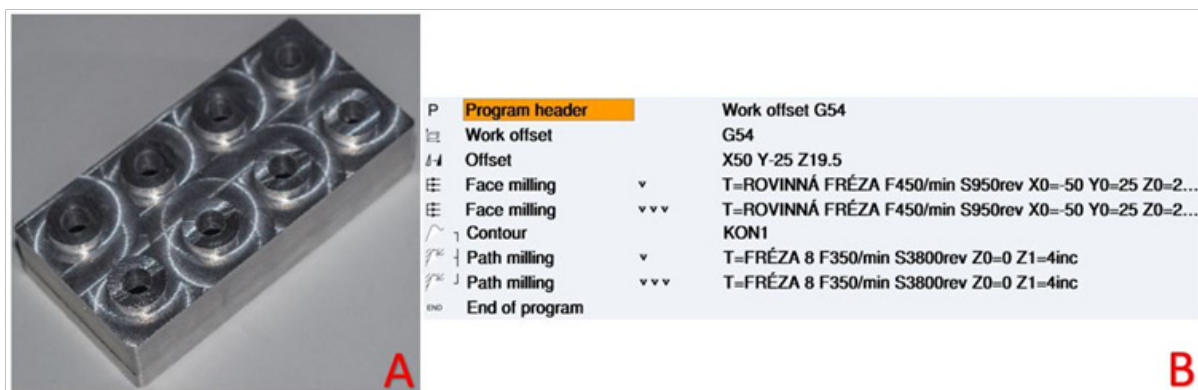**Fig. 4.** Second component and dimensions of regular pocket

Fig. 5. Third components and NC program with defined contour for milling of spigots

between ISO programing and CAM programing (Chapter Comparison of efficincy between types of programming).

COMPARISON OF EFFICINCY BETWEEN TYPES OF PROGRAMMING

Four systems were chosen for a comparison of the effectiveness of creation of NC programs. Specifically, Sinumerik 840D and Sinumerik Operate 840D SL, which are part of the training interface WinNC from EMCO Group and two CAD/CAM systems Edgecam 2013 and PTC Creo 2 (Both CAD/CAM systems are used on DAPS).

It is necessary to consider a few facts at comparison between systems:
- appropriateness of the system – shape complexity of components,
- knowledge and skills of the operator or programmer,
- limits of the system – it can influence the functionality of the final NC program
- step of generating NC program (within the CAD/CAM – model, design, code generation optimization program).

Based on these facts, two comparative methods were selected:
- The time required for preparation of the NC program.
- The number of steps needed to create the NC program.

The time required for preparation of the NC program

The comparison was made in the two groups. In first group ISO programing and workshop programing were compared, so workshop pro-

graming can be used as a replacement for ISO programing.

From table (Table 1) and graph (Fig. 6), it can be seen that the system of workshop programming needs less time for NC program preparation. From the perspective of the knowledge of the ISO code Sinumerik Operate 840D SL is less demanding for an operator than Sinumerik 840D. Second comparison is a comparison between workshop programing and CAD/CAM systems.

In Figure 7 it can be seen that CAD/CAM system Edgecam allows a programmer to create NC program faster, but it requires greater demands on the knowledge and experience of programmer.

The number of steps needed to create the NC program

This comparison compares the number of steps required to create NC program. (Initial state – draft of the parts). Comparison contains of the workshop programming and CAD/CAM systems Edgecam 2013 and Creo 2.0. Principle of creating NC program, for all programming methods, is consisted of the same steps as: setting the zero point, face milling, drilling holes, roughing and finishing operations.

A comparison between workshop programming and CAD/CAM systems (Fig. 7 and Tab. 2)

Table 1. Time for preparation NC programs in Sinumerik Operate and Sinumerik 840D

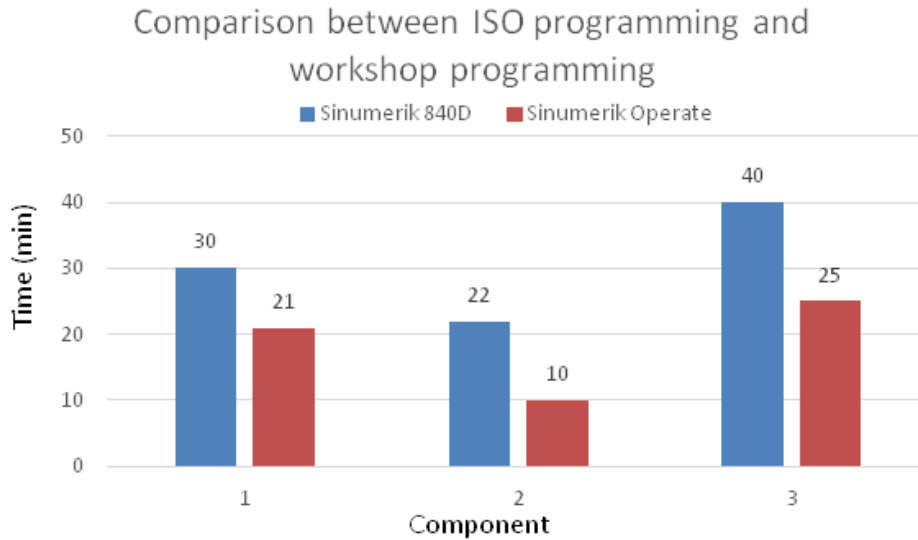| Component	Sinumerik 840D	Sinumerik Operate 840D SL	Difference
1.	30 min	21 min	10 min
2.	22 min	10 min	12 min
3.	40 min	25 min	15 min

Fig. 6. Comparison between ISO programming and workshop programming on three experimental components
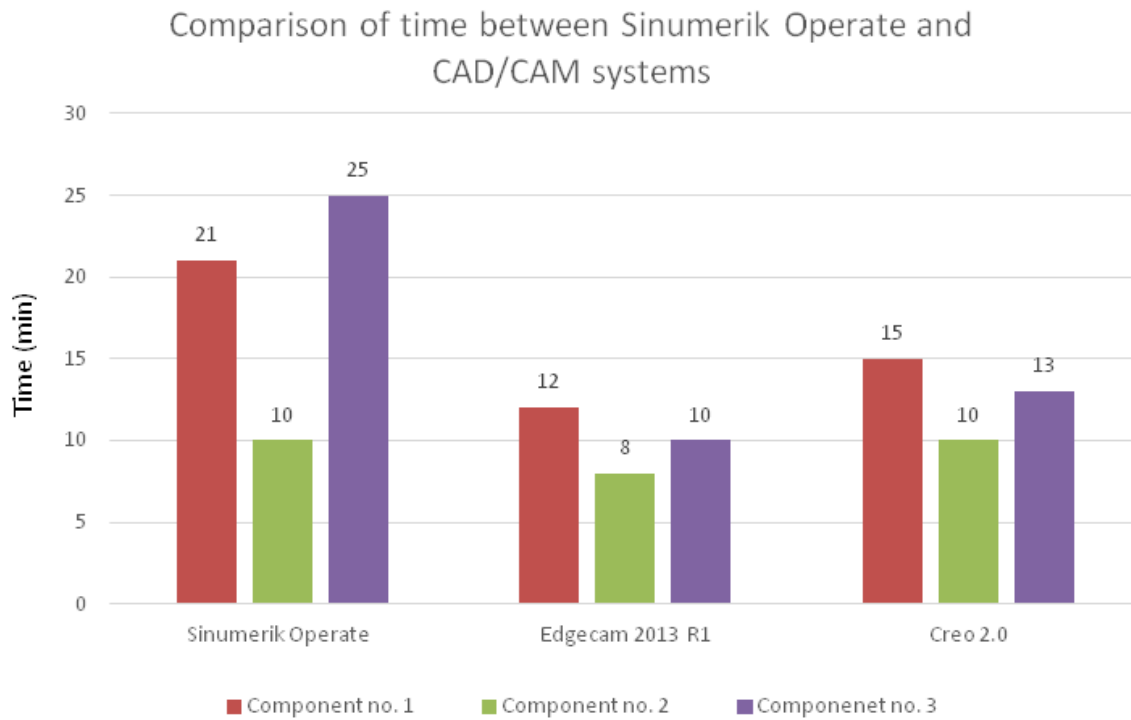

Fig. 7. Comparison of time between Sinumerik Operate 840D and CAD/CAM systems

illustrates the difference in the preparation of the NC program with regard to the degree of chosen systems but it disregarded shape-complexity of components. It is also needed to take into consideration the level difficulty of working with CAD/CAM systems. Although work in CAD/CAM systems Creo 2.0 and Edgecam required less time (Fig. 7) for preparing the NC program, these systems increase the demands on the programmer, compared to the workshop programming Sinumerik Operate 840D SL, which can use the operator of the machine tool.

CONCLUSIONS

The results include verification of the control system Sinumerik Operate 840D SL for the production of components. During creation of NC programs by using workshop programing Sinumerik Operate 840D SL some drawbacks have been found. These drawbacks have influence the development of NC programs and they must be considered in the course of work with system.

The main weaknesses include missing cycle Spigot from menu Contour milling and also less

Table 2. Number of steps required to create NC programs

Steps	Operate	EdgeCam	Creo 2.0
Creation of model	-	1	1
Creation/Setting of work-piece	1	1	1
Setting of zero point	1	1	1
Setting of fixture	-	1	1
recognition of shapes/contours	1	1	1
Setting of cycles/operations	1	1	1
Simulation	1	1	1
Selection of prosprocesor	-	1	1
Generation of NC program	-	1	1
Optimization of NC program	-	1	1
Transfer of NC program	-	1	1
Number of steps	5	11	11

number of available cycles compared Sinumerik Operate 4.5 by Siemens AG. After consultation with the distributor of the EMCO machines it has been found that the current version of Sinumerik Operate 840D SL does not support same cycles. The limited number of cycles available may have an impact on the preparatory times mentioned in chapter Comparison of efficincy between types of programming. These drawbacks can be eliminated with additional system updates.

After verification of workshop programing Sinumerik Operate 840D SL during producing of experimental components, were defined the current system capabilities. Also they were specified current limits of system for further experimental research thesis and projects. The comparison between different types of programming and systems shows the differences in creation of NC programs. The comparison of results points to a principle and possibilities of this type of programming.

Acknowledgement

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